

Understanding the uses and limitations of PAIA, a streamlined LCA methodology

Abstract

Sustainability is an integral part of everything we do here at Dell Technologies. Understanding the environmental hotspots throughout our product's life cycle can improve our overall understanding of technology's environmental impacts and performance. Streamlined Life Cycle Assessment(LCA) methodologies, such as PAIA, provide many benefits such as driving performance improvements, meeting stakeholder expectations, and complying with anticipating legislative requirements. However, it is important to understand the limitations if it is to be used effectively. This whitepaper explores what streamlined LCA's such as PAIA can and cannot be used for.

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Introduction

Individuals and organizations the world over recognize the urgent need to take action to reduce our overall impact on the environment. Understanding the effects purchased products and services have on climate, habitats, natural resources, water quality and more is increasingly important. Life Cycle Assessments (LCAs) and Product Carbon Footprints (PCFs) provide customers with specific insights into those effects and enables more informed purchasing decisions.

Information Communication Technology (ICT), such as computers, mobile phones, televisions, etc. are complex, pervasive, and growing continuously. In response to this, numerous standards bodies and industry consortia have developed, and are continuing to work on, methodologies to evaluate the carbon impact of ICT products. Consortia such as [PAIA](#) are currently working on associated initiatives.

At Dell Technologies, we make sustainability an integral part of everything we do. We feel a deep responsibility to innovate for our customers and our planet, using all the levers at our disposal to make technology work for the world we need. As part of our process, we use PAIA, a streamlined LCA methodology, to estimate the specific impacts throughout a product's lifecycle. This streamlined methodology focuses only on the carbon impacts of a product class.

This whitepaper explains the difference between PAIA's streamlined LCA methodology and traditional LCA. It also explores the capabilities and limitations of PAIA.

What is LCA?

A life cycle assessment is the compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle' – ISO 14040: 2006, sec 3.2. LCA is an approach that covers the whole life cycle of a product or a service, usually "from cradle-to-grave," i.e., from raw material extraction, to manufacturing, packaging, distribution, use and end-of-life management.

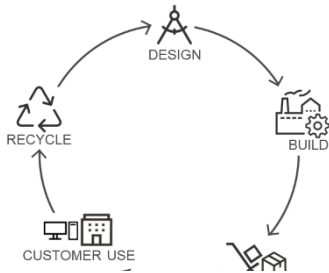


Figure 1: Life Cycle Assessment phases

LCAs can cover a wide range of environmental impacts such as use of resources, raw materials, waste or biodiversity. Many LCAs focus narrowly on selected impacts such as water, ozone or carbon among others, though carbon is considered the most robust and widely used impact category.

What are the main reasons for carrying out LCA?

LCA identifies the main contributors (materials, energy sources, etc.) to key environmental impacts throughout the products entire life cycle and establishes a benchmark against which improvements can be measured.

Understanding the environmental hotspots in the life cycle can provide a unique opportunity to rethink relationships with our suppliers, especially in terms of developing concepts of mutual progress and through improved information exchange and transparency.

“LCA is the compilation and evaluation of the inputs and outputs and the potential impacts of a product system throughout its life cycle.”

Definition from the International Standards Organization (ISO).

PAIA's Streamlined LCA vs. LCA

Dell uses [PAIA](#) (Product Attribute to Impact Algorithm) to perform PCF analyses. PAIA is a streamlined LCA tool developed by [MIT's Materials System Laboratory](#) in concert with Arizona State University, and University of California at Berkeley. PAIA is a streamlined LCA tool that aims to provide an efficient and cost-effective estimate of the carbon impact of a product class, including notebooks, desktops, LCD monitors, servers, network switches and storage. It takes into consideration important attributes of the product that can be correlated to specific activities in order to calculate the overall product carbon footprint, such as screen size, system weight and annual energy consumption.

The PAIA tool conforms with [IEC 62921](#) requirements and uses data from participating companies and secondary emission factors from third party sources (such as Ecoinvent). Statistical analysis generates an estimate of the carbon impact at a component level together with the standard deviation (margin of uncertainty). PAIA enables the PCF to be estimated without the need to calculate it from scratch. The results are therefore based on hardware characteristics and may not capture the specifics of the production process. The results of the PCF analysis reflect our understanding at the time of publishing and are not directly comparable with those conducted by other parties or at other times due to differing assumptions.

The difference between PAIA's streamlined LCA and an LCA is related to the impact categories which are analyzed. PAIA's streamlined LCA only estimates the carbon impacts associated with a product's lifecycle and is often expressed as Greenhouse Gas emissions, in the form of CO₂ equivalents (CO₂e). CO₂e is a useful term for describing different greenhouse gases in a common unit. CO₂ only accounts for carbon dioxide while CO₂e accounts for carbon dioxide and all other gases as well, such as methane, nitrous oxide, and others.

An LCA takes additional impact categories into account, such as land use, water use and acidification

Unlike an LCA, a carbon footprint can be expressed as a single number: e.g., the carbon footprint for a Latitude 5510 is 348 kgCO₂e.

For this product, the estimate has a mean of 348 kg of CO₂e and standard deviation (margin of uncertainty) of 67 kg of CO₂e. Therefore, 348 kg of CO₂e is what we refer to as the Products Carbon Footprint (PCF).

This product's estimated carbon footprint:

348 kgCO₂e +/- 67 kgCO₂e

Estimated impact by lifecycle stage with breakout for manufacturing by component:

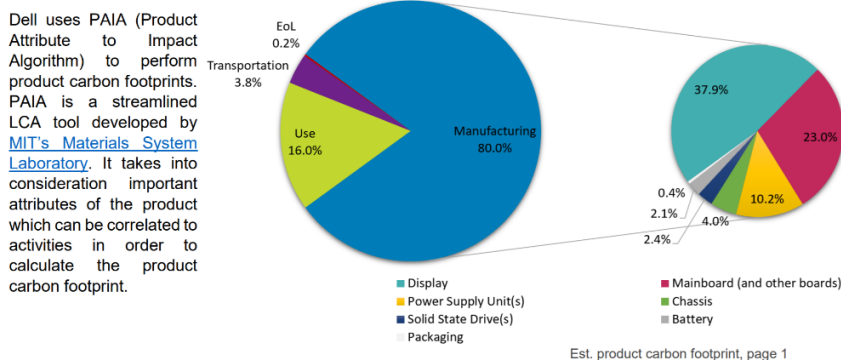


Figure 2: PCF estimate of a Latitude 5510

Click [here](#) to view Dell's Product Carbon Footprint Datasheets

Why do we use PAIA Methodology for Product Carbon Footprint Analysis?

ICT products typically consist of many different components and have long, complex value chains that are scattered geographically. As a result of this, assessments can be costly and time consuming to produce. Additionally, product portfolios tend to evolve rapidly which means that in-depth studies may be out of date quickly. PAIA's streamlined LCA methodology offers an easy-to-use platform to perform a quantitative evaluation of the carbon footprint of ICT products and reduces the time and cost of doing so.

What is streamlined LCA Intended for?

In general, LCA and PCF can be used to:

- provide a reasonable estimate of the range of carbon impact of a product.
- identify the major drivers of impact, or carbon intensive hotspots in the lifecycle of the product, thus identifying where reduction strategies should be focused.
- estimate changes in the environmental impact of a process or product over time.
- spark conversations related to sustainability with suppliers or to innovate new processes/materials uses.

What streamlined LCA cannot be used for?

In general, LCA and PCF cannot be used to:

- compare results of ICT products head to head (i.e. laptop A against laptop B) in terms of carbon impact.
- compare products between other manufacturers.
- aggregate individual LCA/PCF studies to derive a figure for the total carbon impact of ICT and use this figure as a benchmark for reduction targets.

Understanding the Limitations of Streamlined LCA Methodologies

Streamlined LCA methodologies, such as PAIA, provide many benefits such as, driving performance improvements, meeting stakeholder expectations and complying with anticipating legislative requirements. However, it is important to understand the limitations if it is to be used effectively.

Uncertainty

In practice, we cannot compare similar products on the basis of streamlined LCA due to the uncertainty, and therefore lack of consistency, of LCA and PCF results. Measurement inaccuracies, allocation inconsistencies, outdated or obsolete data sources, human bias, error, are all contributors to data uncertainty, thus, uncertainty and variability can never be eliminated entirely. ICT products in particular are prone to uncertainty due to the high speed of evolution within both the technology and its manufacture. The issue with rapidly evolving areas of technology is that you cannot compare like for like over time because the original product has ceased to exist.

Data

Databases are used since it is impractical to collect all the necessary data from original sources. While databases are improving, practitioners need to understand all the assumptions, the age of the data, etc., and this may not be possible for every single data point. There are numerous assumptions made during the analysis. Streamlined LCA methodologies such as PAIA are not robust enough to reliably compare laptop A against laptop B, for instance because of differing assumptions, the use of secondary data and uncertainty in data.

The way we use numbers

There is a strong desire to compare LCA and PCF results. However, the lack of context is particularly problematic when it comes to making such comparisons. If company A publishes LCA or PCF data for a laptop, and company B does the same about its competing device, the immediate temptation is to compare those results. But comparing those results without knowing all the assumptions made, the data sources, databases and tools used is meaningless. Even if the two analysis used the same methodology and tried to match the assumptions, the margin for error would almost certainly make the comparison a pointless exercise.

Understanding the Limitations of PAIA

For full detailed accounting of PAIA's Intended Uses and Limitations please refer to the accompanying guidance document titled '[Intended Uses & Limitations of the PAIA Model](#)'.

Conclusion

Overall, streamlined LCA methodologies such as PAIA are a useful means of identifying which parts of a products life cycle have the most significant carbon impact so that organizations can concentrate on the delivering the greatest improvements. It is also a useful tool for companies to explore the impact of changes to materials or processes on the product's global warming impact. As with any other tool, streamlined LCA tools should be used for the purpose for which it is designed: for identifying the most carbon intensive points in the lifecycle.

As outlined above, there are several limitations to a streamlined LCA methodology. Without strict obligation to model products based on exactly the same assumptions and databases, the margin of uncertainty is likely too great to use LCA and PCF results to compare products in a meaningful way.

Streamlined LCA based methodologies such as PAIA are not designed or equipped to provide all the answers on the carbon impact of ICT products. And while they may not supply us with all the answers we seek, they are providing important insights in certain areas and if allowed to evolve and develop, will certainly play a pivotal role in improving our overall understanding of the environmental impacts and performance of ICT products.

ADDITIONAL RESOURCES

Click [here](#) for Dell Product Carbon Footprint Datasheets

Click [here](#) to learn more about PAIA

support@dellgpc.zendesk.com

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