


Life cycle assessment of Bona floor refinish

Including: Parquet, Vinyl and Linoleum flooring with Traffic HD, Pure HD, Pure Colour, LinoPrime and Classic UX



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Summary

This is the report for a life cycle assessment (LCA) study comparing the environmental impact of Bona refinish process and a floor replacement process. The analysis was done on three different floor types: parquet (wood), vinyl (PVC) and linoleum. The analysis of refinish includes five different Bona products: Classic UX, Traffic HD, LinoPrime, Pure Colour and Pure HD. The comparative LCA study was carried out by IVL Swedish Environmental Research Institute on behalf of Bona AB.

The overall goal of the study is to identify and estimate the environmental benefits of refinishing floors instead of tearing the floors out and replacing them with new flooring. To do so the following goals must firstly be achieved:

- To assess the environmental impact of Bona products for the refinish process
- To assess the environmental impact of Bona refinish process

The following functional unit were used: *100m² and 20m² of flooring over 15 years*

The environmental and resource impacts assessed for the refinish and replacement of flooring were Global warming potential (GWP), Eutrophication potential in freshwater (EP), Acidification, Photochemical ozone creation potential (POCP)m Total use of non-renewable primary energy (PENRT) and Total use of renewable primary energy resources (PERT).

The results show that from a climate perspective is it desirable to use refinish rather than replacing with new flooring for all flooring types. When replacing the floor the GWP was between 5 and 12 times higher for parquet, 9 and 10 times higher for vinyl and 4.4 and 7.7 times higher for linoleum compared to refinishing the existing flooring with Bona products.

From the perspective of primary energy resources used, refinishing was better than replacement as well. More specifically, in terms of PENRT, it was between 5 and 12 times better to refinish parquet floor than to replace it, circa 14 times more advantageous to refinish vinyl floor and 3 to 6 times better to refinish linoleum floor rather than replace it.

When it comes to PERT, parquet refinishing showed the highest potential benefit when refinishing instead of replacing, namely between 150 times and 393 times less renewable energy sources were needed for refinishing. Refinishing vinyl floor lead to 18 to 21 times fewer renewable resources used, while linoleum refinishing was 54 to 88 times more advantageous.

Two sensitivity analyses were conducted for all three refinishing scenarios, focusing on GWP. One assessed the effect of the electricity mix used for sanding and vacuuming, and the other examined the craftsman's round-trip travel distance to the site. When the electricity mix was changed to a 50/50 split between coal and natural gas, the climate impact increased by 6% for parquet, 4% for vinyl, and 3% for linoleum. In contrast, doubling the craftsman's round-trip travel distance from 20km to 40km resulted in larger increases: 18% for parquet, 16% for vinyl, and 16% for linoleum. These results indicate that, within this study, transport distance has a greater influence on climate change impact than regional variations in electricity mix.

These findings support the conclusion that floor refinish with Bona products offer a significant lower environmental impact than floor replacement across all assessed flooring types. To further reduce environmental burdens, Bona may consider optimizing product formulations and promoting the use of local craftspeople to limit transport emissions.

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1 Introduction

1.1 About this report

This report presents a comparative Life Cycle Assessment (LCA) study evaluating the environmental impacts of **floor refinishing** versus **floor replacement**. In this study, floor refinishing refers to increasing the lifespan of the flooring by sanding and applying a new finish to the existing floor. The study was conducted by IVL Swedish Environmental Institute on behalf of Bona AB, a company whose products are manufactured in Malmö, Sweden. The refinishing scenario was modelled as taking place in Germany to better reflect the conditions on a global market.

Primary data for the production of Bona's products and for the refinishing processes were provided by Bona AB. For the replacement scenarios, publicly available Environmental Product Declarations (EPDs) from major suppliers in the German flooring market were used to represent the production and disposal of new flooring materials. Which EPDs to include in the comparison was decided by Bona AB.

The study was initiated in November 2024 and completed in July 2025. It builds on a previous co-funded project involving Bona AB and The Swedish Institute for Water and Air Pollution Research (SIVL), which included a comparative LCA in a Swedish context and the development of a roadmap for improved resource efficiency within the flooring sector (Tegstedt & Ahlm, 2020). The results from this study are not directly comparable to those of the previous study by Tegstedt and Ahlm (2020), as a new standard for EPDs has since been introduced, and the modelling approach has been updated and conducted in greater detail. The increased level of detail in the modelling provides Bona with a more nuanced understanding of the environmental impacts associated with both their products and the refinishing scenarios. Furthermore, the results for Bona's products will not be identical to those presented in their published EPDs, as this study is based on a different background database.

The main purpose of this study is to support internal decision-making and communication within Bona AB. However, the results may also be used in external communications, particularly for customers seeking to understand the

environmental differences between refinishing and replacing the assessed flooring types. This report has not undergone third-party critical review but has been subject to IVL's internal review system.

1.2 What is LCA

Life cycle assessment (LCA) investigates the environmental impacts related to a product or a system during its whole life cycle. This includes evaluating energy and resource consumption as well as emissions, from all life cycle stages including material production, manufacturing, use and maintenance, and end-of-life (Figure 1).

LCA is a widely used and accepted method for studies of environmental performance of various products and systems. The LCA in this report is performed in accordance with ISO 14040:2006 (International Standard Organisation, 2006) and ISO 14044:2006 standards (International Standard Organisation).

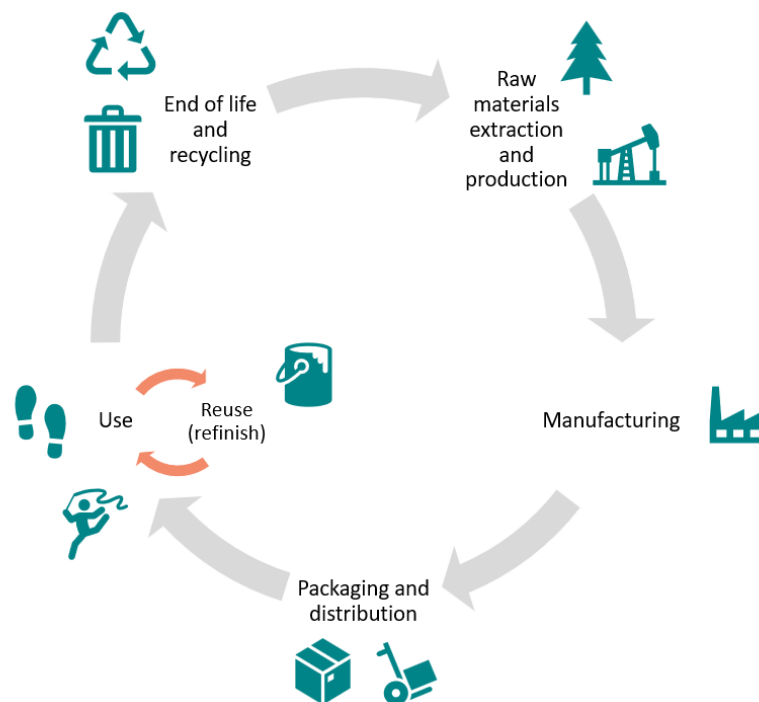


Figure 1: Illustration of the LCA-system.

The results of an LCA help identify which life cycle stages contribute most significantly to the total environmental impact of a product. This insight can guide efforts to reduce impacts, for instance by extending product life or improving

production efficiency. If the production or end-of-life phases show particularly high environmental burdens, extending the product's lifespan—such as through maintenance or refurbishment—can be an effective strategy for reducing overall impact. In the context of flooring, refinishing instead of replacing may be such a strategy, provided that the environmental impacts associated with refinishing are lower than those of producing and disposing of new flooring. This is the core question assessed in this study and the preceding project.

It is important to note that the results of an LCA are context specific. They are valid only within the defined system boundaries, assumptions, and data quality used in the study. Results should not be generalized beyond the scope of this analysis.

When LCA results are presented, they are typically broken down into environmental impact categories. Each category captures a specific type of environmental burden, such as climate change, eutrophication, or photochemical ozone formation. This is necessary because a product or process may contribute differently to each category—potentially reducing impact in one area while increasing it in another. For this study, the selection of impact categories was made by Bona in consultation with IVL, resulting in the following choices:

- Climate change, fossil
- Eutrophication, freshwater
- Acidification
- Photochemical ozone creation potential
- Total use of renewable primary energy resources (PERT)
- Total use of non-renewable primary energy resources (PENRT)

Details on the chosen impact categories are provided in Appendix B.

Comparative LCA allows for the evaluation of alternative solutions that provide the same function, such as refinishing versus replacing a floor, under consistent methodological conditions. This enables stakeholders to make informed decisions based on environmental trade-offs. However, comparative LCA also comes with limitations. Results are highly sensitive to the defined functional unit, system boundaries, data sources, and assumptions. Therefore, transparency and consistency are critical, and sensitivity analyses should be conducted to test the robustness of the conclusions. It should also be noted that the results of this study are not directly comparable to those of the previous project, as methodological

updates have been made, including the use of a new EPD standard and higher modelling detail.

2 Goal and scope

In this chapter the goal and scope of this LCA is defined and explained. The goal and scope should act as guidelines to perform the assessment as well as helping the reader of the report to understand key assumptions, system boundaries, limitations and other aspects influencing the results. Another important element of the goal and scope is the definition of the functional unit, which is the reference unit by which the inputs and outputs of the LCA is related to. For the sake of readability, parts about system boundaries, system expansion, allocation and cut-off criteria are presented in Appendix A.

2.1 Goal

The primary goal of this comparative LCA is to evaluate the environmental impacts of Bona's refinishing system in comparison to the replacement of flooring. To achieve this, the study pursues the following specific objectives:

- Assess the environmental impact of Bona products used in the refinishing process.
- Assess the environmental impact of replacing existing flooring with new.
- Perform a comparison of these two scenarios to understand their relative environmental performance for chosen impact categories.

The comparison is based on three flooring types commonly used in the German market:

- Floating prefabricated (multilayer) parquet (hardwood). *Hereafter referred to as parquet*
- Homogenous polyvinyl chloride (PVC) flooring (resilient). *Hereafter referred to as vinyl*
- Linoleum flooring, 2.5mm (resilient). *Hereafter referred to as linoleum*

For the refinishing process, five Bona products have been included in the assessment (see Table 1).

Table 1. Bona products included in assessment.

Product name	Product use in LCA
Classic UX	1 component primer for wood (<i>parquet</i>) floors
Traffic HD	2 component lacquer for wood (<i>parquet</i>) floors
Pure Colour	2 component paint for resilient (<i>vinyl and linoleum</i>) floors
Pure HD	2 component lacquer for resilient (<i>vinyl and linoleum</i>) floors
LinoPrime	2 component primer for linoleum floors

The result is expected to primarily be used to inform internal stakeholders at Bona about the environmental impact from refinish processes and highlight important aspects contributing significantly to the total impact. Externally, the results may be shared with customers to illustrate the environmental differences between refinishing and replacement. However, this report has not been third-party verified, and comparisons with other publicly available data are not advised, as this falls outside the scope of the study.

2.2 Scope

The study aims to assess the environmental impact of two different scenarios. The first one being refinishing existing flooring and the other being replacement and disposal of old flooring with new. The study was a cradle to grave assessment and the whole lifecycle of both the new and refinished flooring was considered.

The assessment follows a **cradle-to-grave** approach, covering all life cycle stages of both scenarios, from raw material extraction through end-of-life treatment. See Figure 2 for more details. The study did not include the impact from maintenance and cleaning of flooring while in use. The geographical scope of the scenarios was in Germany, however the production of Bona products was in a Swedish setting. In the refinishing scenario, production of the underlying floor material and its original installation are excluded, as the floor is assumed to already be in place.

The number of times flooring can be refinished was not considered in this study. Nonetheless, it is expected that the flooring within the scope of this project can be

refinished two to four times before it must be replaced by new flooring. The analysis and result represent one cycle.

Further on, the lifetime of flooring is not a considered parameter since new and refinished flooring is expected to last equally long before it is worn and in need of maintenance (new flooring or refinish). This assumption is based on the technical lifetime provided by flooring manufacturers and companies supplying refinishing products and services. It is assumed that worn flooring, which is the starting point of the assessment, can be refinished.

The LCA performed is an attributional LCA where the environmental impact from the life cycle of bits is assessed and attributed each product.

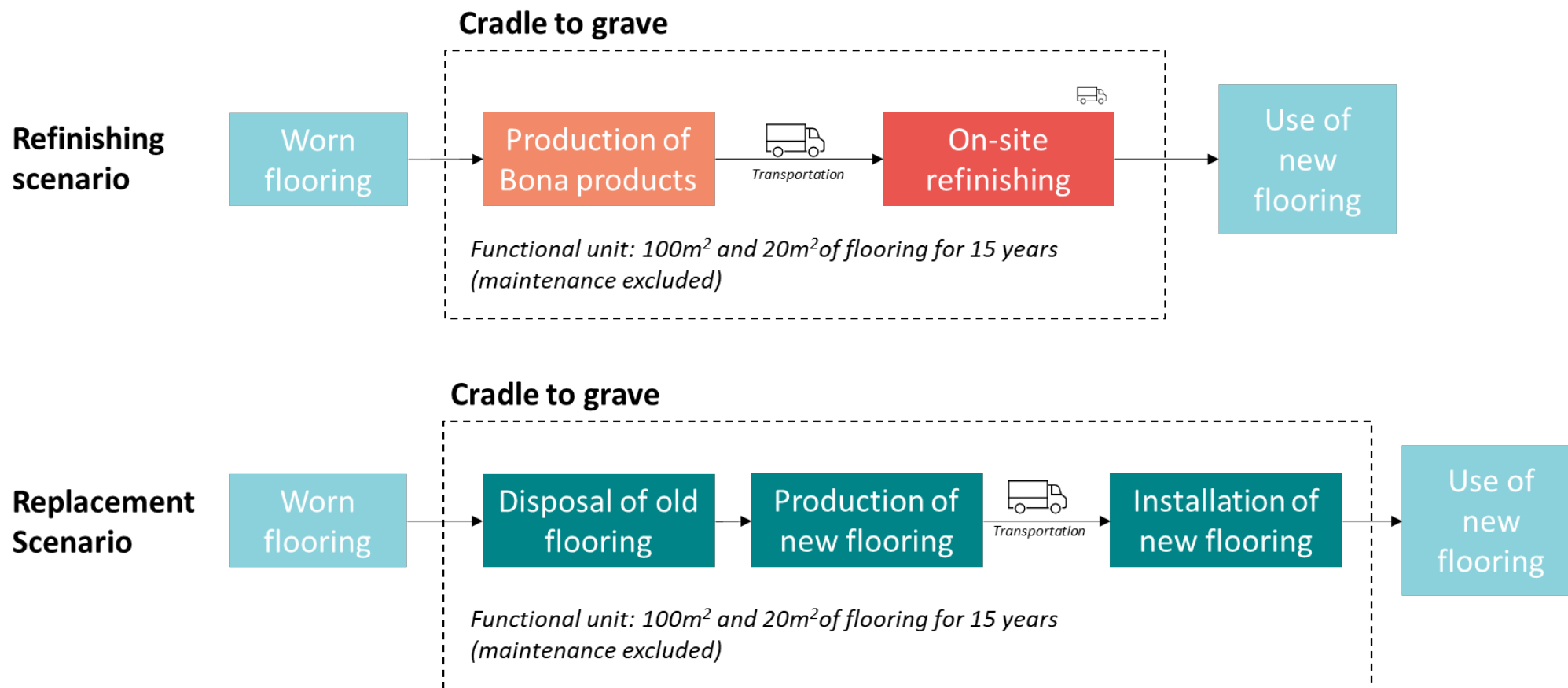


Figure 2. Scope and system boundaries of LCA study.

2.2.1 Functional unit

The functional unit of the LCA and the comparative assessment was 100m² and 20m² of flooring over a 15-year period. These two floor areas were selected by Bona to reflect different types of end-users: 100m² represents typical commercial applications such as retail spaces, while 20m² represents a more typical private or residential use case, such as a single room. This dual functional unit approach enables the study to cover a broader range of relevant use contexts for Bona's customers.

2.2.2 Studied product systems

The study investigates the environmental impact and resource use of refinish with Bona's products compared to replacing with new flooring. What is included in the two scenarios are explained in the following section.

2.2.2.1 LCA of Bona products

The environmental impact from Bona production of products for refinish was calculated using LCA. Information about products, product formulations and product processes were collected from Bona and used as input in the LCA. The LCI used was the same used in Bona's EPDs for their products and included a total of around 60 chemicals per product including transportation data for each chemical. The assumptions and data used in the LCA represents conditions for the Swedish market. The Bona products included are listed below and details can be found in table 1 in chapter 2.1:

- Classic UX
- Traffic HD
- LinoPrime
- Pure Colour
- Pure HD

The system used in this LCA related to the production of Bona products can be seen in Figure 3 below.

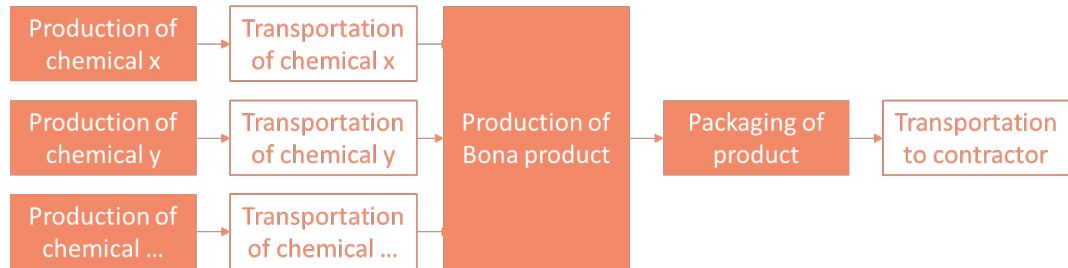


Figure 3. Overview of the considered stages in the production of Bona products.

2.2.2.2 Refinishing scenario

The environmental impacts associated with the floor refinishing scenario were assessed using a LCA model developed for refinishing systems explained by Bona. These systems are specifically designed for flooring applications in commercial and residential properties.

Primary data on product formulations, manufacturing processes (of Bona products), and the refinishing procedures were supplied by Bona and used as inputs to the LCA model. The production-related data reflect conditions at Bona’s manufacturing facilities in Malmö Sweden, while the refinishing process itself was modelled to represent application conditions in Germany, in alignment with the geographical scope of the study.

Three separate LCA’s were created, one for each floor type and its corresponding refinishing processes. The processes and products used for each floor type can be seen in Figure 4 (parquet), Figure 5 (vinyl) and Figure 6 (linoleum).

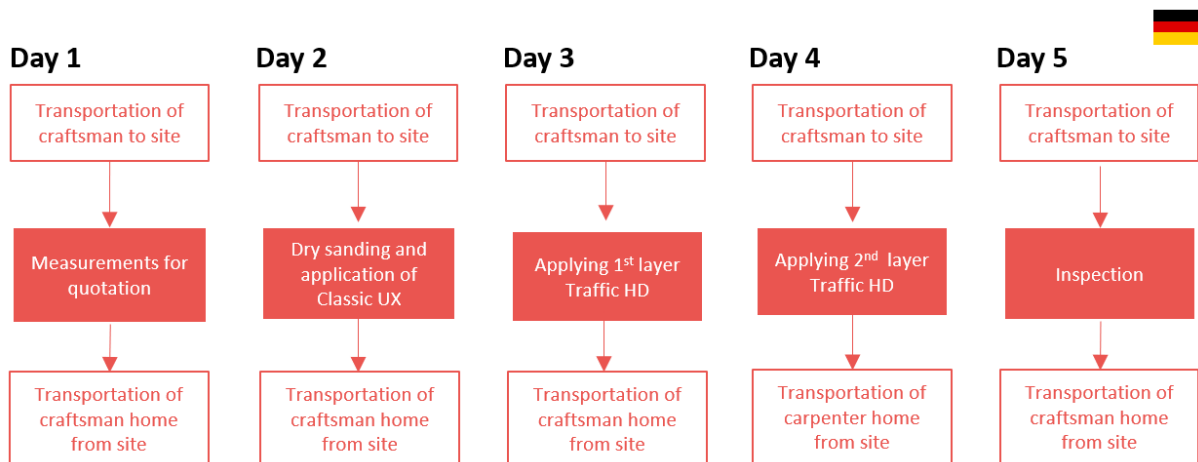


Figure 4. Overview of refinishing process of parquet floor.

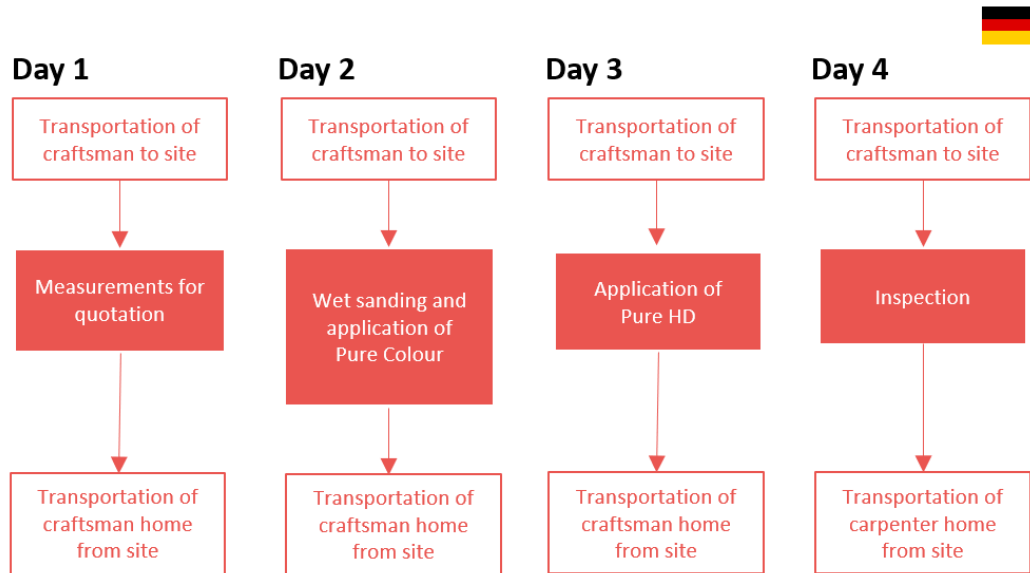


Figure 5. Overview of refinishing process for vinyl flooring.

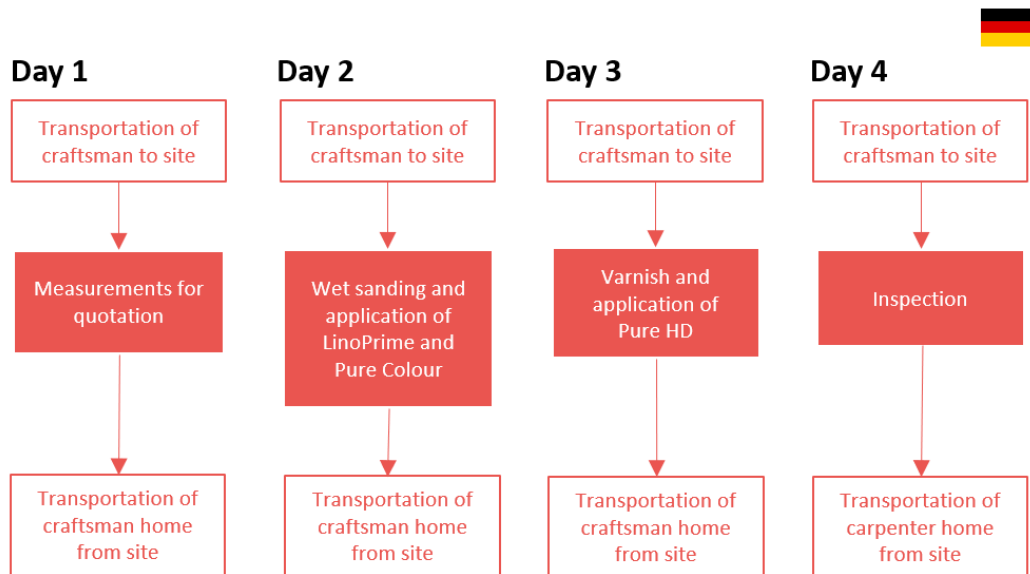


Figure 6. Overview of refinishing process for linoleum floor.

2.2.2.3 Replacement scenario

The environmental impacts of flooring replacement were assessed using data from publicly available Environmental Product Declarations (EPDs) for parquet, vinyl, and linoleum flooring. These EPDs are published by major flooring manufacturers and provide third-party verified data in accordance with relevant standards, offering a representative view of current market offerings.

EPDs divide the life cycle of a product into multiple standardized life cycle modules, following the EN 15804 + A2 framework. These modules include stages such as raw material extraction, production, transport, installation, use, and end-of-life.

Figure 7 illustrates which EPD modules have been included in the assessment of the replacement scenario in this study.

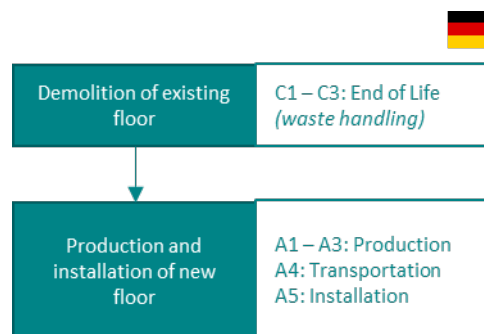


Figure 7. Overview of the considered stages in the replacement scenario.

2.2.3 Important methodology choices

The LCA has to a large extent been aligned with the general and common rules according to the requirements of ISO 14044:2006. The key methodology choices are summarized below:

- The LCA is based on an attributional approach.
- The system boundary is defined as cradle-to-grave.
- The functional unit is 100m² and 20m² of flooring over a 15-year period.
- No system expansion has been applied. As a result, no environmental credits are assigned for energy recovery or material recycling in the end-of-life phase.
- No allocation procedures were applied, as the systems studied did not involve multi-output processes requiring allocation.

When using EPDs as data sources for the replacement scenarios, certain assumptions were necessary to ensure comparability across products. Many EPDs provide more than one scenario for the end-of-life (EoL) phase. To maintain a conservative and harmonized comparison, the scenario with the lowest reported environmental impact was selected in each case:

- For parquet, it varied between thermal and material recycling.
- For vinyl, landfilling had the lowest reported impact.
- For linoleum, it varied between material recycling and landfilling.

In cases where specific modules, such as A4 (transport to site) for parquet, were missing or not reported, those modules were excluded from the analysis to avoid inconsistent assumptions.

When choosing EPD information some assumption had to be made in order to find the most comparable results. Multiple EPDs had more than one EoL scenario. To keep a conservative approach in the comparison was the EoL with the lowest environmental impact chosen.

- For the wood parquet flooring it would vary between thermal and material recycling,
- For PVC landfill had the lowest impact and
- For linoleum flooring it would vary between material recycling and landfill.

EPDs are divided into different modules. Some EPDs did not include all models, such as A4 for parquet. In these cases, those modules were excluded.

2.2.4 Limitations and key assumptions

The outcome of the study is influenced by limitations and assumptions made in the assessment. The main limitations and assumptions of the study are listed below:

- There are challenges with conducting a comparative study using different data sources.
- EPDs were used for the comparison
- The transportation data for input of materials for Bona's production was given in total km and transportation type. The transportation types were truck, boat, and train. If multiple transportation types were listed was the division between the transportation types estimated using sea-distances.org.

2.2.5 Sensitivity analysis

To evaluate the robustness of the study results and understand the influence of key parameters on the overall environmental impact, a sensitivity analysis was conducted as part of this LCA. Sensitivity analysis helps identify how changes in key assumptions affect the outcome and ensures that conclusions remain valid under a range of realistic conditions.

In this study, two sensitivity cases were explored:

- **Electricity mix:** The environmental impact of refinishing was tested under different electricity mixes to reflect regional variation or future energy scenarios.
- **Transport distance:** The distance travelled by the floor refinishing professional was varied between 40km and 20km, representing a range of likely travel scenarios.

These variations were selected based on their potential to significantly influence the outcome and are discussed further in section 4.1.2.

2.2.6 Selected impact categories

The impact indicator used in the life cycle impact assessment is presented in Table 2 and 3. These impact indicators were chosen by Bona with consultation from IVL since they are assumed most relevant for the scenarios. All impact categories are also included in EPD standard EN 15804 +A2 to make sure it will be comparable. Note that major methodology changes took place from EN 15804 + A1 to EN 15804 + A2, which makes direct comparison of results from studies with + A1 standard and + A2 standard not plausible. The indicators are based on the definition in IPCC AR 6 and updated in 2023. Information and details about each impact category and the categories concerning resource use are found in Appendix A.

Table 2: Chosen environmental impact categories.⁽¹⁾

Impact categories	Category indicator	Reference
Global warming potential (GWP), <i>fossil</i>	kg CO ₂ eq.	IPCC AR 6
Eutrophication potential (EP), <i>freshwater</i>	kg P eq.	Struijs et al. 2009 as implemented in ReCiPe
Acidification	mol H+ eq	Seppälä et al. 2006, Posch et al. 2008
Photochemical ozone creation potential (POCP)	kg NMVOC eq.	Van Zelm et al. 2008, ReCiPe 2008

(1) A detailed description of the impact category and the mechanisms causing the impacts are described in Appendix A

Table 3: Indicators describing resource use.⁽¹⁾

Primary energy resource indicators	Unit
Total use of non-renewable primary energy resources (PENRT)	MJ
Total use of renewable primary energy resources (PERT)	MJ

(1) A detailed description of the impact categories and the mechanisms causing the impacts are described in Appendix A

2.2.7 Review procedure

This study and report have been internally reviewed and approved in accordance with IVL's audited and approved management system. No third-party review has been performed.

3 Life cycle inventory

This section describes on an overall level the data collected and used in the modelling.

3.1 Production of Bona's refinishing products

The life cycle inventory for the production of refinishing products used in this study was based on primary data provided by Bona, representing production activities at their facility in Malmö, Sweden. The inventory covers multiple product formulations, with data referring to operations in either 2023 or 2024, depending on the specific product. The given data was the same used as LCI for Bona's EPDs for Classic UX, Pure HD and Traffic HD with data from 2023.

The following processes and data sources were included:

- **Raw material extraction and upstream supply:** Information on the chemical composition of each product, including the names and weight fractions of all input substances, was provided by Bona. For each chemical, the upstream processes such as raw material extraction and manufacturing were modelled using secondary data from the LCA for Experts 2025 background database.
- **Transport of raw materials:** Transport of input chemicals from suppliers to the Malmö production facility was included. Suppliers were geographically distributed globally, and average transport distances were provided. Transport modes (e.g., road, sea, rail) were also indicated. Where multiple transport modes were possible, IVL estimated the distribution to approximate realistic transport chains.
- **Production and utilities:** Site-specific data were provided for energy and utility consumption (e.g., electricity, heating) related to manufacturing processes. No relevant material or energy flows were excluded.
- **Packaging:** All primary and secondary packaging materials used for finished products were included, based on data provided by Bona.

No allocations or cut-off criteria were applied in this part of the study. All reported flows were included and modelled per the functional unit.

3.2 Refinishing scenario

The refinishing scenario represents the environmental impact of on-site refinishing of worn flooring using Bona products. The refinishing process was modelled as a one application cycle over a surface area of 100m² and 20m², in line with the defined functional units. The following data was included and provided by Bona:

- **Transport:** For the craftsman from their work to the site.
- **Sanding:** Information about machinery and papers used and the duration of their use.
- **Consumables:** Such as tray and roller which was discarded after one use.
- **Bona products:** see section 3.1.

The craftsman was assumed to travel using a petrol-powered vehicle compliant with Euro 6 emission standards. The sanding process was modelled using several types of sanding machines and abrasives, all specified by Bona. These included belt sanders, edge sanders, and FlexiSand machines equipped with vacuum systems, along with corresponding sanding materials (ceramic and diamond abrasives in various grits).

Electricity use was modelled using the German electricity mix, reflecting the geographical context of refinishing activities. Transport of the floor refinishing professional to and from the site was included, with assumptions based on a typical job requiring five, alternatively four round trips. A 20km retour distance was used in the baseline scenario, with a 40km variation assessed in the sensitivity analysis. Both distances come from the previous LCA study (Tegstedt & Ahlm, 2020).

Cut-off criteria were applied only to consumables that are reused across multiple refinishing jobs (e.g., mop, roller handle, dusting pad), and are therefore not attributed to the single refinishing cycle assessed. All other material and energy flows were included.

Background data for upstream processes were sourced from the LCA for Experts 2025 database. The refinishing scenario reflects operational conditions and product data current to the years 2023–2024.

3.3 Replacement scenario

The environmental impacts associated with the replacement of flooring were modelled using publicly available EPDs for parquet, vinyl, and linoleum flooring. These EPDs were issued by major flooring manufacturers and are intended to be representative of products available on the German market. The data within the EPDs reflect production activities and assumptions relevant to the period 2019–2023. The EPDs used in the replacement scenario are listed and specified in Table 4 below.

Table 4: Specific floor EPDs included in the study, per material.

Type of floor	Manufacturer	Product name	Declaration number
Parquet	Bauwerk Group AB	3-layer parquet	EPD-BAU-20220152-IBH1-EN
	Hamberger Flooring GmbH & Co. KG	3-layer parquet	EPD-HAM-20220203-ICD1-EN
	Tarkett	Product group 'Total thickness of 13mm and 14mm with Ash, Oak and Oak AM wood from ORZ plant	S-P-06627
	MeisterWerke Schulte GmbH	Longlife parquet	EPD-MWS-20220201-ICA1-EN
Vinyl	Forbo Flooring Systems	Sphera Resilient Homogeneous Vinyl Floor Covering	4791394447.102.1
	Tarkett	iQ Range - Compact	S-P-01346
Linoleum	Forbo Flooring Systems	Marmoleum Sheet 2.5mm	4790859342.101.1
	Gerflor	DLW Linoleum Compact	4791509685.109.1

The EPDs follow the EN 15804 + A2 framework and provide life cycle data divided into standardized modules. The following modules were included in the assessment when available:

- A1–A3: Product stage (raw material extraction, transport, and manufacturing)
- A4–A5: Transport to site and installation
- C1–C4: End-of-life (deconstruction, transport, processing, and final disposal)

In some cases, not all modules were reported. For instance, module A4 (transport to site) was missing in a subset of the parquet EPDs. In such cases, the missing modules were excluded from the inventory to maintain consistency and avoid

speculative estimations. Several EPDs presented multiple end-of-life (C module) scenarios. To ensure consistency and maintain a conservative approach, only the scenario with the lowest reported environmental impact was selected for each product type. This applied particularly to:

- **Parquet:** Choice between thermal and material recycling
- **PVC:** Landfill scenario chosen
- **Linoleum:** Choice between material recycling and landfill

All EPDs used were valid at the time of the study and were published under different EPD program operators. No recalculations or adjustments were made to the EPD values; the reported environmental impacts were used directly in the LCA. No additional background data modelling was performed for these product systems.

4 Results and discussion

4.1 Life cycle impact assessment (LCIA)

This chapter describes the results of the life cycle assessment. First, the refinish is examined for each of the three floor types studied. This is followed by a comparison of results from refinish versus replacement.

4.1.1 Environmental impact - Refinish

4.1.1.1 Refinishing parquet flooring

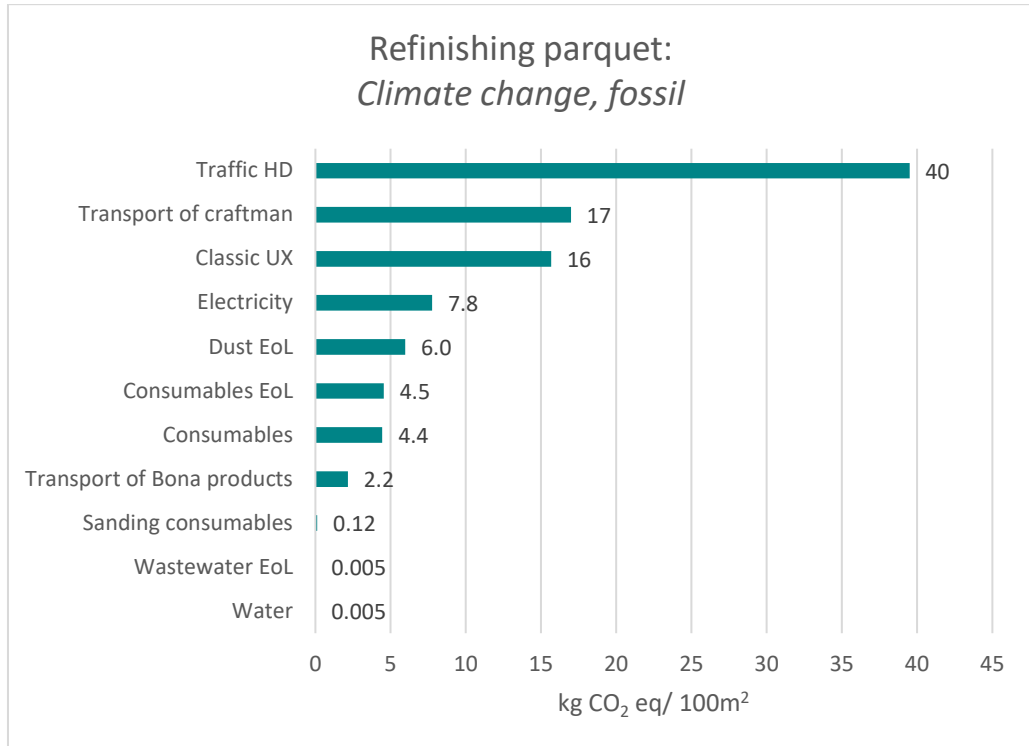
Table 5 below present the results in each environmental impact from refinishing an existing parquet floor with Bona products.

Table 5: Results of the studied impact categories, parquet floor, refinish and replacement

Impact categories	Unit	Impact from refinish scenario (100m ²)	Impact from refinish scenario (20m ²)
Climate Change, <i>fossil</i>	kg CO ₂ eq.	97	19
Acidification	mol H ⁺ eq.	0.26	0.05
Eutrophication, <i>freshwater</i>	kg P eq.	0.005	0.001
Photochemical ozone formation, human health	kg NMVOC eq.	0.19	0.04
PENRT	MJ	1,719	344
PERT	MJ	211	42

Climate change fossil

Firstly, the impact on climate change is shown in Figure 8. Here, the biggest contributing factor is the production of Traffic HD solution. This is followed by transport of contractor and production of Classic UX. Note that the sources of impact are the same even for refinishing of 20m², the only difference being the value, which is 20% of those shown in Figure 8.



*Figure 8: Results of refinished parquet floor – impact on climate change, fossil.
The total is 97 kg CO₂ eq.*

Additional sources of impact are electricity used for sanding and vacuuming, production and waste management of consumables needed for the process, and waste treatment of dust from sanding.

4.1.1.2 Refinishing of vinyl floor

Table 6 below present the results in each environmental impact from refinishing an existing vinyl floor with Bona products.

Table 6: Results of the studied impact categories, vinyl floor, refinish and replacement

Impact categories	Unit	Impact from refinish scenario (100m ²)	Impact from refinish scenario (20m ²)
Climate Change, fossil	kg CO ₂ eq.	80	16
Acidification	mol H+ eq.	0.29	0.06
Eutrophication, freshwater	kg P eq.	0.005	0.001
Photochemical ozone formation, human health	kg NMVOC eq.	0.18	0.04
PENRT	MJ	1,390	280
PERT	MJ	130	26

The environmental impact from refinishing the vinyl floor is presented in Figure 9.

Climate change, fossil

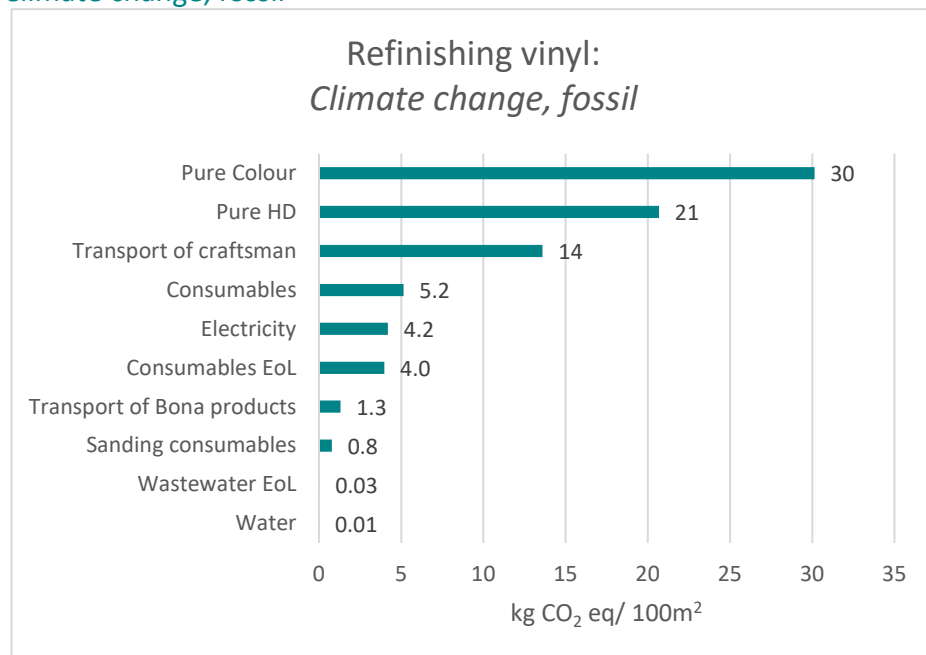


Figure 9: Results of refinishing vinyl floor – impact on climate change, fossil.

The total is 80 kg CO₂ eq.

Additionally, consumables and their end-of-life treatment, as well as electricity used by the craftsman cause impact on climate change. The contributing factors are the same even for refinishing of 20m², their respective values are one-fifth of those indicated in Figure 9.

4.1.1.3 Refinishing of linoleum floor

Table 7 below present the results in each environmental impact from refinishing an existing linoleum floor with Bona products.

Table 7: Results of the studied impact categories, linoleum floor, refinish and replacement

Impact categories	Unit	Impact from refinish scenario (100m ²)	Impact from refinish scenario (20m ²)
Climate Change, fossil	kg CO ₂ eq.	90	18
Acidification	mol H ⁺ eq.	0.36	0.07
Eutrophication, freshwater	kg P eq.	0.006	0.001
Photochemical ozone formation, human health	kg NMVOC eq.	0.23	0.05
PENRT	MJ	1,600	320
PERT	MJ	130	27

Figure 10 illustrates the sources of impact from refinishing linoleum floor in terms of climate change, fossil. The biggest contributors are again the treatment products by Bona, with highest impact caused by Pure Colour.

Climate change, fossil

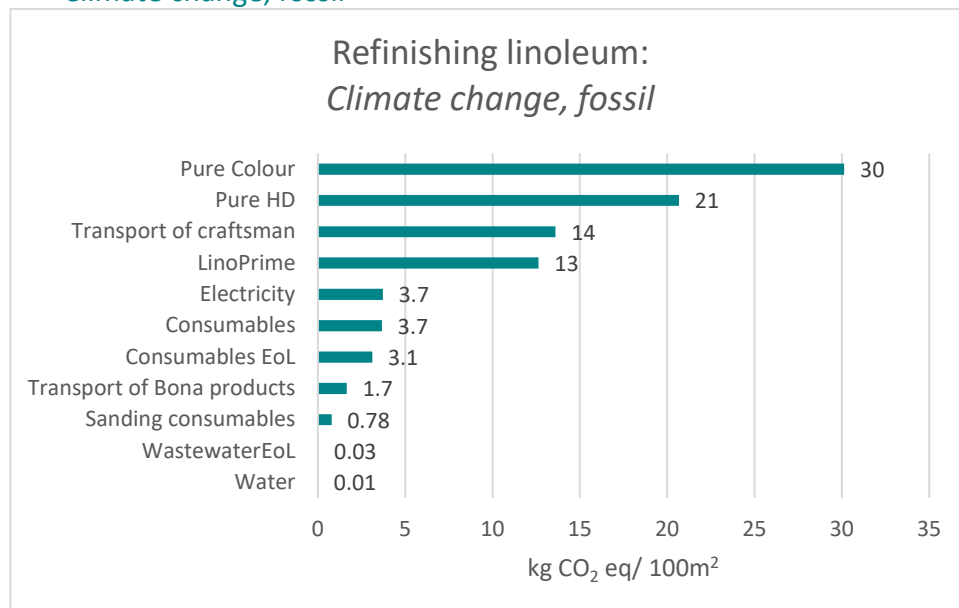


Figure 10: Results of refinishing linoleum floor, impact on climate change, fossil

Similarly, the sources of impact following the Bona products and transport of craftsman, are electricity, consumables, and their waste treatment. The order of inputs contributing to the impact on climate change in case of 20m² is identical to that presented in Figure 10.

4.1.2 Sensitivity analysis

This section presents the sensitivity analysis conducted, per floor type. First, electricity mix is examined, followed by transport distance that the craftsman travels.

4.1.2.1 Parquet refinishing

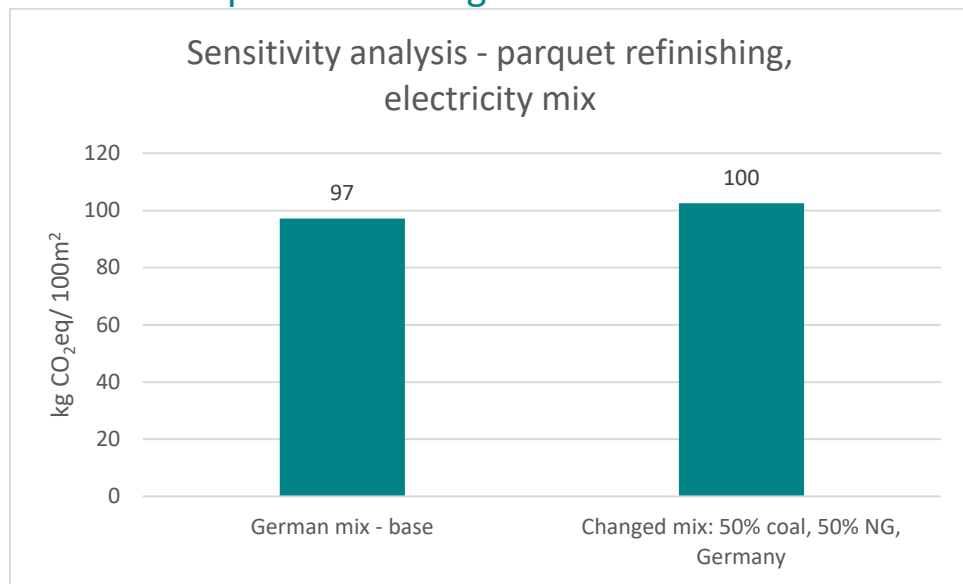


Figure 11: Results of sensitivity analysis, variable – electricity source, impact on total climate change, fossil

As shown in Figure 11, changing electricity source for the refinish processes from German mix (representing the German electricity market) to a scenario with 50% coal and 50% natural gas does lead to an increase in the impact on climate change, fossil. Compared to the baseline scenario, the alternative electricity source leads to 6% more GHG emissions.

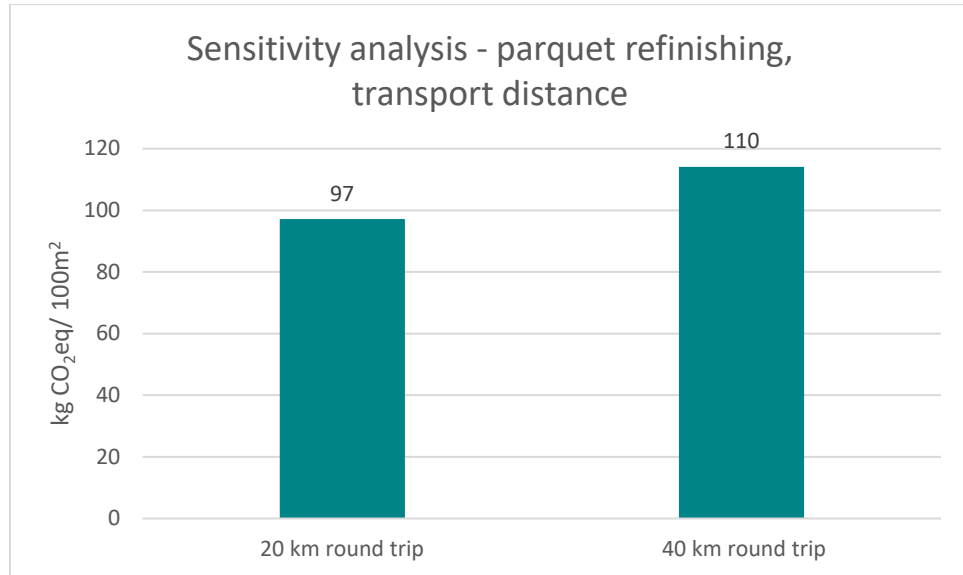


Figure 12: Results of sensitivity analysis, variable – transport of craftsman, impact on total climate change, fossil

Figure 12 analyses the sensitivity of results to another variable – transport distance that the craftsman travels to and from the renovation site. Doubling the transport distance from 20km to 40km leads to an increase of 18%. Thus, the results are more sensitive to the transport distance than the electricity source used for refinishing.

4.1.2.2 Vinyl refinishing

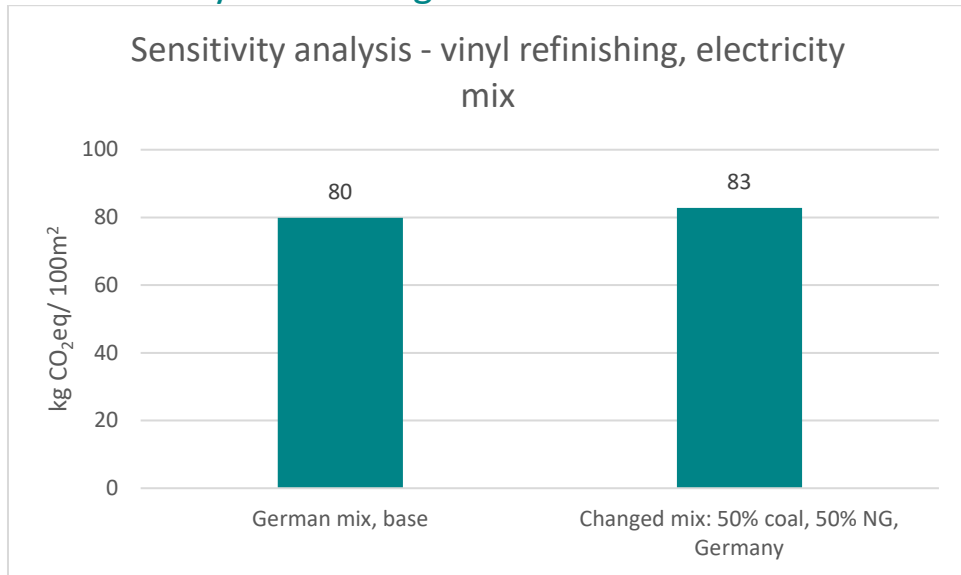


Figure 13: Results of sensitivity analysis, variable – electricity source, impact on total climate change, fossil

As was the case of parquet flooring, changing electricity source in vinyl refinishing also increases the impact on climate change (see Figure 13), however, this increase is rather low, namely 4%.

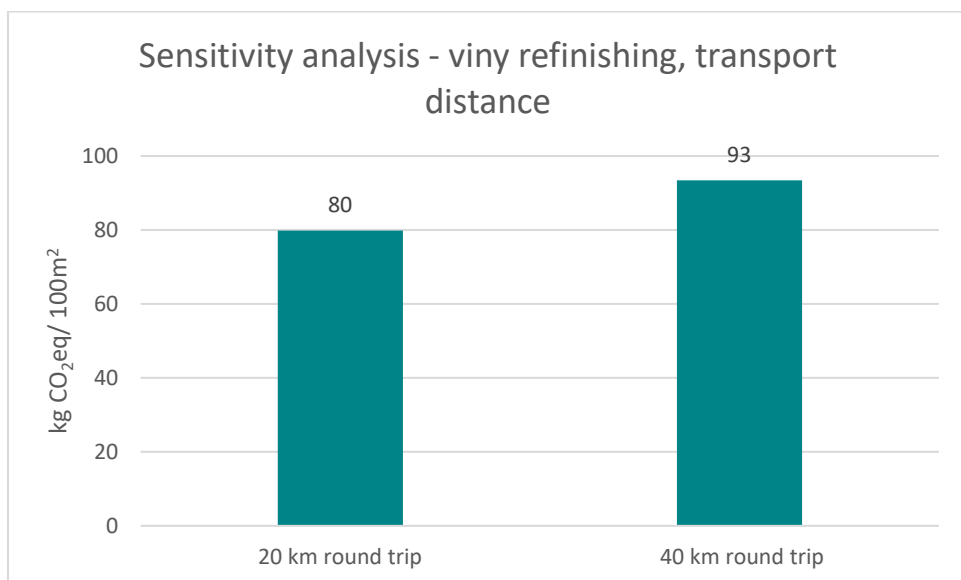


Figure 14: Results of sensitivity analysis, variable – transport of craftsman, impact on total climate change, fossil

Figure 14 illustrates the results of sensitivity analysis on transport distance. Increasing the distance to 40km leads to an additional 13 kg CO₂ eq., or 16%. Again, the results show more sensitivity to this factor than to change in electricity mix.

4.1.2.3 Linoleum refinishing

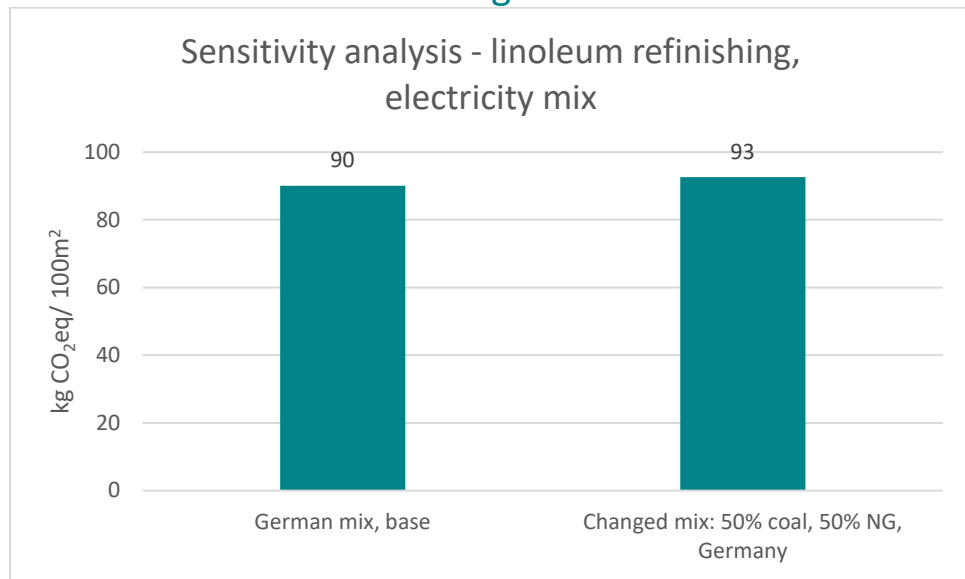


Figure 15: Results of sensitivity analysis, variable – electricity source, impact on total climate change, fossil

As shown in Figure 15, above, changing the electricity source from German mix to a 50/50 combination of coal and natural gas results in a slight increase in the environmental impact on climate change, fossil. This change equals 3%.

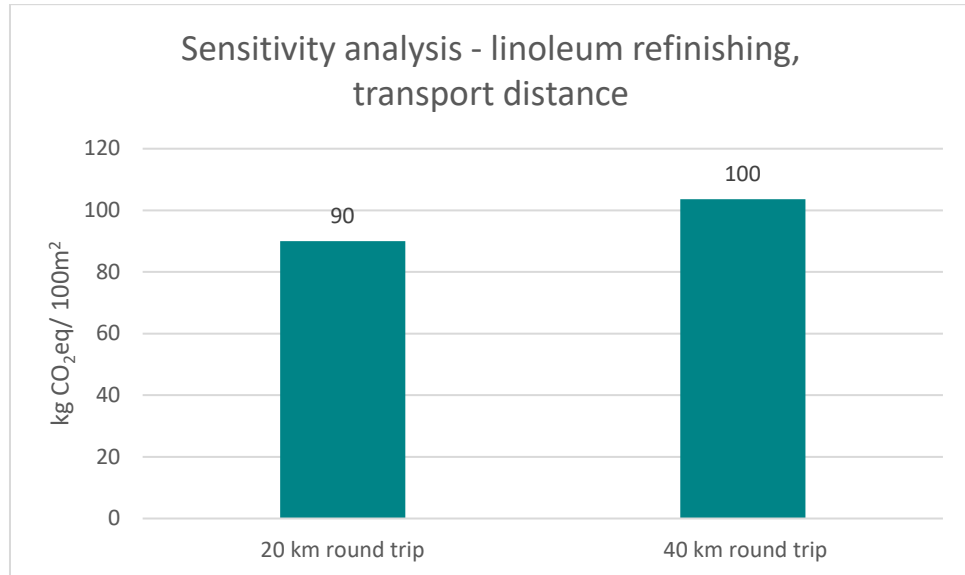


Figure 16: Results of sensitivity analysis, variable – transport of craftsman, impact on total climate change, fossil

Increasing the transport distance between the craftsman and the renovation site causes a rather significant increment in climate change, fossil results, as illustrated in Figure 16. More specifically, 14 kg CO₂eq., equal to 16% are added by doubling the transport distance.

4.1.3 Comparative results of refinishing vs replacing floor

This section provides an overview of environmental impact of refinishing floor with Bona’s products in comparison with discarding of old, existing floor and replacing it with new floor. In line with the previous section, three floor types are compared. For each new floor product, publicly available EPDs were used, representing the most relevant industry players.

4.1.3.1 Parquet floor

Table 8 shows an overview of results for four parquet alternatives – refinishing and three parquet floors intended for installation of new floor.

Table 8: Results of the studied impact categories, parquet floor, refinish and replacement, 100m²

Impact categories	Refinish with	Replacement of and with			
	Bona products for parquet	Bauwerk parquet	MeisterWerke parquet	Hamberger parquet	Tarkett parquet
Climate Change, fossil [kg CO ₂ eq.]	97	820	990	500	1,180
Acidification [mol H ⁺ eq.]	0.26	4.0	3.1	3.0	7.3
Eutrophication, freshwater [kg P eq.]	0.005	0.02	0.02	0.02	0.20
Photochemical ozone formation, human health [kg NMVOC eq.]	0.19	4.6	3.7	3.9	8.0
PENRT [MJ]	1,720	14,000	18,300	8,720	21,300
PERT [MJ]	210	31,800	32,500	32,800	82,800

Although these three floors were not modelled from scratch or analysed in detail, the main source of their impact is the A1-A3 stage, meaning raw material sourcing, transport of raw materials to production site, and the production of the final product.

Climate change

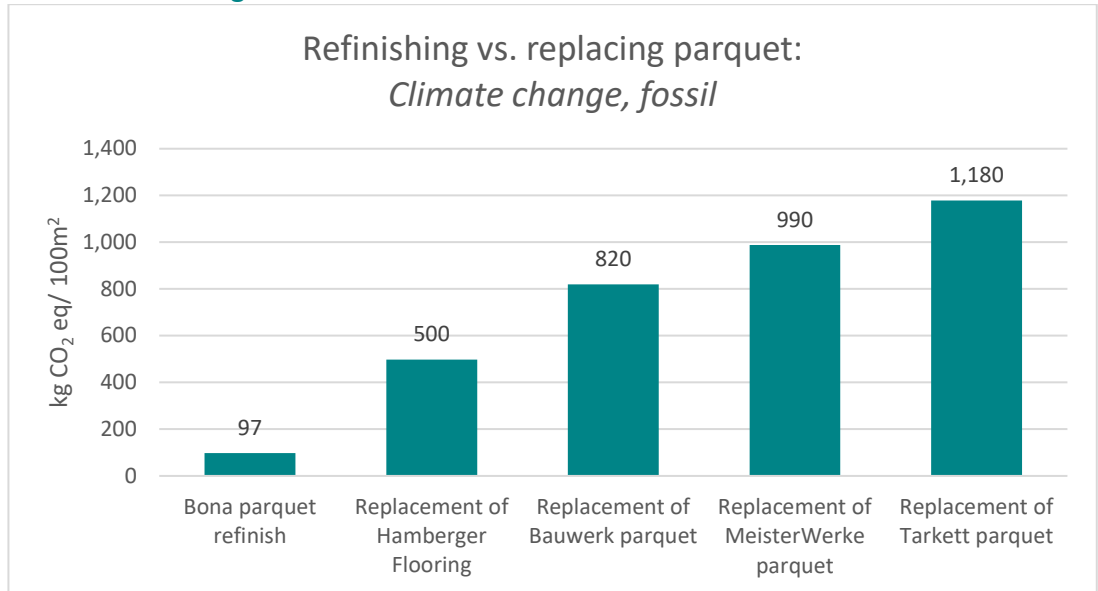


Figure 17: Impact on climate change, fossil from Bona’s refinishing process, and four new parquet alternatives from Hamberger Flooring, Bauwerk, MeisterWerke and Tarkett. The impact from the refinish scenario was based on this study’s LCIA (see 4.1.1.) and the impact from all replacement scenarios were based on publicly available EPDs.

Figure 17 shows that refinishing parquet floor leads to considerably lower impact on climate change than its replacement. Of the three parquet floor alternatives, the alternative with least environmental impact is Hamberger’s parquet, which causes approximately 5. times more greenhouse gas emissions than Bona’s refinish process. Contrarily, the alternative with most impact is Tarkett parquet, leading to 12 times more CO₂ eq emissions than Bona’s refinish process.

Total use of primary energy resources

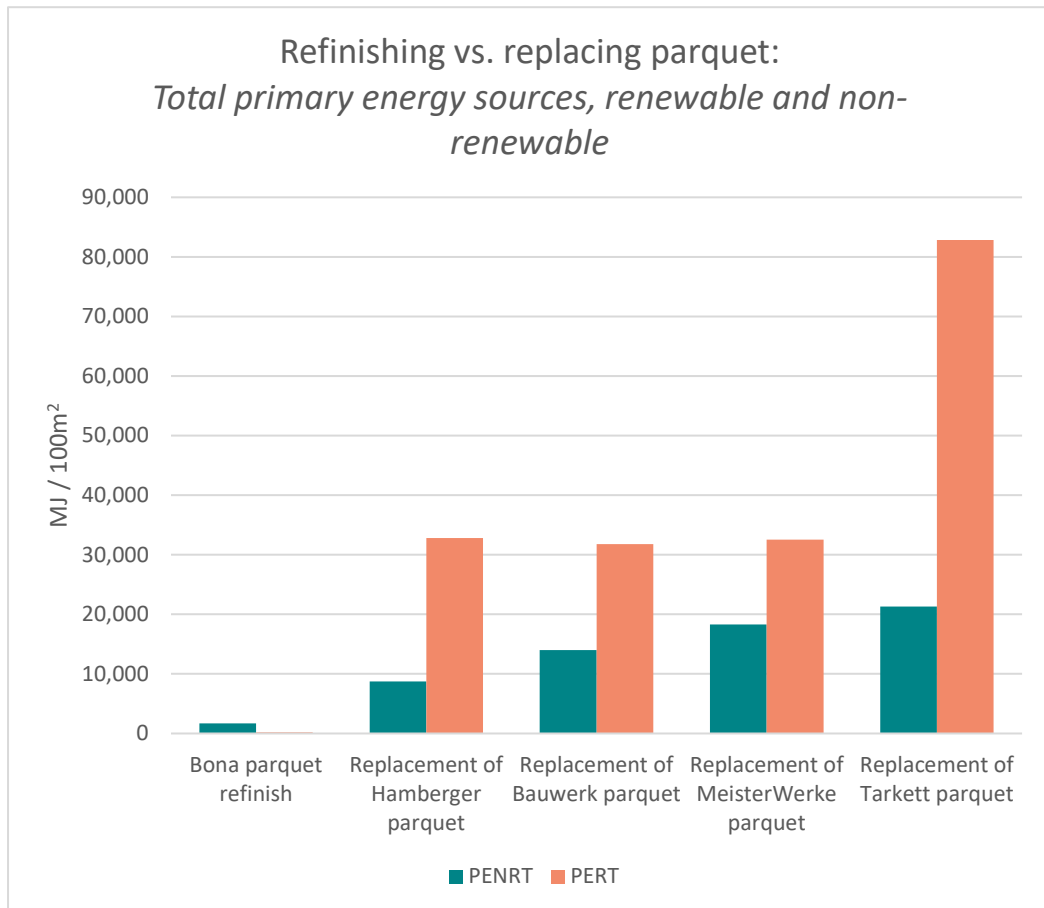


Figure 18: Impact on Total use of renewable primary energy resources (PERT) and Total use of non-renewable primary energy resources (PENRT) from Bona’s parquet refinishing process, and four new parquet alternatives. The impact from the refinish scenario was based on this study’s LCIA (see 4.1.1.) and the impact from all replacement scenarios were based on publicly available EPDs.

As shown in Figure 18, refinishing parquet has an almost negligible impact on PERT and PENRT, especially when compared to replacing it with the chosen alternatives.

4.1.3.2 Vinyl floor

Table 9: Results of the studied impact categories, vinyl floor, refinish and replacement, 100m²

Impact categories	Refinish with	Replacement of and with	
	Bona products for vinyl flooring	Sphera Vinyl Covering	Tarkett PVC
Climate Change, fossil [kg CO ₂ eq.]	80	720	790
Acidification [mol H ⁺ eq.]	0.29	1.7	3.1
Eutrophication, freshwater [kg P eq.]	0.005	0.004	0.34
Photochemical ozone formation, human health [kg NMVOC eq.]	0.18	2.0	2.7
PENRT [MJ]	1,390	18,900	20,800
PERT [MJ]	130	2,850	2,320

Table 9 compares the results of refinishing vs. replacing vinyl floor. In line with the parquet floor, the main impact in case of vinyl floor alternatives is also the A1-A3 module. Regarding the Sphera vinyl covering, it contributes to 85% of the impact on climate change, fossil, and when it comes to Tarkett PVC, it is equal to 66%. The remainder of the climate change impact from Tarkett PVC originates from the construction and installation phase (19%, A4-A5) and end-of-life stage (15%, C1-C4).

Climate change

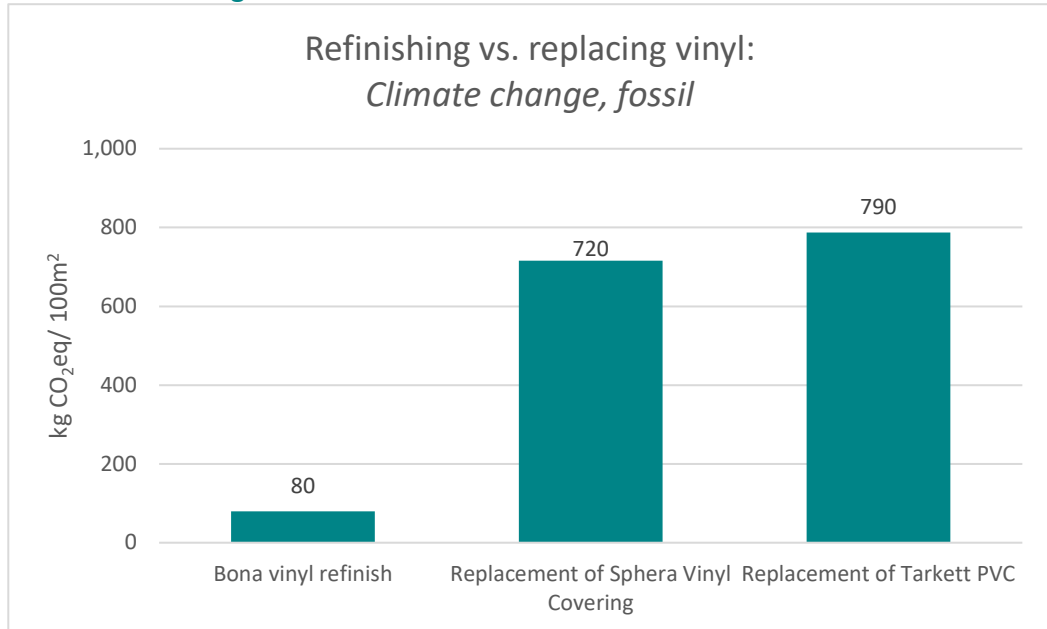


Figure 19: Impact on climate change, fossil from three alternatives – Bona’s refinishing process, and new vinyl floor from Sphera Vinyl Covering and Tarkett. The impact from the refinish scenario was based on this study’s LCIA (see 4.1.1.) and the impact from all replacement scenarios were based on publicly available EPDs.

Figure 19 illustrates the impact on climate change from two vinyl floor alternatives compared to refinishing an existing vinyl floor with Bona’s products. Sphera vinyl covering had the least climate impact of the two replacement floorings, but its CO₂ eq. emissions were 9 times higher than refinishing the floor with Bona products. Similarly, the environmental impact of replacing 100m² of vinyl floor with Tarkett PVC is almost 10 times higher.

Total use of primary energy resources

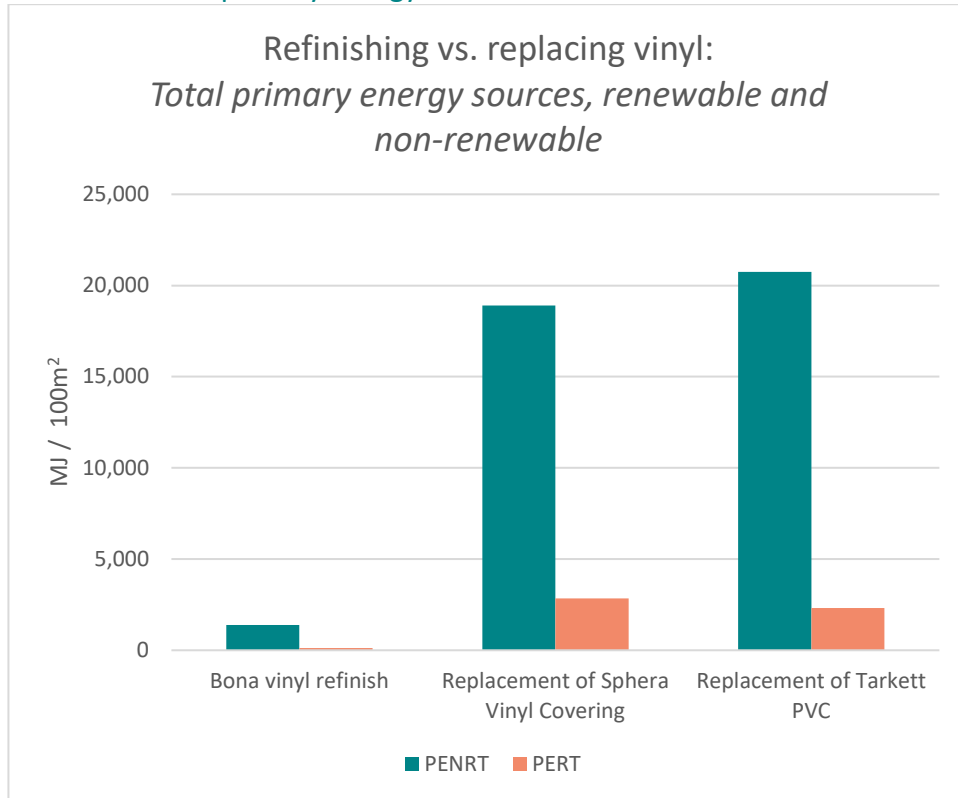


Figure 20: Impact on Total use of renewable primary energy resources (PERT) and Total use of non-renewable primary energy resources (PENRT) from Bona’s vinyl refinishing process, and two new vinyl alternatives. The impact from the refinish scenario was based on this study’s LCIA (see 4.1.1.) and the impact from all replacement scenarios were based on publicly available EPDs.

Similarly, to parquet floor, refinishing the vinyl floor causes significantly less use of primary energy resources, both renewable and non-renewable.

4.1.3.3 Linoleum floor

Table 10: Results of the studied impact categories, linoleum floor, refinish and replacement, 100m²

Impact categories	Refinish with	Replacement of and with	
	Bona products for linoleum flooring	Marmoleum	Gerflor Linoleum
Climate Change, fossil [kg CO ₂ eq.]	90	400	690
Acidification [mol of H ⁺ eq.]	0.36	2.6	64
Eutrophication, freshwater [kg P eq.]	0.006	0.11	50
Photochemical ozone formation, human health [kg NMVOC eq.]	0.23	2.0	52
PENRT [MJ]	1,610	5,260	9,400
PERT [MJ]	130	7,220	11,600

Finally, a comparison of refinishing and replacing linoleum floor is provided in Table 10. The environmental impact of replacing the linoleum floor is mainly the result of A1-A3 module. In terms of Marmoleum, 90% of impact on climate change, fossil is caused by this module and when it comes to Gerflor Linoleum, it is 75%.

Climate change

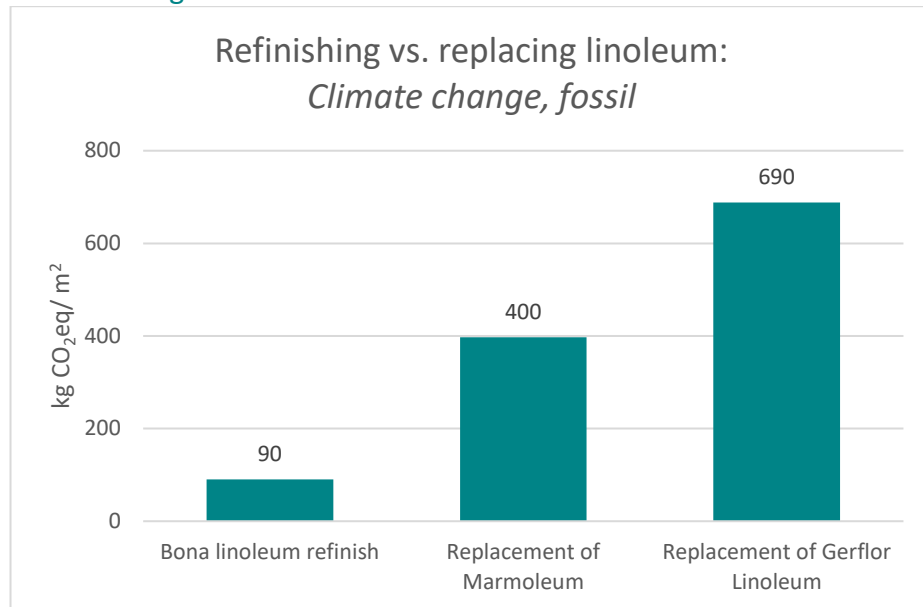


Figure 21: Impact on climate change, fossil from three alternatives – Bona’s refinish process, and new linoleum floor from Marmoleum and Gerflor. The impact from the refinish scenario was based on this study’s LCIA (see 4.1.1.) and the impact from all replacement scenarios were based on publicly available EPDs.

Examining the linoleum floor alternatives, refinishing causes 90 kg CO₂eq, which is 4.4 times less than replacement of floor with Marmoleum and 7.7 times less than replacement with Gerflor linoleum, as can be seen in Figure 21.

Total use of primary energy resources

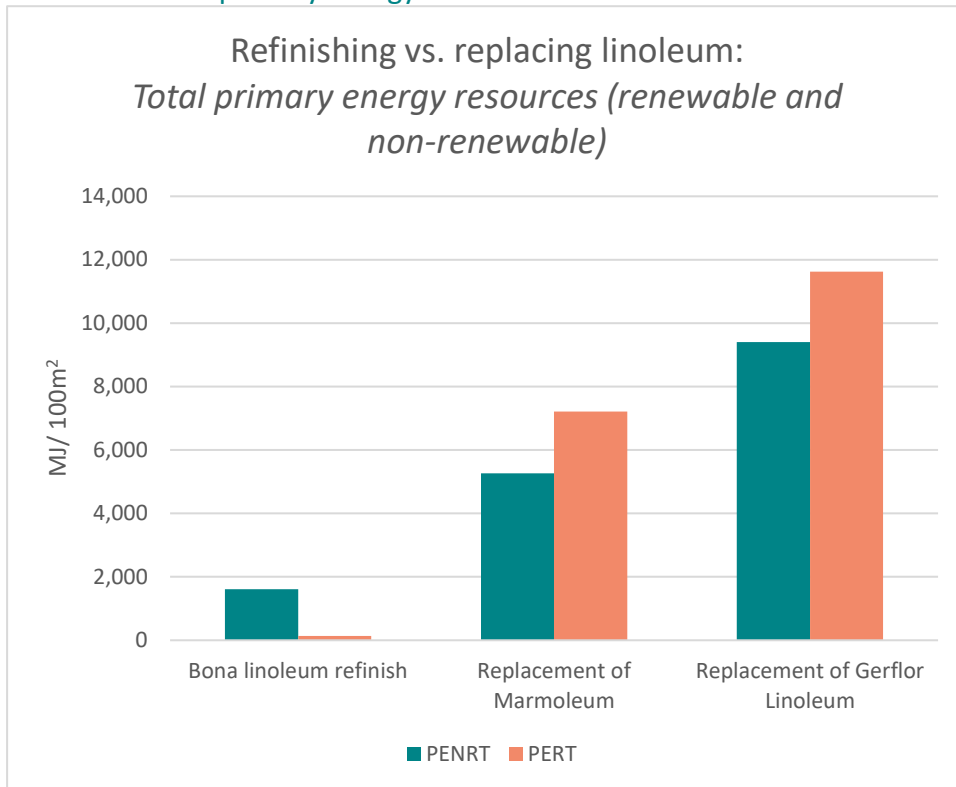


Figure 22: Impact on Total use of renewable primary energy resources (PERT) and Total use of non-renewable primary energy resources (PENRT) from Bona’s linoleum refinishing process, and two new linoleum alternatives. The impact from the refinish scenario was based on this study’s LCIA (see 4.1.1.) and the impact from all replacement scenarios were based on publicly available EPDs.

In line with the other two floor types, refinishing of linoleum also causes significantly less primary energy use. When it comes to renewable resources, the result is almost negligible, while it is 3 to 6 times better in terms of PENRT.

5 Conclusions and recommendations

This study analyzed the process of refinishing three different types of floors (parquet, vinyl, and linoleum), by Bona's refinishing products. The main sources of impact in the refinishing process were the product composition, caused by a variety of chemicals, specified in more detail in chapter 4.1.1. This was followed by the transport of the craftsman, the production of various consumables, the electricity for sanding and vacuuming and the waste management.

Sensitivity analysis showed that while changing the electricity mix from German mix to a combination of 50% coal and 50% natural gas sourced electricity for the refinishing process does lead to a higher environmental impact, this increase is relatively low. Instead, a more significant increase in environmental impact was recorded when prolonging the transport distance from craftsman to the renovation site.

For Bona to improve its environmental performance, it is recommended to address the main contributors of impact in its five products, specified in Appendix C. Additionally, the company can advise the craftsmen to use more environmentally friendly transport modes and/or fuels, and to optimize their planning in order to avoid unnecessary journeys. On the other hand, the end-consumers can also be recommended to hire local craftsmen and thus diminish the distance needed to traverse during the refinishing. In this study, it was assumed that the carpenter travelled using a petrol-powered vehicle compliant with Euro 6 emissions standards. If alternative, lower-impact modes of transport were used, the environmental impact of the refinishing scenario could be further reduced. However, such alternative transport options were not included in the scope of this study.

When it comes to the comparison of refinishing versus replacing the floor, Bona's refinishing process performed significantly better than any replacing alternative based on the eight publicly available EPDs. This is due to high environmental impact linked to production and transport of raw materials and their processing into new floor. It is important to acknowledge the inherent limitations of comparative LCA studies when interpreting and communicating the results. The outcomes are highly sensitive to the definition of the functional unit, system boundaries, data sources, and the underlying assumptions. While the inclusion of a sensitivity analysis helps to test the robustness of key parameters and reduce uncertainty, these methodological limitations cannot be fully eliminated. Therefore,

ensuring transparency in the modelling approach and assumptions is essential to prevent misinterpretation or overgeneralization of the results.

The results of this report can be used for internal communication and further product development. Additionally, it can be used for external communication about the environmental impact from Bona's refinishing products. However, this report has not been third-party verified, and comparisons with other publicly available data are not permitted, as this falls outside the scope of the study.

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Appendix A: Impact Categories

The impact and resource use categories studied in the present study are described below.

Global Warming potential/ Climate change

Global warming is caused by increases in the atmospheric concentration of chemical substances that absorb infrared radiation. These substances reduce the energy flow from Earth in a way that is similar to the radiative functions of a glass greenhouse. The category indicator is the degree to which the substances emitted from the system investigated contribute to the increased radiative forcing.

The characterisation factor stands for the extent to which an emitted mass unit of a given substance can absorb infrared radiation compared to a mass unit of CO₂. As the degree of persistence of these substances is different, their global warming potential (GWP) will depend on the time horizon considered, such as 20, 100 and 500 years. In this study, a time horizon of 100 years has been applied.

Eutrophication potential, *freshwater*

Freshwater eutrophication refers to the over-enrichment of freshwater ecosystems with nutrients which can lead to excessive algal growth, oxygen depletion, and ecosystem degradation. This process disrupts aquatic biodiversity and reduces water quality, impacting both ecological function and human use of water bodies.

The category indicator for freshwater eutrophication expresses the potential of nutrient emissions to contribute to nutrient accumulation in freshwater ecosystems. The characterisation factors are derived from models that estimate the fraction of emitted phosphorus or nitrogen compounds that ultimately reach freshwater bodies, where they may cause eutrophication.

Acidification

Acidification refers to the deposition of acidic substances from the atmosphere into terrestrial and aquatic ecosystems. This process is primarily driven by emissions of sulfur dioxide (SO₂), nitrogen oxides (NO_x), and ammonia (NH₃), which form

acidic compounds upon reaction with water in the atmosphere. These substances can lead to soil acidification, forest damage, and the acidification of freshwater bodies, thereby affecting plant growth, biodiversity, and ecosystem services.

The category indicator for acidification potential represents the extent to which emissions contribute to the formation of hydrogen ions (H^+) in the environment. Characterisation factors quantify the acidifying effect of each emitted substance relative to sulfur dioxide (SO_2), which serves as the reference substance.

Photochemical ozone creation potential

Photochemical ozone creation refers to the formation of ground-level ozone (O_3) through chemical reactions between volatile organic compounds (VOCs) and nitrogen oxides (NO_x) in the presence of sunlight. While ozone in the stratosphere protects life from ultraviolet radiation, ozone at ground level is a harmful pollutant that can cause respiratory problems in humans, reduce agricultural yields, and damage ecosystems.

The category indicator for photochemical ozone creation potential expresses the potential of emitted substances to form ozone in the lower atmosphere. This formation depends on the reactivity of the substances and the atmospheric conditions under which they are released.

Total use of primary energy resources

The category reflects the use of renewable and non-renewable primary energy resources. Renewable primary energy resources are, for example, biomass, wind power and hydropower. Non-renewable primary energy resources are, for example, crude oil, coal and natural gas. Includes even energy resources contained in material, e.g. energy in wood is counted as renewable primary energy source and energy in plastics as non-renewable primary energy source.

Appendix B: System boundaries

In this section the applied system boundaries of the LCA are specified. Aspects such as boundaries towards nature and geographical boundaries, as well as methodological aspects concerning system expansion and allocation are defined and explained.

The study **excludes impacts related to use-phase maintenance and cleaning**, as these are assumed to be similar for both scenarios and are not expected to significantly affect the comparative outcome.

Boundaries towards nature

This study is a cradle to grave assessment, which means that the whole value chain has been covered i.e. that production of fuels, electricity and raw materials are followed from the cradle where the natural resources (e.g. crude oil or uranium) are extracted from the ground. The life cycle also covers all relevant transportation as well as the end-of-life management of the products i.e. the “grave” in terms of the soil (after human activity has ceased), the air (e.g. emissions from combustion of fuels) or water (e.g. water emissions from wastewater treatment).

Geographical boundaries

The LCA study considers Bona conditions and their markets. The Bona products are produced in Malmö, Sweden and the refinish and replacement activities in Germany. The production- and refinishing process was based on information from Bona. The production location of flooring depends on calculations in the producers EPDs.

Time coverage

Primary data collection for this study was conducted between November 2024 and June 2025. Data for the production of Classic UX, Pure HD and Traffic HD by Bona is based on 2023 operational data. Data for Pure Colour and LinoPrime reflects 2024 operations.

Environmental impact data for replacement flooring was obtained from EPDs published by major flooring manufacturers. These EPDs were based on underlying data from the years 2019 to 2023, depending on the specific product and manufacturer. All EPDs used were valid and current at the time of inclusion in the study.

The background life cycle inventory data used in the modelling (via LCA for Experts software) is based on the 2025 version of the background database. As well as data from Ecoinvent, one of world's largest LCA databases.

System Expansion

System expansion means that the systems are expanded to reflect the environmental benefit associated with for instance produced energy (electricity and heat produced in waste incineration of used products) and with the recycled materials (produced in material recycling). System expansion is not applied in this study. Some of the EPDs included system expansion, this was excluded before the data was included in the study.

Allocation

Often allocations are required in LCA studies. This is, for instance, relevant for multioutput processes generating several products and co-products, where it is necessary to distribute (allocate) the environmental impact between these. For this LCA, no allocation has been used.

Cut-off criteria

Cut-off criteria were applied only to consumables that are reused in multiple refinishing processes and therefore do not contribute to the environmental impact of the single refinishing cycle assessed in this study. Such as: mop, microfiber cleaning pad, dusting pad, brush, roller handle, telescope pole. All other material and energy inputs, including consumables such as tray and roller, were included in the system boundaries. No additional cut-off thresholds were applied based on mass, energy content, or environmental relevance.



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This report has been reviewed and approved in accordance with IVL's audit and approval management system.