DGE | **REPORT**

Product carbon footprint methodology report

Lekolar, Osby

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Summary

In response to a request from Lekolar AB, DGE has developed a tool for calculating a simplified carbon footprint associated with Lekolar's products. The objective is to offer an understanding of the global warming impact of Lekolar's upstream- and core manufacturing processes and to communicate this information to customers through their official website.

The method used follows the guidelines set forth in ISO 14067:2018, a standard established by the International Organization for Standardization (ISO) that outlines the procedures for calculating and communicating the carbon footprints of products in terms of greenhouse gas emissions.

The calculation tool ranges from cradle to gate, with an additional inclusion of end-of-life management. Hence, activities included in the tool are material production and refining, product assembly, inbound transportation to Osby and end-of-life management. The selected indicator for measuring the carbon footprint of the products is the Global Warming Potential (GWP100) impact category developed by IPCC.

The primary objective is to outline the methodology employed in the simplified carbon footprint tool. All carbon footprint results are accessible on each product's webpage.

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No.	Date	Comment
1	2023-10-03	Original version

1 Introduction

In todays' society, the public awareness regarding sustainable development and environmental protection is ever increasing, as well as its importance on the global agenda. The concerns regarding how the products we consume affect the environment has accelerated the development of methods and tools for measuring and mapping environmental impacts. These tools enable us to gain a comprehensive understanding of the full scope of our actions and provide the groundwork for informed decision-making to mitigate these impacts.

Several approaches exist for evaluating the climate impact of products, including Life Cycle Assessment (LCA), Environmental Product Declaration (EPD), and Carbon Footprint for Products (CFP). Furthermore, the ISO 14067 standard plays an important role by offering guidelines for quantifying and communicating the carbon footprint of products. This standard presents a structured methodology for assessing the greenhouse gas (GHG) emissions associated with a product and provides guidance on how to effectively communicate this information to various stakeholders.

The ISO 14067 standard also strives to establish a consistent and transparent approach to carbon footprinting. This consistency enables consumers to make meaningful comparisons and gain knowledge about a product's environmental impact, while organizations can use this data to identify opportunities for reducing their environmental footprint. In essence, ISO 14067 empowers both consumers and organizations to make informed choices and contribute to environmental sustainability.

1.1 Background

Lekolar AB has requested a simplified carbon footprint tool to be able to calculate and communicate a footprint for a wide range of their products. The simplified carbon footprint tool differs from previous evaluations. In the past, LCAs have been conducted for three product series: Slumra, Helmi, and the Mandal series. Additionally, EPDs have been developed for two product series: the Chair Matte and Table 12:38. The results obtained from the LCAs and EPDs have further used for communicating the carbon footprint for products in these series.

1.2 Abbreviations

CO_2e – Carbon dioxide equivalents
CFP – Carbon Footprint for Products
EF – Emission factor
EPD – Environmental Product Declaration
GHG – Greenhouse gases
LCA – Life Cycle Assessment
PCR – Product Category Rules

2 Goal and scope

2.1 Goal

The goal of the calculation tool is to assess the impact of products on global warming, measured in carbon dioxide equivalents (CO_2e), by quantifying all significant greenhouse gas emissions associated with material production and refining, inbound transportation, assembly of products and end-of-life management. The purpose of the calculations extend to obtaining a deeper understanding of the products footprint and to effectively communicate this knowledge to various stakeholders on Lekolar's website.

2.2 Scope

The scope of the calculation tool includes the total greenhouse gas (GHG) emissions arising from specific processes within a product system. These emissions are quantified and represented as CO_2 equivalent units. The declared unit chosen is one product, and material, energy and transport demands modelled are all related to the declared unit chosen.

2.3 Products description

The calculation tool includes an examination of the carbon footprint associated with different products offered in Lekolar's product range. These products exhibit diverse functions and sizes, encompassing a collection of materials and are manufactured through varying processes. Lekolar's main customers are preschools and schools, and they have a wide variety of items in their product range, such as toys, furniture, and playground equipment. These products are designed to encourage educational and creative involvement.

2.4 Critical review

A critical review is carried out internally at DGE.

2.5 Declared unit

The declared unit is set to 1 unit of product.

2.6 System boundary

The calculation tool establishes its system boundary from cradle-to-gate, with the addition of end-of-life management. Hence, the calculation tool includes material production and refining, transportation from suppliers to Osby, assembly of products and end-of-life management. The comprehensive nature of the tool encompasses a diverse selection of products with varying applications, which is why the use phase is excluded as a simplifying measure.

2.6.1 Allocation procedure

The calculation tool identifies the processes shared with other product systems and deals with them according to the stepwise procedure presented below:

Step 1: Wherever possible, allocation is avoided by dividing the unit process to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes. An alternative option is expanding the product system to include the additional functions related to the co-products.

Step 2: Where allocation cannot be avoided, the inputs and outputs of the system are partitioned between its different products or functions in a way that reflects the underlying physical relationships between them; i.e. they should reflect the way in which the inputs and outputs are changed by quantitative changes in the products or functions delivered by the system.

Step 3: Where physical relationship alone cannot be established or used as the basis for allocation, the inputs are allocated between the products and functions in a way that reflects other relationships between them. For example, input and output data are allocated between co-products in proportion to the economic value of the products.

2.6.2 Allocation

The inputs and outputs of the life cycle are allocated to the different products and processes according to clearly stated procedures, which is documented and explained together with the allocation procedure. The sum of the allocated inputs and outputs of a process shall be equal to the inputs and outputs of the process before allocation. Whenever several alternative allocation procedures seem applicable, a sensitivity analysis shall be conducted to illustrate the consequences of the departure from the selected approach.

Allocation of environmental aspects may occur when a process produces more than one product. The basis for allocation in the calculation tool is primarily physical properties and secondarily economic value. If the allocation has low importance, it may be “cut-off”, i.e. not considered, instead all load is on the studied product.

In the calculation tool, the basis for all allocations made is mass ratio, e.g. production volumes in Lekolar’s and the suppliers’ manufacturing processes. Additionally, some assumptions are made which led to possible exclusions. All cut-offs and assumptions are stated and described in *2.2.6 Cut-off.*

2.6.3 Cut-off

The method chosen for the allocation procedure of the tool is the cut-off method. When the cut-off method is used, processes which can be assumed to contribute less than 1 % to the environmental impact do not have to be included (Baumann H. & Tillman A-M., 2004).

To the best of our knowledge, all input and output data for the processes are included, hence nothing is intentionally cut-off. Nevertheless, simplifications are made. The calculation tool uses a cradle-to-gate perspective, with an inclusion on end-of-life management. Additionally, simplifications and assumptions are made regarding the following:

- Transportation modes and distances between the material production sites and Osby
- Factors for different manufacturing processes
- Factor for the assembly of products
- Spillage rates for production of different materials

All simplifications and assumptions are described in detail in *4. Methodology for quantification.*

2.6.4 Data and data quality assessment

To meet the goal of calculation tool, the data is required to in a good way represent the studied system. None of the datasets used is older than five years, hence the data is considered applicable for the present processes it is intended to model. All datasets used in the tool are representative for the geographical region they intend to model; either the data is specific, or the generic dataset chosen originally represents the accurate region, or existing processes are modified to adapt to regional conditions relevant for the calculation tool. The technical representativeness for the modelled processes is considered sufficient, since the data used are representative both in time and in regional specifics, and nothing but conventional methods are considered.

Table 1 outlines the general prioritization rules governing the selection of emission and activity data. The simplified carbon footprint calculations rely exclusively on generic emission data. As for the activity data, a combination of specific, generic and proxy data is incorporated in the calculations. Most of the activity data is generic, and specific activity data is only used for the material composition. Additional details regarding emission and activity data can be found in *4. Methodology for quantification*.

Table 1. General priority rules for emission and activity data.

Type of data	Activity	Data source	Comment
Specific	Raw material composition Supply transport Manufacturing Distribution	Measured at production site	Producer specific data is used when available.
Generic	When specific data is unavailable	Ecoinvent 3.9	Ecoinvent 3.9 is an LCI database with around 17000 LCI datasets, updated annually and reviewed to ensure the data quality.
		Industry data 2.0	Industry data 2.0 is a database containing data collected by industry associations and was latest updated in 2019.
		Agri-footprint 5	Agri-footprint includes unit process inventories of crop production, crop processing along with data on transport and other auxiliaries. Agri-footprint 5 was last updated in December 2019.
Proxy	When specific and generic data is unavailable		Estimations based on similar processes or data gathered from published topical reports not included in the generic databases.

2.6.5 Uncertainty

Uncertainties with the calculation tool stems from various sources, encompassing data uncertainty due to incomplete or outdated information, model uncertainty arising from simplifications outlined in section *2.6 System boundary*, and parameter uncertainty, which encompasses factors like energy, manufacturing processes, and transport distances. To tackle these uncertainties, tools such as sensitivity analysis, completeness checks, and consistency assessments are employed. This is further elaborated upon in section *6. Interpretation of results*.

3 Life cycle inventory

The life cycle inventory includes the compilation and quantification of inputs and outputs for all products. The inventory covers a collection of activity and emission data from producers and LCI databases for the following key stages: (i) material production, (ii) material refining, (iii) assembly of products, (iv) inbound transportation and (v) end-of-life management. This is followed by calculations in which all data is related to the declared unit.

4 Methodology for quantification

4.1 General methodology

Two types of data are used when calculating the carbon footprints using the calculation tool, activity data and emission data. In both cases, the approach involves utilizing either specific data sourced from Lekolar or their producers or collecting data from established databases with reliable information.

For all the products included in the simplified carbon footprint calculations, activity and emission data is required for aspects such as: material composition and weights for the product, material extraction and material production, manufacturing of the product (assembly process), the transportation from supplier to Lekolar and end-of-life management. Details on activity and emission data are presented in the sections *4.1.1 Activity data* and *4.1.2. Emission data.*

4.1.1 Activity data

Lekolar collects specific activity data from their suppliers whenever feasible. In cases where specific data is unavailable, generic data is collected from acknowledged databases such as Ecoinvent 3.9.

More specifically, Lekolar provides data on material composition for their products, including the product weight and material content, along with details on transportation and country of origin. Transportation distances between the different suppliers and Lekolar's location in Osby, Sweden, are estimated using Google Maps.

The level of detail regarding the country of origin decides which approach to choose for distance assumption. In cases where the country of origin is known, the assumed distance is measured between the capital city and Osby. Notably, exceptions are made for Denmark and Germany, where distances are measured from Aarhus and Frankfurt respectively. In scenarios where the product's origin is described as Europe, the assumed distance is measured between Paris and Osby. When the country of origin is indicated as China, or when origin information is missing, the assumed distance is measured from Shanghai to Osby. For all transportations, informed decisions are made regarding the mode of transportation, encompassing various shipping modes such as truck, ferry, and container ship.

In addition, activity data for material production and the assembly of products is collected. In cases when specific data can be collected by Lekolar, processes within Ecoinvent are modified and completed with the specific data. When no specific data is available, generic data from Ecoinvent is employed for the relevant process.

4.1.2 Emission data

To ensure that data on emission factors is consistent, the Ecoinvent database is employed. When Ecoinvent lacks the necessary generic data, alternate databases such as Industry data 2.0 and Agriculture footprint 5.0 are used. In cases where generic data remains unavailable, the processes within Ecoinvent are updated with proxy data. Alternatively, proxy data from other databases or reports is incorporated to enhance the precision of system representation.

The generic data is further modified to represent the geographical region they intend to model. When specific data on geographical region is not available, a global perspective is employed for the processes. Nothing but conventional methods are used.

To analyse product manufacturing, it is necessary to obtain emission factors related to material production, material refining, and the assembly of products. Within material production, a factor for spillage is added to ensure a more accurate representation of the system. Specific spillage rates for materials like metals and plastics are already embedded in the generic data. However, for fabric and added colours, a 2% spillage rate is incorporated into the material production calculations. Furthermore, spillage rates of 30% for wood materials and 10% for ferrite magnets are used for the calculations. These spillage factors are established based on expert knowledge and industry experiences, providing a solid foundation for the analysis.

Furthermore, in cases where there is a lack of generic emission data for material refining, an additional factor of 45% is introduced. This value is determined as the average from the data collected for material refining, where complete generic data is accessible. In cases where specific or generic data is absent for product assembly, an additional 1,5% assembly factor is included in the emission calculations.

As for transportation, all emission factors are derived from Ecoinvent and expressed in terms of kilograms of CO_2 equivalents per kilogram per kilometre (kg CO2e/kgkm) for the different transportation modes. These factors are subsequently multiplied by the product's weight and the distances covered during transportation. Furthermore, default load factors and fuels are employed in the Ecoinvent transportation processes. For trucks, the assumed emission data pertains to a 16-32 metric ton lorry classified as EURO6, within the European context. In contrast, emission data for container shipping and ferries are considered on a global scale.

Finally, for the end-of-life management, all materials are categorised into six groups: (i) metals, (ii) paint, (iii) plastics, (iv) bioplastics, (v) textiles, and (vi) woods. If is further assumed that all metals and woods are recycled, while the paint, plastics, bioplastics, and textiles are incinerated as municipal waste. All emission factors are derived from the generic Ecoinvent database, due to the absence of specific data.

5 Impact assessment

5.1 General results

The outcome of the carbon footprint calculation indicates the potential impact of each emitted greenhouse gas on climate change. This is expressed using the IPCC Global Warming Potential indicator, which employs a 100-year time frame and presents the impact as $kgCO_2e$ per declared unit.

All simplified carbon footprint results are documented on Lekolar's official website and accessible via the individual product webpages.

6 Interpretation of results

6.1 Completeness check

The objective of the completeness check is to ensure that all relevant information and data needed for the interpretation are available and complete. If any relevant information is missing or incomplete, the necessity of such information for satisfying the goal and scope of carbon footprint calculations is considered, and these findings and its justifications are further recorded.

Overall, the inventory is considered to be modelled with sufficient representativeness and accuracy with regards to both system boundaries and data completeness for the goal and scope of the calculation tool. Data used to calculate the simplified carbon footprint is either supplier specific data or generic data from acknowledgeable databases meeting the requirements set for data quality and are therefore representative for the studied system.

However, the quantification of the calculation tool highlights aspects that require attention. One challenge refers to the absence of specific data, particularly concerning the transportation phase, assembly process and end-of-life management. Accurate and detailed information related to these stages is essential for comprehensive carbon footprint calculations. The scarcity of such data influences the accuracy of the calculations and highlights the need for improved data collection and transparency in these areas.

Additionally, the calculation tool highlights another challenge linked to the availability of data in generic databases. Specifically, there is a notable data gap concerning some of the material refining processes. The reliance on generic data from these databases can introduce uncertainties and inaccuracies into the calculations. Addressing this challenge requires collaborative efforts to enhance data coverage and quality within these databases.

Nevertheless, given the negligible influence of transportation and minor uncertainties associated with generic databases, the carbon footprint calculations are deemed to satisfy the quality criteria for the calculation tool. The available data can confidently serve the purpose of modelling and effectively pinpointing the phases that wield the most substantial impact.

6.2 Consistency

Consistency in data sourcing plays a pivotal role in establishing the credibility and reliability of carbon footprint calculation tool. In the context of the calculation tool, a significant portion of the data originates from the Ecoinvent database, renowned for its extensive coverage, which contributes to a robust foundation.

This commitment to consistency extends to the incorporation of regional data and the integration of market-specific processes. The approach to data sourcing maintains consistency across all products that are included in the simplified carbon footprint calculations.

6.3 Uncertainty and sensitivity analysis

When calculating the carbon footprint, it is necessary to recognize and address uncertainties associated with the data sources and methodologies employed. Moreover, the sensitivity of the system to changed conditions varies across different aspects. Hence, this section discusses some uncertainties and sensitivities related to the calculation tool.

The calculation tool relies on the Ecoinvent 3.9 database, which is recognized for its comprehensiveness and depth of environmental data. Nevertheless, it is crucial to recognize that even such a robust database is not immune to sources of uncertainty. These include data completeness, data quality, temporal factors, and geographical specificity. While Ecoinvent aims to provide a comprehensive representation of processes, it may not encompass all possible variations or emerging technologies.

The use of generic data introduces its own set of uncertainties. Generic data offers a simplified, average representation of products and processes, which may not precisely align with the specific circumstances of the system being analysed. To account for these uncertainties, a conservative approach is taken by incorporating additional factors. This approach involves adding conservative estimates to data points where specific data may be lacking, ensuring that the calculation tool errs on the side of caution.

To gain deeper insights into the robustness of the result, a sensitivity analysis is conducted to identify the areas within the system that are particularly sensitive to altered conditions. One key observation is the limited impact from changes in the transportation stage. Changes in transportation modes and efficiencies have relatively small effects on the overall carbon footprint of the assessed products. This observation underscores the significance of emissions generated from other stages of the product life cycle, indicating that transportation, while important, may not be the primary focus for substantial emissions reductions.

In contrast, another noteworthy finding is that the majority of the emissions are generated during the stages of raw material production. This finding emphasizes the key role of these early stages in the product life cycle in determining the overall environmental impact. As such, efforts to reduce the carbon footprint of the assessed products should prioritize interventions in these areas, e.g., by reducing the amount of materials used.

6.4 Limitations

When calculating the simplified carbon footprint, there are some limitations to bear in mind. The methodology includes only one impact category, Climate Change, which enables to provide a single score for the product's impact. However, this means that other environmental aspects, as well as social and economic aspects are missed out on. This limitation provides a rather narrow perspective.

Furthermore, the calculation tool excludes the use phase, meaning that the tool does not account for the environmental effects during product use and maintenance. However, this exclusion does not expect to have any significant impact on the overall carbon footprint, given that the majority of Lekolar's products are passive. Therefore, the use phase emissions are assumed to be negligible.

6.5 Comparability

LCAs and EPDs have previously been conducted for a variety of Lekolar's products, and their outcomes are used to communicate the carbon footprint of these products. Consequently, it is likely that the results of these assessments will be compared with the simplified carbon footprints obtained from the calculation tool.

The methodologies behind the calculation tool, the LCAs and the EPDs differ in terms of their depth and precision. LCAs and EPDs offer a comprehensive overview of multiple environmental impacts. EPDs also provide other standardized environmental data for informed choices. The calculation tool is specifically designed to enable simplified high-level assessments of the carbon footprint of products.

The LCAs and EPDs include specific emission and activity data to a larger extent than the calculation tool. Additionally, all LCAs and EPDs adopt a cradle-to-grave perspective, considering emissions throughout the entire product life cycle, whereas the calculation tool employs a cradle-to-gate perspective (with end-of-life treatment included). This is particularly important to consider when comparing carbon footprints of various products, as the cradle-to-gate perspective exclude certain activities such as transportation, energy consumption etc. in the use phase.

The differences in methodologies underscore the importance of communicating the assessment type and its specific methodologies alongside the carbon footprint results. All results are presented on Lekolar's official website. Comprehensive reports supporting the EPDs are made available on the product webpages, while for products that are included in an LCA, a complete report can be provided upon request.

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