Ericsson White Paper
GFMC-24:000065 Uen
February 2024

ERICSSON

Embodied carbon in the telecom industry

A streamlined approach to assessing the carbon emissions of telecom equipment

Content

Executive summary

In response to scientific alarms about climate change and its impact, the transition towards a Net Zero emission society will be vital. Consumer demand and the societal transition has already resulted in cost increases and regulations but more metrics are needed, such as greenhouse gas (GHG) emissions related to purchased products. The telecom industry is at the forefront and many communications service providers have ambitious Net Zero targets and strive for zero GHG emissions across their full value chain, which is why they need to know the emissions from the use of purchased products and the production of those products. GHG emissions associated with telecommunication networks depend, to a large degree, on the energy mix used to operate it and the upstream emissions from the supply chain related to the production of hardware products of the network. This paper recommends assessing these emissions separately, leading to more valuable data for improvements.

Upstream GHG emissions occurring from raw material acquisition, including extraction, initial processing of materials and the material transports, up to the final product delivery, are the so-called embodied carbon emissions. These can be used as an indicator to estimate the category of capital goods under Scope 3 in the GHG protocol. These measurements are gaining momentum throughout the telecommunications industry.

The current state of assessing the different embodied GHG emissions across the value chain presents a significant challenge to transparent measurable industry-wide efforts. An easy to use and streamlined method to assess product-level embodied GHG emissions that is also harmonized across the industry doesn't exist.

A scalable, streamlined methodology that is granular enough is required to be adopted in the industry to foster consistency, comparability and transparency when assessing product level GHG emissions. There is also ongoing standardization activity within the International Telecommunication Union (ITU).

The objective of this paper is to present a methodology that estimates the embodied GHG emissions in a way that fulfills the telecom network infrastructure vendors' internal needs, for example, for product design improvements, and for external reporting, but also to support our customers in their Scope 3 upstream GHG accounting and decision making.

To reach a consensus on a common methodology for embodied carbon emissions assessments that is streamlined, scalable and compliant with industry standards should be a common wish for the telecommunication sector [1]. The proposed approach in this paper can enable vendors to generate consistent and reliable data on the embodied carbon footprint of their products, fostering a more transparent and informed market.

Industry transformation towards Net Zero

The evidence is clear: Current climate change is human induced [2]. To limit global warming to 1.5°C above pre-industrial levels, scientists say the world must reach Net Zero by 2050 at the latest. To achieve this, the global GHG emissions must be halved by 2030 compared to 2020, and then halved again by 2040 [3].

Joint efforts are needed globally to drastically reduce GHG emissions, and the telecommunications industry is committed to this objective.

To reach Net Zero across the value chain, emissions from all life cycle stages must be reduced. Society is progressing towards a future with less GHG emissions, and with that, the demand for assessing GHG emissions related to purchased products is increasing.

GHG emissions from products in use are quite straightforward to assess, while GHG emissions released during the production are not. The assessment of GHG emissions from production must often rely on data from complex supply chains. One way to capture the supply chain GHG emissions is to assess GHG emissions embodied in purchased products.

To date, 62 service providers representing 61 percent of the industry by revenue and 46 percent by connections have committed to a science-based target of rapidly decreasing their direct and indirect emissions by 2030. Several service providers have also committed to Net Zero targets by 2050 or earlier, representing 39 percent of mobile connections and 43 percent of global revenues [4]. This will, in practice, mean that they must actively reduce not only their own GHG emissions, but also emissions across their value chain. The sector is actively shifting to renewable energy, moving from a global average of 24 percent (Europe: 80 percent, the US: 40 percent) in 2022 to an expected 65 percent in 2030 [5]. When service providers upgrade the energy used for running networks to renewable or fossil-free energy, emission reductions upstream become more important to address.

Among telecom network equipment vendors, it is also common practice to have Net Zero targets in place and to actively reduce both their direct GHG emissions and those across their value chain. Network equipment vendors typically have their largest emissions in the use phase, making energy performance of products a priority.

For equipment vendors in the forefront with ambitious Net Zero targets, supply chain actions are increasing. Measures to reduce the supply chain GHG emissions consist of low carbon design, such as light-weight equipment, low carbon material selection and supplier engagement programs.

However, a challenge is the availability of harmonized metrics on the product level that can be used to track supply chain GHG emission reductions. There is a need for such a methodology that is detailed enough to guide design and purchasing, while not being extremely complex. Such harmonized metrics could also support service providers in their ambitions to reduce their supply chain emissions. To succeed in this challenge, a streamlined approach for calculating product embodied emissions could be used. Imagine balancing accuracy through a systematic and robust approach, with speed by standardizing and generalizing components and materials used.

The telecom sector has made ambitious voluntary commitments to reducing its GHG emissions. In addition, both vendors and service providers are subject to legal requirements making them obliged to report and disclose information on their GHG emissions and reduction plans.

Although the European Union (EU) is regulating on these topics through the EU Corporate Sustainability Reporting Directive (CSRD), the reporting requirements are also coming from other regions, such as the US, Australia and Asia. These external disclosures need to be fact-based and follow standardized protocols, and are often scrutinized by auditors.

Product embodied carbon values are also being requested in the newly decided European Carbon Border Adjustment Mechanism. So far, these requirements are not specifically for complex ICT products, but the likelihood of this becoming generally required for products in all sectors is high.

Companies require data from their value chain to be able to report the GHG emissions within their annual Sustainability and Corporate Responsibility statements. This reporting has evolved into a key performance indicator (KPI) for investors evaluating the sustainability performance of companies. For companies with substantial upstream emissions, the embodied GHG emissions is a key metric for the category of capital goods under Scope 3 in the GHG protocol.

Assessing the environmental impact of products

Life cycle assessment (LCA) is the preferred methodology to determine the full environmental impact of products, including telecommunication networks. In 1994, the International Organization for Standardization (ISO) created today's LCA standards, including guidelines and the principles and framework. LCAs involve many modeling choices and include large datasets across the life cycle of a product. For telecommunication network products, this is extremely complex, and the data collection is challenging, both due to the complexity and nature of the products and the limited data maturity in some segments of the supply chain. LCA results are always model-based representations of the real environmental impact, which can only be understood in relation to the limitations, boundaries and conditions set in the modeling.

A full LCA investigates multiple environmental impact categories, such as climate change, resource depletion, toxicity and so on. The ITU L.1410 standard promotes climate impact assessment as the most important impact category to assess by positioning it as the only mandatory category. Information based on an assessment of solely climate impacts cannot be used to make conclusions regarding other impact categories, and an LCA covering only climate change does not give an understanding of a product's full environmental impact [6]. This paper only focuses on climate change.

As reflected in the ITU L.1410 standard, LCA results are not comparable between suppliers and not even full LCAs provide a proper basis for product comparisons without ensuring similarity in assumptions, background data and modeling. For this reason, and due to its complexity and demand for qualitative resources, detailed LCAs are less suitable as a basis for monitoring the development of a large range of products. As this is true for detailed assessments, it is even more true when applying simplified approaches, which are usually, to a larger extent, based on generic data and simplifying assumptions. The ITU L.1410 Appendix IX [7] gives a description of limitations related to the use of LCAs.

There is a need to assess and communicate the life cycle impact of products beyond the detailed approaches of the ITU L.1410 standard. Crucially, there is a need for a streamlined approach to assessing the impact of individual products. Such data can provide information for different needs, such as input for:

- companies' Scope 3 upstream reporting
- environmental impact product evaluation and hot spot analysis
- information to end users
- assessment of services

Even though the use phase of telecommunication network equipment is normally the life cycle phase with the biggest carbon emissions, there is value in identifying GHG emissions occurring while producing a product. These embodied GHG emissions can be assessed using different simplified approaches. In this paper, we investigate a product characterization methodology for embodied carbon emissions.

All environmental impact assessments, both full LCAs and streamlined methods, come with big uncertainties but are crucial for both producers and consumers to understand the environmental impacts of products and services.

There are several sources creating uncertainties:

1. The boundary and scope need to be clear (what's included and what's not). An example is when assessing emissions from transportation — is the impact from the production of cars and infrastructure, such as the roads, included or not? Another example is overhead or office work and related activities like business travel, which are activities that are typically not included, especially not consistently across the whole supply chain.

2. The use of generic secondary data sets from different data providers is another source creating uncertainties, for example the age of data and how representative they are for the supply chain of the assessed product.

3. To establish an emission factor for a component or part of a product almost requires a small LCA of its own. Just the difference in GHG emissions per consumed kWh of electricity varies around the world and can vary from one utility provider to another in the same region. For complex electronic products with large complex supply chains, many "mini-LCAs" may be required.

Some of these uncertainties could be mitigated in the future as suppliers enhance their emission data.

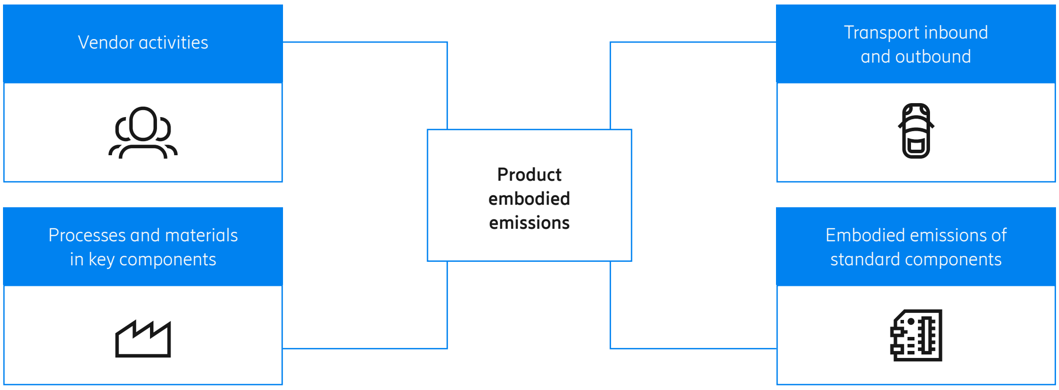
How to streamline the assessment of embodied emissions

Telecommunication network products generally comprise thousands of components, from small resistors to large heatsinks.

The current LCA method requires having environmental impact data on all the thousands of individual components and all the processes across the entire supply chain involved in manufacturing the product. This would require a paramount effort to develop, maintain and secure quality across all these data points, with limited contribution at the product level. Having more streamlined methods allowing scalability to large portfolios of products is needed.

Embodied carbon emissions are the emissions occurring from the material extraction, refining and transport, supplier production of parts and components, and the telecom vendor’s production and transport up to customer delivery.

Figure 1: Different components comprising product embodied emissions



To avoid the unnecessary complex task of making full LCAs for all products in a broad product portfolio with data points across the supply chain, our proposal is to develop a streamlined parameterized methodology.

The calculation should cover the extraction, refinement and transportation of raw material, supplier production of parts and components and their transport, as well as the telecom vendor's production and transport up to customer delivery. The methodology streamlines product data, enabling a more efficient assessment of the embodied GHG emissions.

Having conducted comprehensive LCAs in accordance with the ITU L.1410 standard for several years on selected products, we have a solid foundation for understanding the material and processes that have the most significant impact on the embodied GHG emissions of a product.

Defining the product composition

To enable a streamlined assessment, the product composition must be defined. This is done via the bill of material (BOM) for the full product, including all components.

Group standard components

With the structure of the full product and all its thousands of individual components, the grouping of components can start. Small standard components are grouped into around 20 different categories, such as resistors, and each item is assigned a standard factor depending on the category. The bigger components that remain (approximately 100) are more complex non-standard items that will need manual handling. These non-standard components correspond to the majority (more than 95 percent) of the embodied carbon emissions.

Deep dive on key components

The next step is to manually handle the non-standard components by retrieving more detailed information that affects the GHG emissions, such as dimensions (typically weight), raw material content and actual processes and yield needed to manufacture the component. Furthermore, building emission models for complex types of components, for example, ASIC models which use different wafers, dies and packings, should be taken into consideration. Emission values for these components are estimated based on the material content and processes.

Overhead emissions

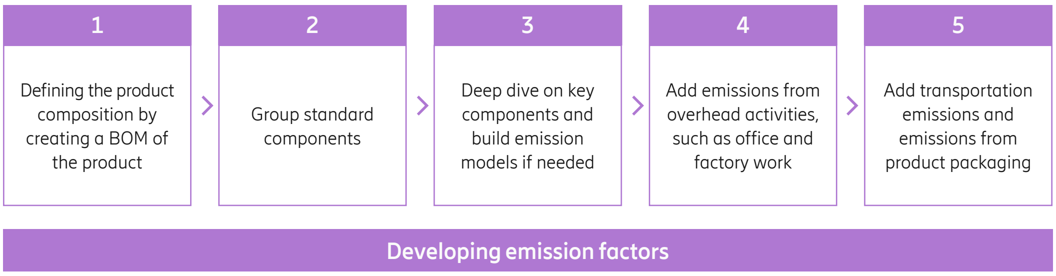
To complete the embodied carbon emission calculation, the telecom network infrastructure vendor's emissions are added. These include emissions from the vendor's own activities such as office work, testing and other activities executed at the vendor's facilitates, and, of course, emissions from the vendor's own production.

Emissions from transportation and product packaging

Finally, emissions from product transportation and product packaging are added to the embodied GHG calculation.

Advanced and accurate internal software for embodied emissions calculation needs to be used across all product lines. This simplifies the work and increases quality in the results obtained.

Figure 2: Streamlined Parameterized Embodied Emission Methodology — process flow



Developing emission factors for the streamlined methodology

The emission factors used in the assessments are a mix of emission factors from external organizations, internal calculations, supply chain inputs and expertise. A robust and transparent process for developing emission factors used in the calculations is vital for a reliable result and should also be published with the result. We suggest that all emission factors are gathered in a common library file to enable version control and easy access.

Material and process factors used by Ericsson are, to a large extent, coming from Ecoinvent [8] while the electricity grid emission factors are purchased from the International Energy Agency (IEA). In some cases, when the Ecoinvent factors have been deemed inaccurate enough for a specific process or material, other sources have been used. When deriving a new emission factor, a literature review must be carried out, and the most reliable factors used are validated against a variety of external sources to guarantee alignment with the sector evolution.

Developing emission factors

Conclusions and recommendations

We are keen to support the telecom industry in its transformation towards Net Zero. On this journey, it is important to harmonize the ways of calculating embodied GHG emissions from producing telecom products.

Our three key recommendations on this topic:

1. **There is a need for a streamlined embodied methodology that balances accuracy and complexity.**
   GHG emissions from operating a telecommunication network depend, to a large degree, on emissions from the energy used, and the upstream product emissions depend on the emissions from the supply chain. Therefore, it makes sense to assess these emissions separately.

   Such a methodology must align with the "cradle-to-gate" scope of a complete carbon footprint calculation, meaning it should include all emissions from material acquisition through to last-mile delivery to customers, as well as overhead activities associated with the product. A streamlined calculation should facilitate the transition from "too-vague data" to more valuable data points on products, and strike a balance between accuracy and scaling.

2. **The streamlined and scalable method described in this paper can be useful for the whole industry.**
   We believe that the method described in this paper is useful for the whole industry as it's streamlined and scalable and can be used for assessing the upstream product emissions. The method is less complex and time consuming than a full LCA but provides better quality in GHG emission values compared to only spend-based methods that may result in misleading conclusions. It is also generic enough to be utilized by all complex products and the product values can easily be summed up to portfolio level.

3. **ICT industry alignment is essential to have harmonized metrics that can create the transparency we all need in our upcoming Net Zero transition plans.**
   Embodied carbon footprints are typically associated with large uncertainties and comparisons of different studies from different sources, even for very similar products, cannot be made with enough accuracy to support business decisions today. The lack of a standardized methodology hinders transparency and alignment, and as an industry, we need to harmonize the assessment methodology.

   We welcome an industry-wide conversation on this method and invite collaboration to pursue and improve it.

There is a need for a streamlined embodied methodology that balances accuracy and complexity.

The streamlined and scalable method described in this paper can be useful for the whole industry.

ICT industry alignment is essential to have harmonized metrics that can create the transparency we all need in our upcoming Net Zero transition plans.

References

1. Recommendation ITU-T L.1410, in many places, refers to the importance of equal assumptions, for example, on page 51: "This LCA result cannot be compared to the result of another LCA unless all assumptions and modelling choices are equal."

2. World Meteorological Organization (WMO): The WMO is the United Nations agency responsible for monitoring global climate. In its 2021 State of the Climate report, the WMO concluded "it is unequivocal that human influence has warmed the atmosphere, ocean and land. The atmosphere has warmed by about 1 degree Celsius since the pre-industrial era."

3. IPCC Special Report on Global Warming of 1.5°C (2018): The IPCC, the leading international body for the assessment of climate change, concluded that "global emissions of greenhouse gases would need to decline by about 45% from 2010 levels by 2030, reaching net zero emissions around 2050, in order to limit warming to 1.5°C above pre-industrial levels."

4. Mobile Net Zero: State of the Industry on Climate Action 2023.pdf, www.gsma.com/betterfuture/wp-content/uploads/2023/02/Mobile-Net-Zero-%E2%80%93-State-of-the-Industry-on-Climate-Action-2023.pdf

5. Mobile Net Zero: State of the Industry on Climate Action 2023.pdf, www.gsma.com/betterfuture/wp-content/uploads/2023/02/Mobile-Net-Zero-%E2%80%93-State-of-the-Industry-on-Climate-Action-2023.pdf

6. Simplifying a life cycle assessment of a mobile phone, link.springer.com/article/10.1007/s11367-014-0721-6

7. Opportunities and limitations in the use of LCAs for ICT goods, networks and services, www.itu.int/rec/T-REC-L.1410

8. Ecoinvent database: Ecoinvent 3.8, 2021, ecoinvent.org/the-ecoinvent database/data-releases/ecoinvent-3-8/ (subscription needed)

9. Emissions Factors 2023 – Data product – IEA, www.iea.org/data-and-statistics/data-product/emissions-factors-2023 (subscription needed)

Authors

Jenny Sandahl is the Sustainability Director for Design and Materials at Ericsson, working with supply chain climate action and the circular economy. She has 20 years of experience in the environmental area, with a demonstrated history of working with sustainable development in the information technology industry. Jenny has a Master of Science in Chemical and Environmental Engineering from KTH.

With around 30 years at Ericsson, currently an Expert Radio Realization and Modularity, **Kristian Lindskog** brings a wealth of expertise to product realization. He excels at integrating diverse technologies seamlessly into compelling products, with a key focus on minimizing their environmental impact. His passion lies in learning new things, which includes understanding the carbon footprint of materials and processes to inspire the development of innovative and sustainable design solutions.

Nina Lövehagen is a Master Researcher at Ericsson Research. She joined Ericsson Research in 2000 and, in recent years, has focused on the climate impacts of ICT. Her main focus has been on methodology development for assessing the enablement effect of ICT in other sectors, as well as simplified methodologies for understanding the full environmental footprint of ICT.

Acknowledgements

Ulrika Aronsson

Pernilla Bergmark

Johanna Eklund

Noelia Lopez

Jens Malmodin

Daniel Paska

Tomas Sandin

Ana Maria Galindo Serrano

Mandeep Taneja