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CARBON FOOTPRINT OF PANDORA CHARMS – 2024

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1. EXECUTIVE SUMMARY

This report is a cradle-to-grave carbon footprint study according to the international standard for carbon footprints of products (ISO 14067:2018), this study follows the general methodology in the standard for life cycle assessment (LCA) (ISO 14044:2006). The study assesses two charms from Pandora.

The report presents scientifically based carbon footprint information for the two charms. The purpose of this study is to communicate the results for marketing purposes. The results are not intended to be used for comparisons between the charms or other competing products, nor are any other comparative assertions made in this study. The application of the results is to be used in business-to-consumer communication. Any communication to consumers should follow the requirements of ISO 14026:2017 (Principles and guidelines for footprint communication).

The two assessed charms are a Family Tree, one made of sterling silver, the other of 14k gold. The analysis is for the entire life cycle of each charm, covering raw material acquisition, crafting processes, use phase, end-of-life phase, and transport. The greenhouse gas emissions are calculated and reported as carbon dioxide equivalents (CO_2e). Both charms are made with recycled silver or gold. The total carbon footprint of the charms is presented in Table 1 and the charms are shown in Figure 1.

Table 1 The assessed charms and the carbon footprint per charm

SKU no.	Name	Charm weight (g)	Carbon Footprint (kg CO_2/charm)
797590	FAMILY TREE STERLING SILVER CHARM	2.05	0.23
759132C00	FAMILY TREE 14K GOLD CHARM	2.06	0.33

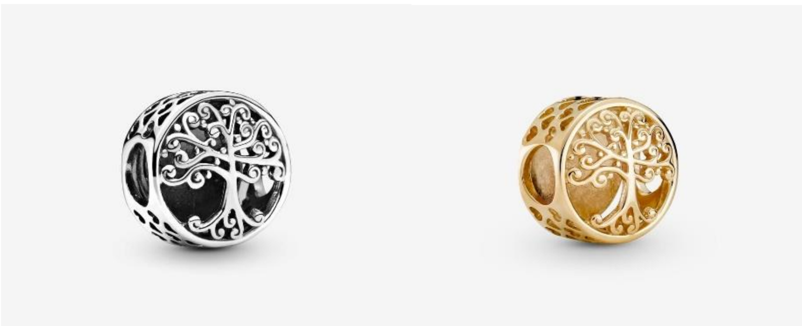

Figure 1 Family Tree sterling silver charm (on the left) and Family Tree 14K gold charm (on the right). Photos: Pandora (2023)

In the main study, the results show that the primary contributor to the carbon footprint is the raw materials of the silver charm and the use phase of the gold charm. Second and third largest impacts are use phase and transport to store of the silver charm. Second and third largest impacts for the gold charm are raw materials and transport to store.

This study has some limitations that might affect the results. In general, assumptions have been made conservatively following the precautionary principle to avoid underestimating the impact of unknown data. The results in this study are potential and not predictions of impacts.

One general limitation with any carbon footprint study is that it does not include other resource uses and environmental impact categories. This limitation could lead to an impact shift between life cycle phases or other impact categories when intended measures are applied to lower the carbon footprint.

2. GOAL AND SCOPE

Two charms assessed in this study are produced with 100% recycled silver and 100% recycled 14K gold. The charms are produced at the Pandora crafting site in Thailand and shipped to distribution centres around the world.

This study is a cradle-to-grave carbon footprint study according to the international standard for carbon footprints of products (ISO 14067:2018), this study follows the general methodology in the standard for life cycle assessment (LCA) (ISO 14044:2006). Relevant PCR or CFP-PCR could not be found. The report presents scientifically based carbon footprint information for the declared charms. The purpose of this study is to communicate the results for marketing purposes. The results are not intended to be used for comparisons between the charms or other competing products, nor are any other comparative assertions made in this study. The application of the results is to be used in B2C – Business-to-consumer – communication. The target group is primarily media outlets and consumers. Any communication to consumers should follow the requirements of ISO 14026:2017 (Principles and guidelines for footprint communication).

2.1 Products assessed

The study assesses two jewellery charms from Pandora, and the declared unit is one charm, see section 2.2. Two products are assessed in this study: one Family Tree sterling silver charm (further called silver charm) and one Family Tree 14K gold charm (further called gold charm). The charms' specifications are presented in Table 2, and the charms are shown in Figure 2.

Table 2 The assessed charms

SKU no.	Name	Charm weight (g)	Primary metal
797590	FAMILY TREE STERLING SILVER CHARM	2.05	Sterling silver
759132C00	FAMILY TREE 14K GOLD CHARM	2.06	14K gold

Figure 2 Family tree sterling silver charm (on the left) and Family tree 14K gold charm (on the right). Photos: Pandora (2023)

2.2 Declared unit

The declared unit for this cradle-to-grave study is **one metal charm** with a life span of 50 years.

2.3 System boundaries

The system boundaries are illustrated in Figure 3. The cradle-to-grave carbon footprint study includes all life cycle phases of the charm's life cycle. The life cycle stages included are charm crafting, use phase, end-of-life phase, and all transports. Two end markets are assessed for the charms based on each largest market, i.e., Spain for the silver charm and the US for the gold charm. The raw material and end-of-life impact of the charm packaging is included. Note that the burdens of the recycling process and benefits of recycling are not included in the main study, see 2.4. Each of the stages is described further in Chapter 3.

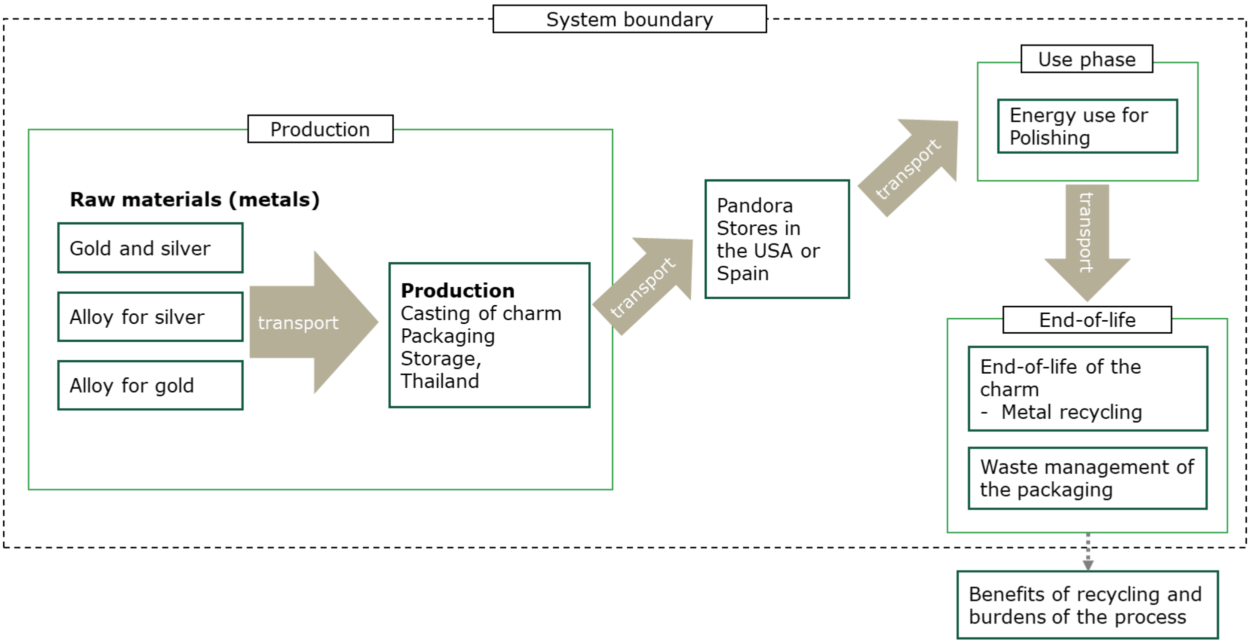

Figure 3 Simplified flow chart illustrating the flows, cradle to grave, between the processes and locations for both charm variants.

2.3.1 Time boundary

The life span for the charms is set to be 50 years; this is an assumed service life. Characterisation factors for the global warming potential represent a 100-year perspective. This study's expected validity and representativeness are assumed to be five years or as long as no major changes occur within the scope. The study is based on data concerning the charms produced and sold during 2023 and should be used only for these charms. The crafting of the charm is based on 2022 data while the sales data (to determine the largest market for the charms) is based on YTD November 2023.

2.3.2 Nature

The cradle boundary to nature includes material extraction, i.e., mining. However, there are no cradle boundaries to forestry or agriculture or grave boundaries to long-term emissions from landfills.

The greenhouse gas emissions are calculated and reported as CO_2-equivalents (CO_2e) and the GHG emission gases are not separately reported. Emission factors used in this study are assumed to contain all the relevant greenhouse gas emissions outlined in the standard for carbon footprints of products (ISO 14067:2018). Biogenic GHG emissions and removals are not reported separately since the biogenic share is insignificant compared to the dominating fossil GHG emissions.

2.3.3 Geography

The charms are produced in Thailand, with the raw materials coming from other places worldwide. Although, the charms are sold globally, this study is limited to the largest market of each charm. The US (for the gold charm) and Spain (for the silver charm) are set as end markets in this study. Specifications of, e.g., material origins are listed in chapter 3. The local aspects were considered whenever relevant and possible (e.g., local electricity mix).

The environmental impacts of all activities in the life cycle are included regardless of geographic location. The sensitivity of the recipient environment in question is not relevant for climate-related environmental impacts.

2.4 Allocation and assumptions

Total electricity consumption and auxiliary materials at the charm crafting location are allocated per mass of charm. At the crafting in Lamphun, Thailand, many kinds of jewels are produced with a variety in mass and materials; it would therefore be inaccurate to allocate the annual energy use per piece. Hence, the annual electricity used during 2022 at the crafting site is allocated on the total mass of jewellery produced during 2022. The oven used during casting is 100% electric.

The allocation method used for recycled materials is the cut-off approach. This method means that the recycled metal used as a resource in the charms carries no burden from before the point it enters the recycling process. At the end-of-life, when the metal enters the metal recycling process, the charms carry the environmental burden until the metal reaches a recycling facility. ISO 14067 Informative Annex D (ISO, 2018) suggests other allocation principles, e.g., the closed-loop allocation. Therefore, a sensitivity analysis has been completed to explore the potential differences between the allocation approaches, see section 4.1.2 and 4.2.2.

2.5 Cut-off

The study does not include the production of capital goods, e.g., factories, vehicles, and Pandora stores.

2.6 Environmental impact categories

This study used the LCIA method IPCC AR6 2021 GWP100, whenever study-specific calculations were made.

2.7 Interpretation

The findings of the inventory analysis and the impact assessment are evaluated concerning the defined goal and scope to reach conclusions and recommendations. The main results are presented and analysed per charm. No comparisons are made between the charms since this is not the purpose of the study. The analysis of the contribution of different life cycle stages, separate processes, and materials is done to identify areas of potential improvement. Two sensitivity analyses were carried out for both charms to evaluate the effect of the Renewable Energy Certificate (REC) compensation (see section 3.3) and the choice of allocation method.

2.8 Data quality

The data quality of the foreground data (collected figures) is evaluated as good regarding raw material supply, casting, and transport to store since it is primary data collected from Pandora. The foreground data is good regarding time, geographical, technological coverage, and precision. The casting data is site-specific, as required by the standard for processes under Pandora's control. Based on conservative assumptions, the data quality regarding the use phase and waste management is adequate.

The data quality of the background data (representativeness of emission factors) is evaluated as good on average, especially regarding datasets used for significant processes. The background data is good regarding time and geographical coverage, and adequate regarding technological coverage and precision. The emission factors are adapted to represent a life cycle emission factor when needed. More on study and data limitations in section 4.3.

2.9 Data collection procedures

This study is attributional. Whenever relevant and possible, specific data was collected from Pandora and its suppliers. All the environmental data for processes are generic. The limitations due to data selection and quality are presented in section 4.3. In general, assumptions have been made conservatively following the precautionary principle to avoid underestimating the impact of unknown data.

The specific crafting data is collected from Pandora's crafting site in Thailand. The specific manufacturing data is for the year 2022. All otherwise not specified data is collected from Pandora. Section 3 presents the inventory and some specific information regarding data collection.

The data used for the carbon footprint of the recycled and primary gold and silver are from the study done by Sphera Solutions GmbH (2020). Literature and datasets for secondary, recycled metals and auxiliary materials are studied in the Sphera Solutions GmbH study, and recommendations are made on which data is the most relevant for Pandora's supply chain (Sphera Solutions GmbH, 2020). The data for the other metals in the alloys, and other materials not included in the above study are based on Ecoinvent version 3.9.1 (2023) and Sphera Professional Database, as implemented in LCA for Experts version 10.7.1.28 (Sphera, 2023).

The carbon footprint data for transport included in this study are from the UK Government GHG Conversion Factors for Company Reporting (UK Government, 2023). The data for road transport includes both fuel production and combustion emissions. The emission factor for freight flight includes fuel production and operation emissions, including the indirect effects of non-CO_2 emissions. The distances for road transport are according to the longest route recommended by Google Maps (Google, 2023). The distances for air transport are according to Flight Connections, direct flight when possible, and transit when necessary (Flight Connections, 2023).

The electricity mix used at the suppliers is a low voltage mix for the Thailand market; the data is from Ecoinvent 3 (2023), the cut-off alternative, as implemented in LCA for Experts version 10.7.1.28 (Sphera, 2023). The data for auxiliary materials is based on a literature study by Sphera Solutions GmbH (2020), UK Government GHG Conversion Factors for Company Reporting (UK Government, 2023), and Ecoinvent 3 (2023), as implemented in LCA for Experts version 10.7.1.28 (Sphera, 2023). A few of the auxiliary materials were left out due to dataset gaps, see section 2.5.

The data for incineration (cardboard and plastic in the packaging) is based on Ecoinvent 3 (2023), as implemented in LCA for Experts version 10.7.1.28 (Sphera, 2023).

2.10 Critical review

The critical review is a process intended to ensure consistency between a carbon footprint study and the principles and requirements of ISO 14067. This assessment is not classified as a comparative assertion as defined in ISO 14044:2006, and a critical review by a review board is therefore not mandated.

Apart from internal review and quality control by Ramboll, a third-party review is applied in this project to verify that the assumptions, data used, and statements made in this assessment are clear and well founded.

The third-party review was performed by: Viktor Hakkarainen, CHM Analytics
Viktor.hakkarainen@chm-analytics.com

Viktor is an expert in life cycle assessment (LCA) and founder of CHM Analytics AB. Since 2020, he has successfully authored and reviewed over 30 LCA reports and over 60 Environmental Product Declarations (EPDs) for a wide range of products including furniture, windows, solar panels, data centre cooling, dehumidifiers, steel products, concrete, asphalt, biochar, PVC carpets, plastic products, ballast, and kitchen hoods. Viktor is an approved individual verifier in the EPD International and EPD Norway systems.

3. LIFE CYCLE INVENTORY

Included stages of the life cycle and parts of the crafting stage are described below in detail, including some specific information about data collection.

3.1 Metals

Recycled gold and silver grains are used and supplied by a supplier in Bangkok and one in Switzerland. The alloys consist of primary copper and other primary metals**Error! Reference source not found.**. The alloys are supplied by a supplier in Germany. **Error! Reference source not found.**

3.2 Transport of raw materials

The transportation of the metals and alloys from outside Thailand is done by air. A diesel van was assumed for all road transport between airports and sites. That is, from the supplier's production facility to the nearest airport and from the airport to the Pandora crafting site in Lamphun, Thailand.

3.3 Crafting of Charms

The Pandora crafting site receives the main metals, alloys, and auxiliary materials from suppliers.

The crafting of the charms begins with the crafting of the wax charm copies, these are cast in a reusable rubber mould, see Figure 4. The wax copy of the charm (see Figure 4) is the exact shape of the charm with an added holder that is attached to a wax tree.

Figure 4 Reusable rubber moulds and wax copies of charms and other jewels including the holder.

The wax trees are placed in a metal cylinder and filled with gypsum powder, see Figure 5. The cylinders are placed in an oven where the heat makes the wax melt and pour out of the gypsum mould. Left in the gypsum cylinder is a charm mould. Melted metals are poured into the mould and the charms are cast, see Figure 5.

Figure 5 First figure from the left shows the wax trees in the metal cylinder filled with gypsum. The middle figure shows cylinders being placed in an oven. Figure on the right side show the casting.

The gypsum surrounding the charms is cleaned away and the metal holder part is cut away. All metal holders and metal spruces are recycled and reused in the metal melt. Since it is assumed that the spruces can be remelted unlimited times their impact is not added to the raw material carbon footprint. The charms are tumbled, polished, black oxidized, and finally cleaned before being packed.

An individual charm is packed in a small bag, and then collected in larger zip-lock bags. All zip-lock bags are labelled with a ribbon label. The cardboard boxes are stored at the Pandora crafting site in Lamphun before being transported to different distribution centres around the world, see section 3.4 for more information.

The electricity mix used at the Pandora crafting site is 100% solar power through on-site and Renewable Energy Certificate (REC) compensation. The documentation is provided for review. Most auxiliary materials used during crafting are specified and used in the study. Some of the auxiliary materials were left out due to dataset gaps, see section 2.5.

3.4 Transport to stores

From Pandora’s storage facility in Lamphun, all the charms are transported to specific distribution centres for each market and then to the stores. For this study, one end market is chosen for each charm. The final stores are chosen based on being the highest seller of each charm. The end market for the silver charm is Madrid in Spain and the end market for the gold charm is New York in the US. The route to the end markets begins in Thailand. All charms are first flown to New Delhi, India then to Köln, Germany.

3.5 Use phase

The Pandora stores in Madrid and New York do have a carbon footprint. However, if the carbon footprint is allocated to all jewellery stored and sold at the store the impact per charm would be small or insignificant. It is assumed that the impact of the store is negligible.

It is assumed that customers do not travel only to visit Pandora stores, but rather in conjunction with other errands. Therefore, the impact connected to customers' transport to the store is assumed to be insignificant.

The use phase includes polishing the charms. Based on information from Pandora, it is assumed that professional polishing is done once every five years for both charms, excluding the last use phase year, i.e., nine polishings. The energy consumption for the polishing is calculated from the energy consumption of a buffing machine per minute and the time for one polishing. The time for one polishing was assumed to be 5 minutes. No transportation is included for the polishing as it is assumed that this is done in combination with other errands.

3.6 End-of-life phase

At the end-of-life phase, the charms are assumed to be sent for recycling. The gold is recovered from the 14K gold charms, and silver is recovered from the silver charm.

No burdens of the recycling process or benefits of recycling are included in the study, following the cut-off approach allocation method, see 2.4.

The end-of-life of all the packaging (plastic bags and carton) is included in the study. The charms' packaging is sent to end-of-life management, the carton is recycled and the plastic bags are incinerated at both end markets. The transportation to the recycling facility is included (for the charm and packaging), and the impact is calculated based on the emission factor for waste transportation (UK Government, 2023).

3.7 Sensitivity analysis

This section presents the background for the analysis for estimating the effects of the choices made regarding electricity mix and allocation method on the outcome of the main study.

3.7.1 Electricity mix for cutting and polishing

Pandora has purchased Renewable Energy Certificates (RECs) for the electricity used during 2022 at the Lamphun casting site. The documentation supporting this is provided for review. This change makes the casting of the charms to be produced with 100% renewable energy (solar power), which is reflected in this study. However, according to the 14067 standard (ISO, 2018), a sensitivity analysis should be done in cases using green electricity certificates. Therefore, sensitivity analyses without using REC for casting are included in the study. In this case, a low voltage Thailand mix is used for the casting.

3.7.2 Allocation method

The allocation method used for recycled materials is the cut-off approach. However, the informative Annex D (ISO, 2018) suggests other allocation principles, such as closed-loop allocation and open-loop allocation; therefore, a sensitivity analysis was done using closed-loop allocation to explore the potential differences in the results.

The closed-loop allocation of recycling applies when the material is recycled back into the same product life cycle or recycled into another product but without a change in inherent material properties. Since gold and silver are recycled without much change in the material, a closed-loop approach could be applicable in this study. The closed-loop approach suggested by ISO 14067 (informative Annex D) implies bearing the full burdens of recycled materials as if they were primary and getting credit for the share that is then recycled at the end of life. Thus, using recycled material is assigned the same burdens as using primary material. For the sensitivity analysis, emission factors for virgin gold and silver were used instead of the emission factors for recycled/secondary emission factors used in the main study. The burdens and benefits of recycling silver and gold were included during the end-of-life phase.

The gold recovery rate in the 14K gold charms is assumed to be 90% (Gold.info, 2023; Sphera Solutions GmbH, 2020), and the silver recovery rate in the silver charm is 90% (Wilts, et al., 2015). The silver in the gold charm is assumed not to be recovered. The other metals, e.g., materials in the alloys, are assumed not to be recovered. This omission is a conservative assumption to avoid overestimating the benefits of recycling. Hence, no credit is given for recycling the alloys.

4. RESULTS

The results from the main study are presented for each charm together with one sensitivity analyses concerning the allocation approach.

4.1 Sterling silver charm

The carbon footprint of the entire life cycle of the silver charm is calculated to be 0.23 kg CO_2e/silver charm. The total impact and distribution between different life cycle stages are presented in Figure 6 and Table 3 below.

Table 3 Carbon footprint of the sterling silver charm, unit kg CO_2e, and life phase share of total

Raw materials	Crafting	Transport (cradle-to-gate)	Transport to store	Use phase	End-of-life	TOTAL
0.086	0.021	0.002	0.044	0.077	0.002	**0.23**
37%	9%	0.7%	19%	33%	0.9%	**100%**

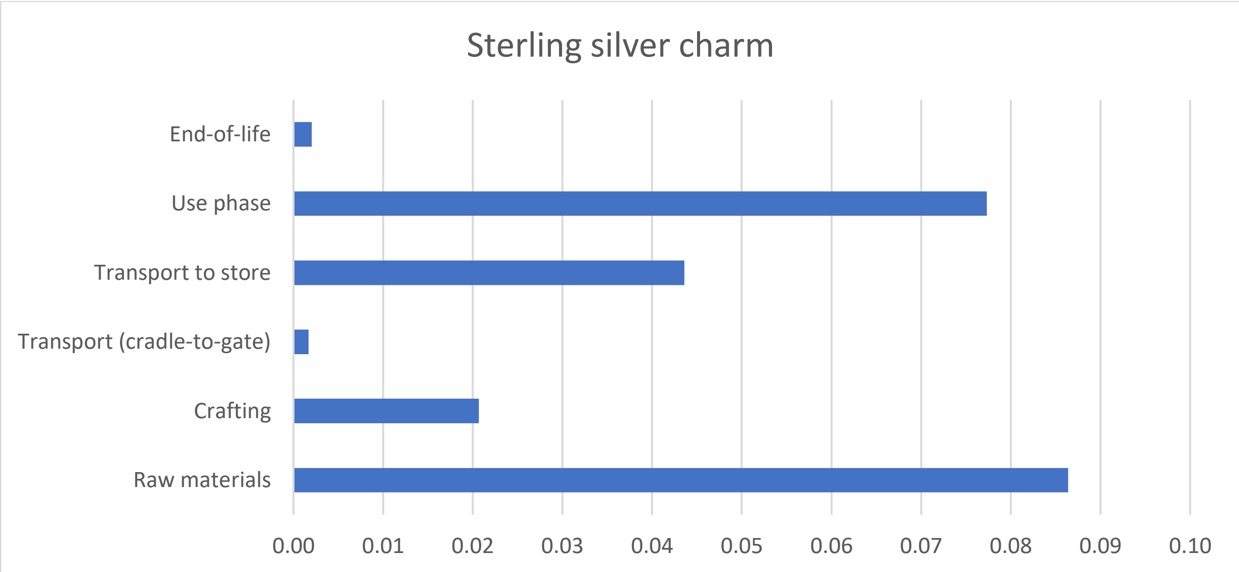

Figure 6 Carbon footprint of the sterling silver charm, unit kg CO_2e

As illustrated in Figure 6, the largest contributor to the carbon footprint is the raw materials of the silver charm. The impact during the raw material phase is almost completely dominated by the carbon footprint of the recycled silver, approximately 98% of the total raw material impact. The second largest impactful life cycle phase is the use phase followed by the transport to store impacts. During the use phase the charm is assumed to be polished every five years during the 50-year lifetime. The electricity used for the polishing is a Spanish electricity mix since the end market for the silver charm is Spain.

The impact during crafting is dominated by the impact of gypsum and rubber mould for the wax casting impact of approximately 29% and 28 % respectively. The third largest impacts during casting are due to the electricity used, approximately 24%, i.e., the REC solar power.

4.1.1 Sensitivity analysis - electricity mix for casting

The sensitivity analysis comprises using Thailand grid electricity for the casting process instead of renewable (solar power) energy with RECs. The results are presented in Figure 7 and show that the total carbon footprint of the silver charm increases with 75% without the use of RECs in the casting process. Hence, the choice of energy used for silver charm casting dramatically impacts the overall result.

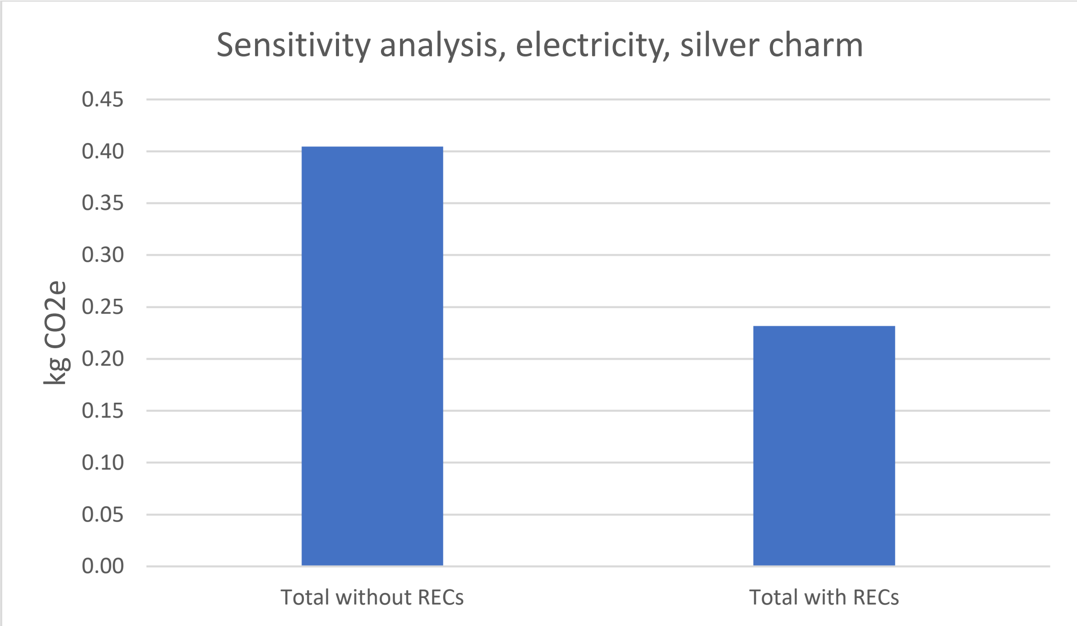

Figure 7 Carbon footprint of a silver charm without and with the use of RECs for the casting process

4.1.2 Sensitivity analysis – allocation

The sensitivity analysis results with the closed-loop allocation are presented in Table 6 and

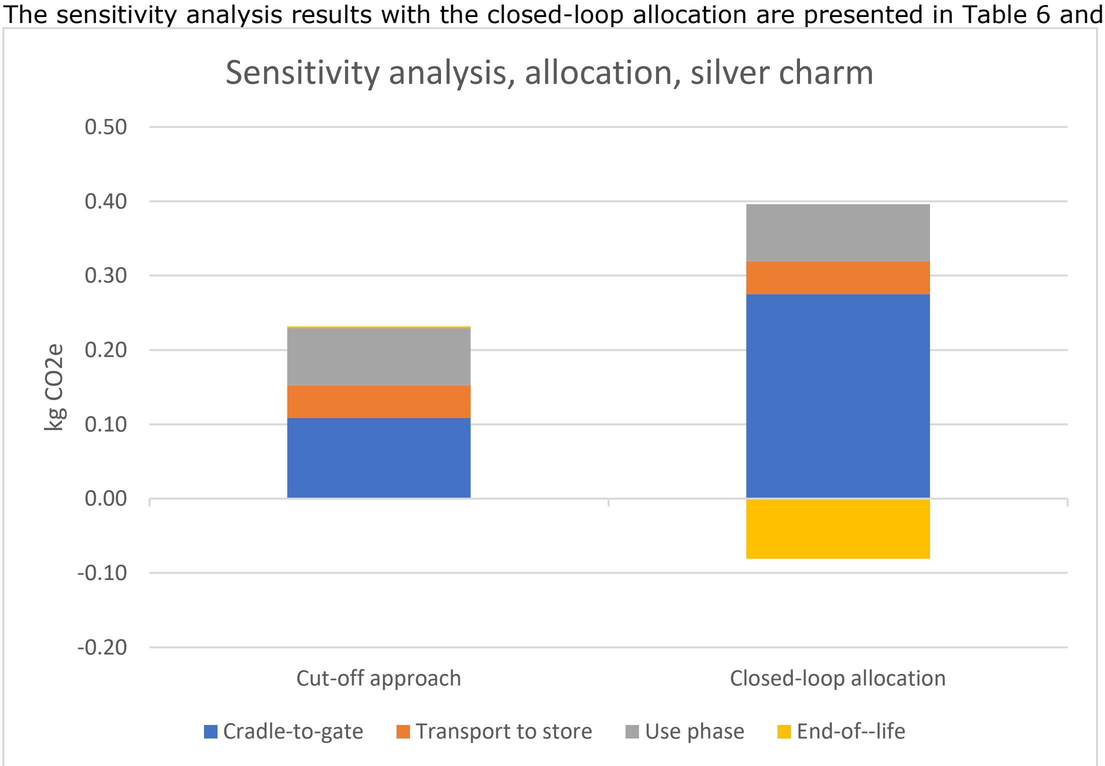

Figure 8. The closed-loop allocation is calculated with virgin silver. During the end-of-life phase both the benefits of recycled material and burdens of the recycling process are included in the closed-loop allocation. Hence, the avoided burden of virgin silver gives a negative impact due to that 90% of the silver is recycled. The overall carbon footprint over the entire life cycle is higher when using closed-loop allocation than the cut-off approach. The closed-loop allocation leads to a higher impact from the raw materials since there is no benefit of using recycled content. When considering only cradle-to-gate impacts (first row in

Table 4), the cut-off approach leads to a slightly lower carbon footprint compared to the closed-loop allocation approach.

Table 4 Results of the sensitivity analysis with the closed-loop allocation compared to the cut-off approach, unit kg CO2e/silver charm

	Sterling Silver Charm	
	Cut-off approach	Closed-loop allocation
Cradle-to-gate	0.109	0.275
Transport to store	0.044	0.044
Use phase	0.077	0.077
End-of-life	0.002	-0.081
Total	**0.232**	**0.316**

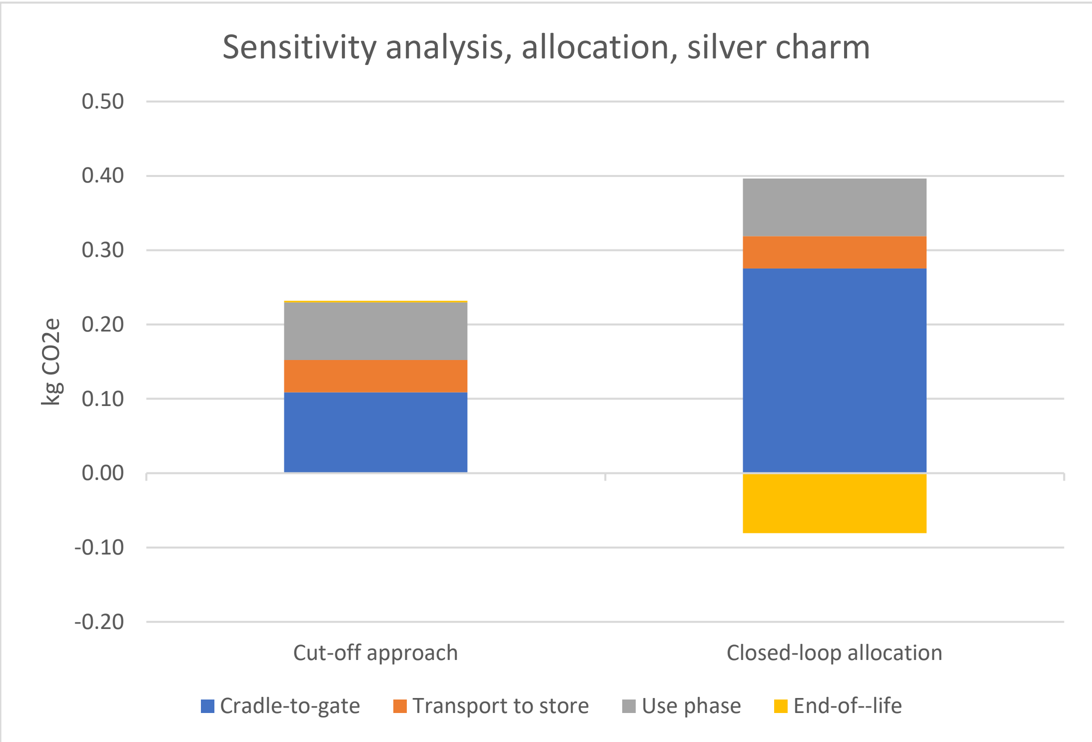

Figure 8 Carbon footprint of a silver charm with two allocation approaches, unit kg CO_2e/silver charm

4.2 14K gold charm

The carbon footprint of the complete life cycle of the 14K gold charm is calculated to be 0.33 kg CO_2e. The impact distribution between different life cycle stages is presented in Table 5 and Figure 9.

Table 5 Carbon footprint of the 14K gold charm, unit kg CO_2e, and life phase share of total

Raw materials	Crafting	Transport (cradle-to-gate)	Transport to store	Use phase	End-of-life	TOTAL
0.078	0.023	0.023	0.068	0.133	0.002	**0.33**
24%	7%	7%	21%	41%	0.6%	**100%**

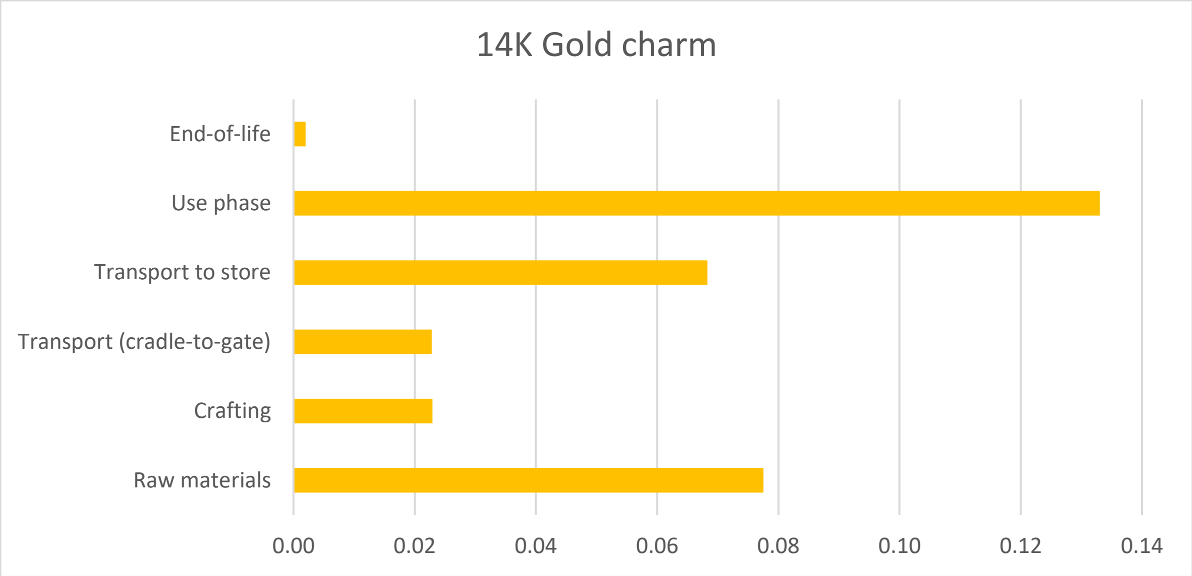

Figure 9 Carbon footprint of the 14K gold charm, unit kg CO_2e

Figure 9 illustrates that the carbon footprint is dominated by the use phase. During the use phase the charm is assumed to be polished every five years during the 50-year lifetime. The electricity used for the polishing is a US electricity mix since the end market for the gold charm is the US. The second largest impactful life cycle phase is raw materials closely followed by the transport to store impacts. The impact during the raw material phase is dominated by the carbon footprint of recycled gold, approximately 86% of the raw material impact.

4.2.1 Sensitivity analysis - electricity mix for casting

The sensitivity analysis comprises using Thailand grid electricity for the casting process instead of renewable (solar power) energy with RECs. The results are presented in Figure 7 and show that the total carbon footprint of the gold charm increases with 53% without the use of RECs in the casting process. Hence, the choice of energy used for silver charm casting dramatically impacts the overall result.

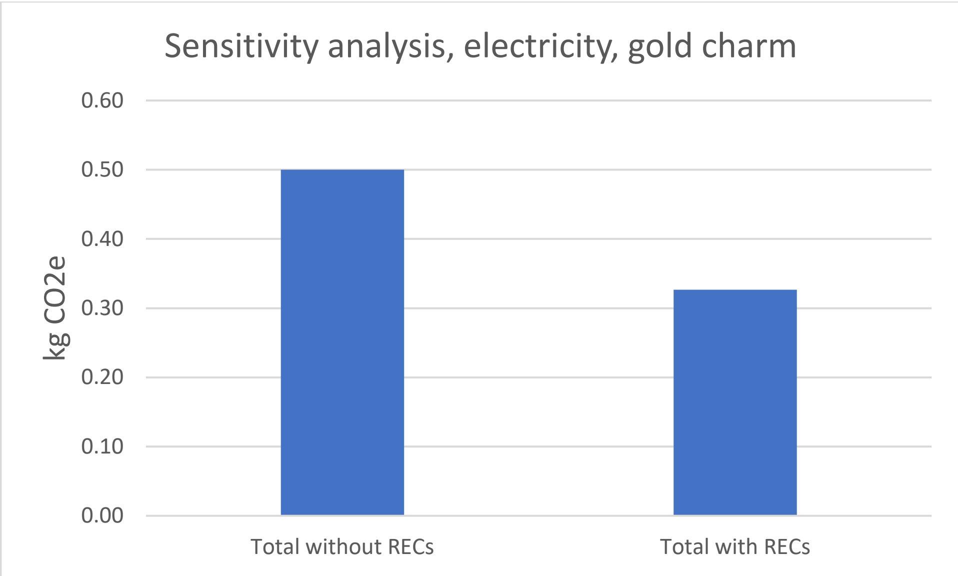

Figure 10 The total carbon footprint of a gold charm without and with the use of RECs for the casting process

4.2.2 Sensitivity analysis – allocation

The sensitivity analysis results with the closed loop allocation are presented in Table 6 and Figure 11 below. The closed-loop allocation is calculated with virgin silver and gold. During the end-of-life phase both the benefits of recycled material and burdens of the recycling process are included in the closed-loop allocation. Hence, the avoided burden of virgin gold gives a negative impact due to that 90% of the gold is recycled. The overall carbon footprint over the whole life cycle is higher when using closed-loop allocation due to the accounting for burdens of virgin metals, which is not included when using the cut-off approach allocation method. The cut-off approach leads to a significantly lower carbon footprint when only considering the cradle-to-gate phases.

Table 6 Results of the sensitivity analysis with the closed-loop allocation compared to the cut-off approach, unit kg CO_2e

	14K Gold Charm	
	Cut-off approach	Closed-loop allocation
Cradle-to-gate	0.123	46.585
Transport to customer	0.068	0.068
Use phase	0.133	0.133
End-of-life	0.002	-40.135
Total	**0.327**	**6.651**

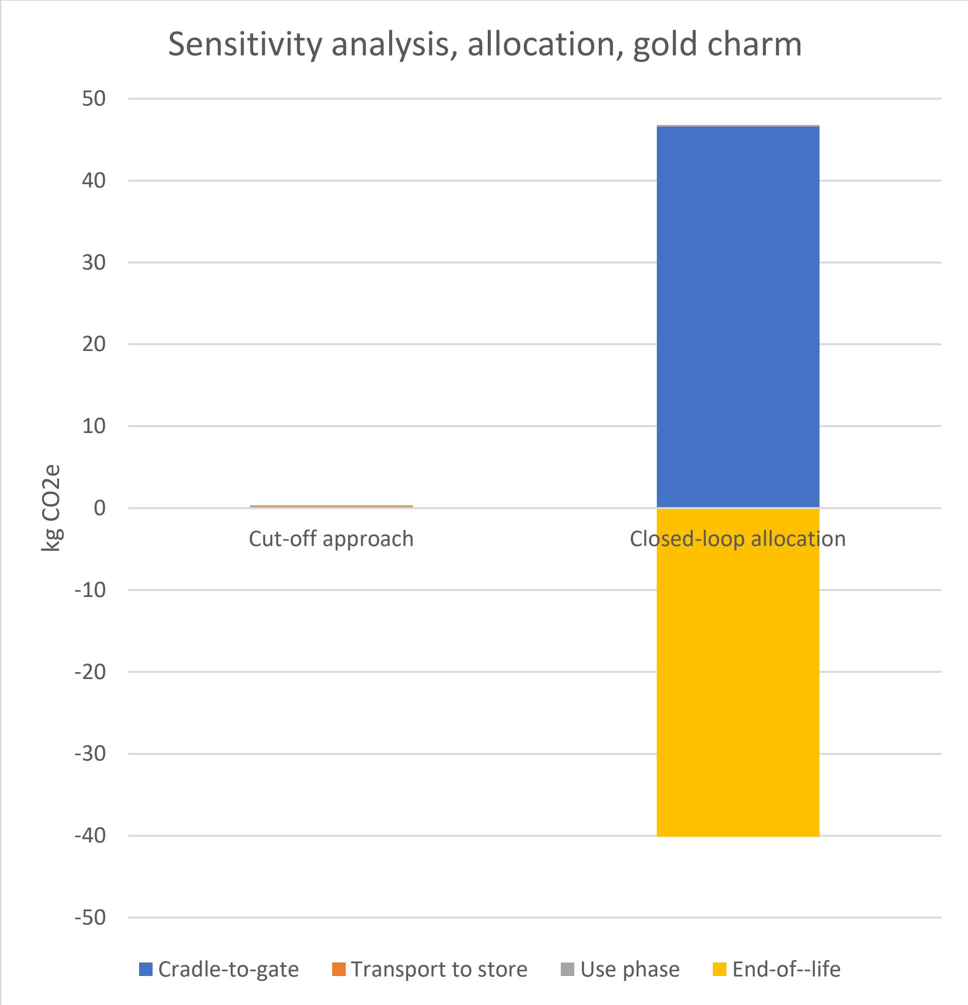

Figure 11 Carbon footprint of a 14K gold charm with two allocation approaches, unit kg CO2e

4.3 Limitations

This study has several uncertainties and limitations that might affect the results. These could be a consequence of, e.g., data gaps and quality. In general, assumptions have been made conservatively following the precautionary principle to avoid underestimating the impact of unknown data.

The explicit underlying greenhouse gases, e.g., CH_4 and N_2O, are not presented or calculated separately. This limitation means that the contribution of different greenhouse gases is unknown. It is unclear what emissions are accounted for and, consequently, the transparency of this study is affected. There might also be an inconsistency between the characterisation factors in this study and referenced study from Sphera Solutions GmbH (2020).

Several auxiliary materials used during the crafting could not be given a specific emission factor (EF) due to limitations in current datasets and published sources. To avoid a data gap and underestimating the impact of the auxiliary materials, a proxy EF was calculated from the average EF of all identified auxiliary material EF. The proxy might be an overestimation or an underestimation, but it was considered a better choice than to have a data gap. There are some minor uncertainties concerning the transportation routes for the charms. Conservative assumptions regarding transport mode and distance are made to decrease the risk of underestimating the impact. The raw material emission factors using the "market for" version includes the downstream transport of the material. In this study, it is assumed that the "market for" transport is to the supplier. The transports included in this study are the transports from the supplier to Pandoras site in Lamphun. There is a risk of double accounting the transport impact. However, it is important to show the difference in impacts between the charms due to that the silver charm raw materials are only transported by road while most of the gold charm raw materials are also transported by air.

The impacts of the Pandora retail store are assumed to be insignificant. The retail impacts are to be allocated to all jewellery stored and sold at the shop, and the impact shared by a charm is assumed to be small or insignificant. Hence, the final effect on the result is minor.

The customer's transportation to a store and a jeweller for polishing is assumed to be insignificant. It is assumed that visits to a Pandora store are done together with other errands, and the impact of that transportation is shared between the different activities making it small or insignificant. However, if a customer would drive a car specifically to go to a Pandora store, that would significantly affect the total carbon footprint of the charm. It could be argued that since Pandora cannot influence the customer's travelling habits directly, the impact of customer transport should be omitted from this study either way.

One general limitation with any carbon footprint study is that it does not include other resource uses and environmental impact categories. This limitation could lead to an impact shift between life cycle phases or other impact categories when intended measures are applied to lower the carbon footprint.

5. CONCLUSIONS AND DISCUSSION

The carbon footprint was calculated cradle-to-grave for two charms, and the results for the main study and sensitivity analyses are presented and discussed.

The total carbon footprint of the Family Tree sterling silver charm is 0.23 kg CO_2e.

The total carbon footprint of the Family tree 14K gold charm is 0.33 kg CO_2e.

In the main study, the results show that the primary contributor to the carbon footprint is the raw materials of the silver charm and the use phase of the gold charm. Second and third largest impacts are use phase and transport to store of the silver charm. Second and third largest impacts for the gold charm are raw materials and transport to store. The reason the gold charm emissions connected to polishing during use is higher than for the silver charm is due to the higher carbon footprint of the US electricity mix compared to the Spanish electricity mix.

To lower the emissions, it would decrease the carbon footprint significantly if the electricity mix used during the professional polishing at a Pandora store is from a renewable source. Naturally, if the polishing is done by another actor, then Pandora does not have any right to decide regarding the electricity mix.

5.1 Sensitivity analysis – electricity

ISO 14067 (§6.4.9.4.4) states that a sensitivity analysis with average grid data should be made when green certificates are used in a country where such certificates can be sold without excluding the renewable energy from the supplied (residual) mix. The report includes a sensitivity analysis where average grid data are used for electricity in Thailand, instead of REC data for solar power. Without the use of RECs for the casting process, the impact of the silver charm would increase by 75% and increase by 53% for the gold charm carbon footprint.

5.2 Sensitivity analysis – allocation

The allocation choice is less critical if the whole life cycle is considered, but the impact differs depending on the approach. The closed-loop allocation approach results in a higher impact for both of the analysed charms. This difference is due to the raw materials since there is no benefit to using recycled content. However, accounting for the benefits of recycling leads to a moderately lower carbon footprint, though not as low as the cut-off approach. The choice of allocation method also showed a higher impact on the gold charms' carbon footprint. The carbon footprint for virgin silver is almost three times higher compared to recycled silver, while the carbon footprint of virgin gold emits more than 600 times more carbon than recycled gold.

The sensitivity analysis concerning the allocation choice shows that the impact of the main metals (gold and silver) is relatively low owing to the recycled content. The overall impact would be significantly higher if virgin metals were used instead of recycled.

In this study, the total electricity consumption and auxiliary materials at the charm crafting location are mass allocated per charm. The allocation could also potentially be based on economic revenue of the charms in relation to the total revenue. Since the gold charm has a higher revenue value an economic allocation would allocate more impact on the gold charm compared to the silver charm. However, according to Pandora the crafting process electricity and auxiliary materials needed are similar between the two charms. Therefore, the increased impact allocation on the gold charm would be unfair. This study has some limitations that might affect the results. In general, assumptions have been made conservatively following the precautionary principle to avoid underestimating the impact of unknown data. The results in this study are potential and not predictions of impacts.

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7. REVIEW REPORT

Review report	
For CF of:	Pandora charms
CF commissioned by:	Pandora A/S
CF Authored by:	Katja Tasala Gradin, Ramboll Yevgeniya Arushanyan, Ramboll
CF report Date:	2024-01-09
Reviewed documents:	Charm Calculation 2024-01-09 to 3partyreview.xlsx Pandora Charms CF 2024-01-09.docx
Critical review iteration number:	3
Previous critical review iterations:	**2023-12-21 – Review 2** **Reviewed documents** Charm Calculation 2023-12-22 to 3partyreview v3.xlsx Pandora Charms CF 2023-12-22 to 3partyreview v2.docx **2023-12-15 – Review 1** **Reviewed documents** Pandora Charms CF 2023-12-12 to 3partyreview v2.docx Charm Calculation 2023-12-13 to 3partyreview v2.xlsx Data collection 2023-12-13 for 3partyreview.xlsx IREC_Redemption_Statement_Pandora Thailand 2022.pdf
Critical reviewer:	Viktor Hakkarainen
Reviewer filiation:	CHM Analytics AB
Reviewer contact details:	Viktor.hakkarainen@chm-analytics.com

This critical review is performed according to ISO 14044 chapter 6.2 (Critical review by internal or external expert) and ISO 14071.

The review has been performed at the end of the CF study.

The review has included an assessment of the LCI model.

The review has included a sampling of individual datasets.

The CF study at this point of the critical review (iteration 3) is in conformance with the standards noted below:

Standard	Compliant
ISO 14040:2006	Yes
ISO 14044:2006	Yes
ISO 14067:2018	Yes
ISO 14071:2014	Yes

7.1 Review report on carbon-footprint study of pandora charms

Viktor Hakkarainen, Gothenburg, January 11th 2024

To keep a coherent reporting template between CFP studies commissioned by Pandora, this review statement is based on the review report structure given by Tomas Ekvall in the review of Pandora Brilliance[1]

Summary

This carbon-footprint (CFP) study is based on the international standard for CFP: ISO 14067:2018. The methods used in the calculations are consistent with the standard for all relevant results. The foreground data collected directly from Pandora is transparently reported and the background data choices are representative of the relevant flows. The calculations are transparent and adheres to the EULA for the used databases.

The report does not strictly follow the requirements for third-party reporting as written in ISO 14044:2006 but from the scope of the study, it is also not relevant in this case. The report does also not fulfil all formal requirements (I.e., all "shall" clauses) of ISO 14067:2018, but those requirements that are not fulfilled are also not relevant to the scope of the study (such as disaggregated reporting of GWP).

The results and interpretation are thoroughly written and well-analysed. All assumptions, cut-offs and evaluation of data quality are explained and justified.

The study follows the cut-off (also called Polluter-Pays) approach in the study which is the most relevant aspect regarding the results. If the study would follow the closed-loop approach as detailed in ISO 14067:2018 annex D, the results would be more than 2 000% higher.

This review has not assessed the report and results in regard to ISO 14026:2017 (Communication of footprints). If any public communication of the results from the footprint is performed, it is recommended to follow the requirements of ISO 14026.

Background

The jewellery company Pandora commissioned Ramboll to compare the carbon footprint (CFP) of a gold and a silver charm. The study is made using the methodology of the international standard for carbon footprints of products (ISO 14067:2018), which in turn is based on the standard for life cycle assessment (LCA; ISO 14044:2006). The results will be used for marketing purposes but are not intended to be used for comparisons between the charms or with other competing products. Due to EU legislation on green claims, Pandora needs a 3rd party verification of the environmental claims that will be based on the CFP calculations. As of the green claims proposal adopted by the EU commission in March 2023, it is stated that an independent verifier needs to be accredited. The green claims text does not yet specify what this implies but an independent verification of a CFP is beneficial regardless. ISO 14067 requires that a review, if any, is conducted according to ISO/TS 14071.

The focus of this review was on:

- The consistency with the methodology in ISO 14067:2018
- The collected foreground data and chosen background data
- The performed calculations
- The relevance of the scope and results of the study

[1] Carbon footprint of Diamonds by Pandora collection, 14th of August 2022
Authors: Katja Tasala Gradin, Yevgeniya Arushanyan
Third party verifier: Tomas Ekvall

- The performed interpretation; and
- The validity of the conclusions, given the goal, scope and limitations of the study.

The review also addressed the completeness of the report in relation to the formal requirements in ISO 14044 and ISO 14067, and the transparency and technical validity of the report. ISO 14044 (§5.2) requires that a transparent third-party report be made available to any external party to which the results are communicated. Section 5 in ISO 14044 and Section 7 in ISO 14067 details what should be included in such a report. The review was made in three rounds. A first set of comments was written based on a preliminary full CFP report from Ramboll, and a second review found all amendments satisfactory except a small detail about the cut-off criteria for auxiliary materials which was adjusted for the final report. This final review report is based on a revised report for internal use at Pandora. The publicly available report will exclude confidential information that is available in the internal report.

Due to the quick work by staff at both Ramboll and Pandora, all of the review comments have been adequately dealt with before this final review statement.

All formal comments and requirements can be seen in the full review document.

7.2 Critical review statement summary

I hereby confirm that, following the checks performed, in accordance with the limits of the scope of our appointment, nothing has come to the independent third-party reviewer's attention to suggest any data errors or deviations from the requirements by the above-referenced CF and its project report, in terms of the underlying data collected and used for the CF calculations, the way the CF-based calculations have been carried out to comply with the calculation rules, the presentation of environmental performance included in the CF, and any other information included in the declaration.

I confirm that, in accordance with the limits of the scope of our appointment, the company-specific data has been examined as regards plausibility and consistency. The declaration owner is responsible for its factual integrity and that the product does not violate relevant legislation.

I confirm that I have sufficient knowledge and experience of charms and the region where they're produced for the CF to carry out this review.

I confirm that I have been independent in my role as a reviewer i.e. I have not been involved in the execution of the CF or in the development of the declaration and have no conflicts of interest regarding this critical review.

Name and organisation of reviewer:	Viktor Hakkarainen, CHM Analytics AB
Approval date	2024-01-11
Location	Gothenburg
Signature: