OVERVIEW OF THE MICROSOFT CONSUMER DEVICES LIFE CYCLE ASSESSMENT METHODOLOGY VERSION 2.0

Author: Environmental Compliance & Sustainability Team

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At Microsoft, actions to reduce the environmental impacts of our activities are driven by data. We achieve reductions in the carbon footprint of Surface, Xbox, and other products by implementing a structured Ecodesign approach that balances design decisions based on technical, economic, and environmental considerations.

The process we use to quantify the environmental impacts of devices and measure improvements is Life Cycle Assessment. Life cycle assessment or LCA is the systematic assessment of environmental impacts associated with all the stages of the life cycle of a product, process, or service. We follow the recognized procedures for conducting LCAs in the ISO 14040 and ISO 14044 standards, along with additional guidance available through various initiatives including the Product Environmental Footprint initiative driven by the European Commission.

Life Cycle Assessment limitations

While LCA is a powerful tool for estimating quantifiable environmental impacts such as greenhouse gas emissions and consumption of mineral resources, it also presents some limitations:

- **Modeling impact and use of secondary datasets**
  - Modeling relies heavily on generic processes in commercially available databases. These processes are usually based on averages and literature data and are often outdated and not representative of the latest technologies nor the supply chain of a company.
  - These models are often aggregated preventing the LCA practitioner from incorporating supply chain specific data.
- **Scalability is limited**
  - Modelling a product or service in LCA software is time consuming. Data collection is done manually through products teardown and data is manually entered into the LCA model by an expert. This limits the ability to scale the use of LCA to a large number of products.

These limitations present significant challenges to the use of LCA in the decision-making processes of companies, organizational scope 3 emissions reporting, scaling the measurement and communication of the environmental impacts across the product portfolio, and periodic quantification of suppliers' impacts and progress over time.

An innovative approach to LCA

To transform our LCAs from being a purely directional modeling process to a more supply chain specific environmental impact accounting process, **Microsoft has invested in an innovative approach leveraging internal software engineering teams and Makersite**, an AI and data company specializing in digital twins to power sustainable products and supply chain decisions at scale. Our new approach was created to automate and scale the modelling of complex electronic products with a significant increase in accuracy, transparency, and representativeness. The key differentiation from common practices is that Makersite's artificial intelligence analyzes the bill of material (BOM) of each device and the material composition from full material declarations (FMD) collected from suppliers to automatically model each part, component, and sub-assembly down to its actual chemical composition. A model of a representative manufacturing process is associated with each part in the BOM using data from Makersite, IDEA and Ecoinvent, cutting out much of the manual effort and providing our LCA practitioners a running start. Effective scaling up of this modeling

is enabled by integration of our product data management system with Makersite. LCA experts are still involved in the process. They focus on completing the model with suppliers' primary data, performing quality analysis and ensuring the model is representative. We refer to our new approach and methodology as Microsoft's Devices LCA Methodology Version 2.0.

Commitment to continuous improvement

The LCA database is not immune to the limitations described in the previous section; however, the data is fully disaggregated allowing Microsoft to progressively replace generic data by suppliers' specific (primary) data. This data focuses on aspects significantly contributing to the carbon footprint of devices such as suppliers' energy data, manufacturing scrap rates, and recycled content. Microsoft also participates in research projects such as the IMEC Sustainable Semiconductor Technologies and Systems (SSTS) to better understand, measure, and reduce the environmental impacts of key electronic components such as integrated circuits. Our transition to the new LCA approach and methodology enables us to scale up our collection of supplier data and integrate it into LCAs.

Benefits of Microsoft Devices LCA Methodology Version 2.0

The benefits of transitioning to Microsoft's Devices LCA Methodology Version 2.0 include:

- **Improved quality and representativeness**
    - of the modelling of the product's composition leveraging full material declarations shared by the suppliers
    - Parts are modelled down to their chemical composition by leveraging supplier provided full material declarations, with data quality checks performed by Microsoft LCA practitioners
    - Disaggregated model that enables progressive replacement of secondary datasets by supplier specific (primary) data to model manufacturing processes
    - The percentage of the total carbon footprint calculated based on suppliers' primary data went from an average of 20% in the previous LCA methodology (a level representative of most complete LCAs) to close to 50% with the new methodology.
        - Material composition and quantities are from suppliers
        - Manufacturing process of sub-assemblies is by default modelled with secondary data from the LCA database but is progressively replaced by suppliers' primary data
        - Production of the raw material is modelled by default using secondary data from the LCA database but is progressively being replaced by material suppliers' primary data
- **Increased accuracy** by reducing the inconsistencies associated with the LCA practitioners' decisions, such as choice of datasets
- **Reduction of the modelling time** allowing us to focus our efforts on collecting and processing suppliers' primary data and performing data quality assurance and data analysis
- **Better identification of environmental impact hotspots** in our supply chain
    - The first LCA results conducted through this new methodology demonstrate that LCAs relying on secondary datasets rather than suppliers' primary data have a high level of uncertainty and can underestimate impacts from intensive manufacturing processes. This lack of technological

representativity of secondary datasets is true for a wide range of material, manufacturing processes and electronic components. For example,, secondary data used to model Integrated Circuits is based on 12 years old data. We also found that the Computer Numerical Controlled (CNC) machining process modelled using primary data from Microsoft's supplier is up to 20 times more carbon intensive than the generic datasets available in the most recognized Life Cycle Inventory databases. This difference is due to the low technological representativity of the secondary datasets available in LCA databases.

- Enable the measurement of **benefits associated with potential increase in product lifespan due to repairability**

Transition to our new approach

Starting in October 2022, the environmental impacts, including product carbon footprint we publish in new Ecoprofiles will be calculated using Microsoft's Devices LCA Methodology Version 2.0 and will include a reference to the Methodology Version 2.0. Over time we will use Microsoft's Devices LCA Methodology Version 2.0 to update the LCA results and Ecoprofiles for older products to achieve consistency across our entire product portfolio. In the meantime, Ecoprofiles for products launched prior to October 2022 will remain available and will display LCA results using our previous methodology (Microsoft Devices LCA Methodology Version 1.2).

Due to the differences explained above, **LCA results from the different methodologies are not comparable**. A higher reported product carbon footprint for a new device as calculated by using Microsoft Devices LCA Methodology Version 2.0 does not indicate that its environmental impacts are greater than an older device as calculated by using Microsoft Devices LCA Methodology Version 1.2. On the contrary, we are making improvements to our products from one generation to the next to drive down the per-product carbon footprint. A higher carbon footprint using Microsoft Devices LCA Methodology 2.0 can be attributed to the change in our data sources and scope expansion of the LCA to include more breadth and depth into the supply chain and manufacturing processes.

Our goal is to improve the representativeness, granularity, and consistency of LCA results. As we continue working with the new methodology and produce results for older products going back to 2020, we will build a robust database of product and component LCA results that will give us and our customers greater insights into our carbon reduction progress. Updated LCA results for many of our older products will be available in early 2023.

Promoting transparency and collaboration

Microsoft's Devices LCA Methodology Version 2.0 is a first step towards the development of a more accurate, representative, scalable, and dynamic Life Cycle Assessment approach. Supplier specific (primary) data is vital to understanding the environmental impacts of our products and is best achieved by collaborating with others in the industry. Therefore, this methodology and the learnings from this new approach to LCA will be shared externally to support industry collaboration and alignment.

Additional resources

IMEC Sustainable Semiconductor Technologies and Systems (SSTS)

Microsoft Devices Ecoprofiles

Notes

This document may be updated for clarity or to reflect changes to our devices LCA methodology over time. Please refer to the most recent version of this document available on our website.