The Transition from Corporate to Product Carbon Footprinting

Developing a Configurable and Parameterizable Life Cycle Assessment Model for Printed Circuit Boards

1 Project Info

This work demonstrates how companies can be supported in transferring their corporate **Life Cycle Assessment (LCA)** to the **product level**, covering a **cradle-to-gate** perspective to identify environmental hotspots. Using an exemplary rigid-flex printed wiring board, relevant processes, material inputs, and energy flows are examined, including Scope 1, 2, and 3 upstream emissions. Furthermore, the study illustrates the **development of a methodology** and underlying **Product Carbon Footprint (PCF) models** that enable parameterization and ensure transferability to other products.

2 Technology & Application Fields

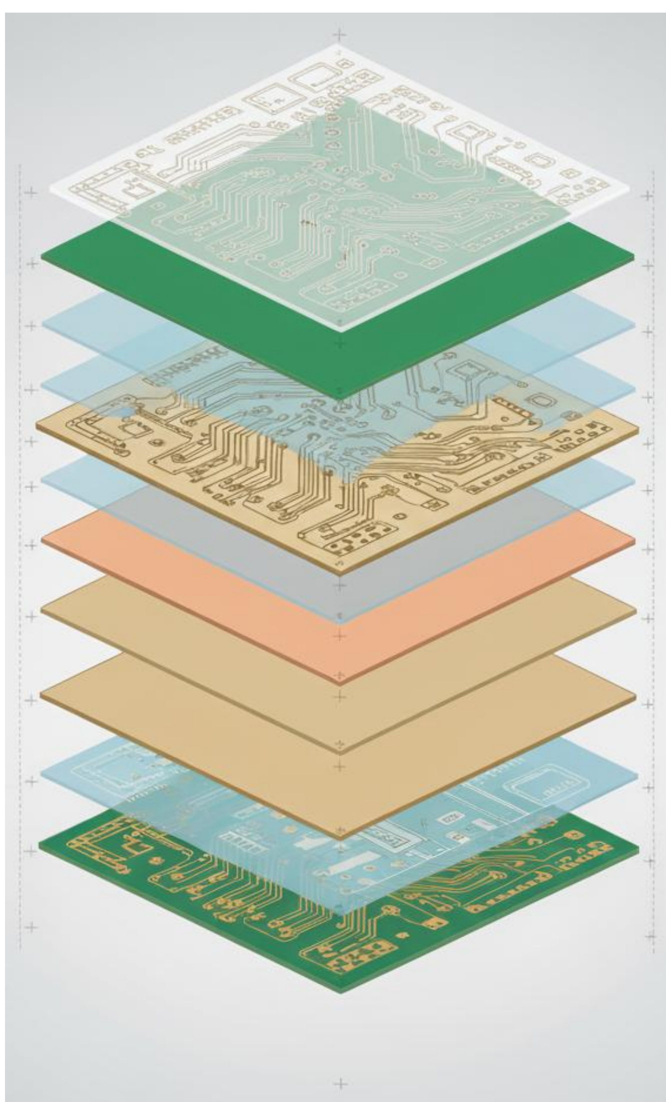
Rigid-flex PCBs are used where compact designs exposed to dynamic mechanical stresses are required, such as aerospace systems, medical implants, military electronics, consumer devices like smartphones and cameras, and automotive electronics for sensors and control units.

3 The Challenge Companies Face

Currently, there are **no robust standards** or scalable models with underlying datasets for determining the PCFs of printed circuit boards. It is therefore necessary to **collect** a wide range of specific environmental data on **processes, material flows, and energy flows**. This is further complicated by the **high product diversity** and cross-functional complexity within companies, which often leads to product-related or functional groupings.

As a basis for efficient data collection in PCF determination, a company-wide understanding of life cycle assessment is of central importance. To this end, a PCF methodology tailored to the company's specific products and manufacturing processes, while incorporating hotspot analysis, plays a key guiding role.

The identification of emission hotspots serves to pinpoint products, components, and manufacturing processes that drive emissions, so that these can be examined in greater detail. At the same time, it enables a cost-benefit assessment to abstract products or manufacturing processes that contribute only minimally to the PCF.



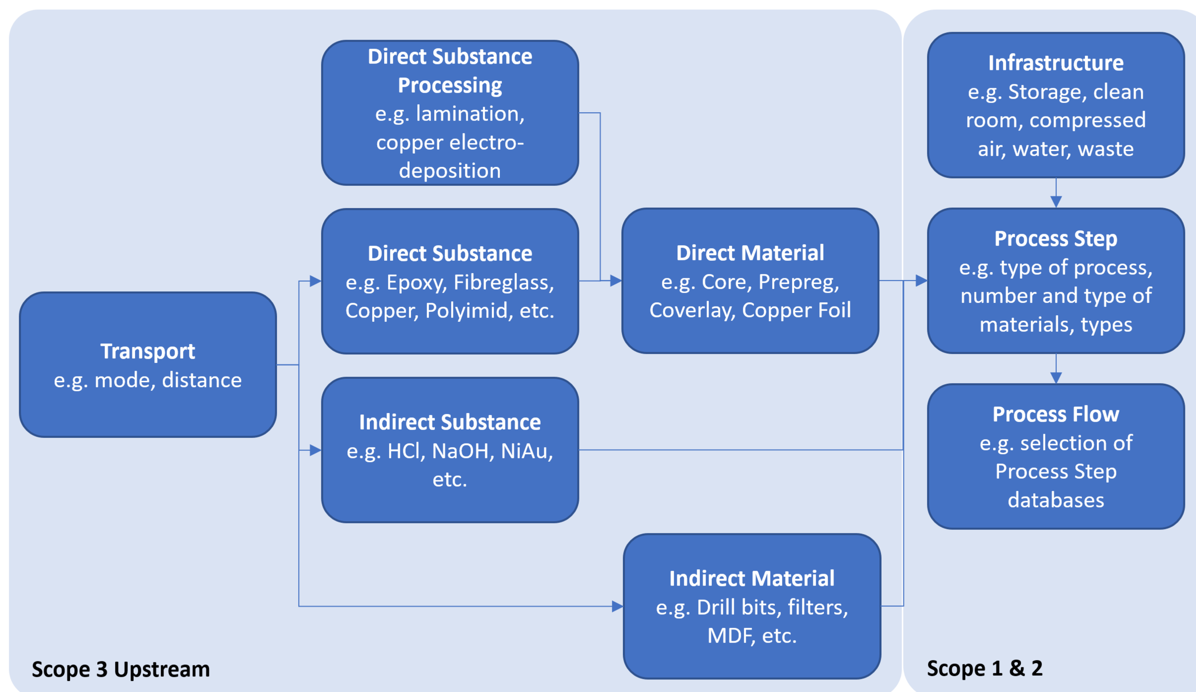
4 Project Goals & Methodology

The goal is to build capabilities in methodology development, data collection, data modeling, and interpretation of results. Based on an exemplary rigid-flex PCB by Würth Elektronik, Fraunhofer IZM supports the determination of the PCF and assists in developing a methodology and underlying data model that can be scaled and transferred to other products.

Würth Elektronik collects the relevant primary data for the associated Scope 1 & 2 emissions for the life cycle inventory, while Fraunhofer IZM supports with the determination of emission factors and emissions from the upstream supply chain – Scope 3.

During a first PCF iteration a top down approach is followed, transferring Würth Elektronik's competences in corporate carbon accounting to the product level.

Allocation of annual energy and material consumptions per process step are allocated to surface area per processed PCB layer. The data model allows a subsequent transition to a product specific bottom up approach during future iterations.



5 Future Potential

Parameterisable LCA models for PCBs enable scalable, flexible, and transferable assessments across different technologies. By integrating key process parameters, material compositions, and energy flows into adaptable models, companies can quickly generate product-specific PCFs. This reduces efforts and costs but also allows for scenario analyses, sustainability-driven design choices, process optimizations, or supply chain changes.

6 Contact

chris.eckstein@izm.fraunhofer.de
Fraunhofer IZM
Gustav-Meyer-Allee 25, 13355 Berlin

WÜRTH ELEKTRONIK

Fraunhofer IZM

Gefördert durch:
Bundesministerium für Forschung, Technologie und Raumfahrt