Joint assessment of environmental and social impacts for electronics

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Abstract—Large scientific literature analyzes the environmental impacts of electronics, while social impacts are less considered. When these two dimensions of sustainability are addressed together, the two assessments are usually run in parallel, with an integration only in the last phase of results and interpretation. This work explores the data and analyses common to the two assessments in the four phases of LCA.

Keywords—LCA, S-LCA

I. Introduction

The electronics industry is recognized to have a significant impact on the environment for both the production and usage of the devices. Examples of environmental impacts of electronics are the great demand for critical raw materials, the high energy consumption during manufacturing and the contribution to the e-waste (electrical and electronic waste). Less acknowledged are the social impacts related to this industry, despite the associated harmful effects and risks for human beings. For example in [1], where a model to assess social impacts is tested on an integrated desktop computer in a cradle to grave case study, the results indicate potentially negative social impacts on workers, local community and society. The most impactful phases are raw material extraction and production of basic materials. In contrast, low impacts are related to the value chain actors and consumers.

Life Cycle Assessment (LCA) is a recognized method to assess environmental and social impacts, and to identify the hotspots in the life cycle of a product. While environmental and social LCAs (LCA and S-LCA, respectively) share the same phases for the analysis, their objectives and target impacts are substantially different. Hence, the two assessments are usually carried out separately. Besides being time consuming, this approach results in considering the environmental and social pillars of sustainability as two separate dimensions. Consequently, eco-design and social design continue to be separate strategies without common analysis, possibly leading to different decisions based on the same source data.

For the assessment of the different dimensions of sustainability, LCSA (Life Cycle Sustainability Assessment) and C-LCSA (Circular LCSA) [2] are appropriate foundations. LCSA combines and applies in parallel LCA, S-LCA and LCC to the same Functional Unit and equivalent system boundary. C-LCSA adds circularity assessment as a new dimension. These methods join environmental and social assessments only for the compilation of the results and the interpretation.

Our work combines, for the first time, environmental and social LCA in a single methodology. The focus is on the sharing of analyses and data with the final objective of defining an eco-social LCA. We also discuss the choice of whether to use separate databases for environmental and social data, or a common database.

II. Eco-social methodology

LCA and S-LCA are standardized in ISO 14040 [3] and 14075 [4], respectively. Some content of ISO 14040 constitutes requirements for ISO 14075. To combine environmental and social LCAs in a single methodology, the study focused on the features that are common to the two assessments, the stages that are only partially shareable, and the parts with a scope exclusively environmental or social. The resulting eco-social methodology is shown in Figure 1. In every LCA stage, some analyses can be shared between environmental and social assessment.

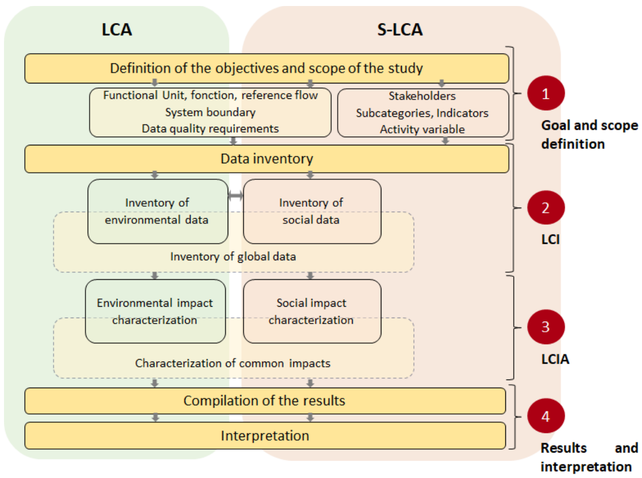

Figure 1: Eco-social methodology

In the goal and scope definition stage, the following elements are common to LCA and S-LCA: Functional Unit, function of the product, reference flow, system boundary, data quality requirements. Other elements are specific to S-LCA: categorization and involvement of interested parties, activity variable. Subcategories and associated indicators are not standardized and their selection is made according to the objectives of the study. The list of categories of interested parties takes into account the individuals, groups or organizations potentially affected by processes during the life cycle of the product. It includes workers, consumers, local communities, children, value chain actors and society [5]. The activity variable is a measure of the activity of a process that provides information about the relative importance (or intensity) of the process in the product system, and that can be linked to a Functional Unit. A commonly used activity variable is the number of hours worked in a process to produce a given quantity of process output.

In the LCI (Life Cycle Inventory), while LCA considers only quantitative data, in S-LCA also semi-quantitative and qualitative data may be required. Semi-quantitative data uses yes/no responses or a rating scale. Qualitative data can take the form of descriptive text that can be collected through interviews, questionnaires, observations, and written assignments. The inventory of the data depends on the models and databases selected for the eco-social LCA. Two choices are possible. The first considers separate models and databases, where environmental assessment models are based on physical flows and environmental data (e.g., ecoinvent data [6]), while S-LCA models are based on monetary flows and social data (e.g., PSILCA data [7]). The second choice considers a common model and a joint database. A known joint database is ecoinvent-soca [8], which combines LCA, S-LCA and LCC. It is based on soca, an add-on for ecoinvent database developed by GreenDelta.

In the LCIA (Life Cycle Impact Assessment), the categories of impacts are mostly distinct between the two assessments. Only the human toxicity and the human health can be related. The possible overlapping must be handled in the LCI. S-LCA proposes two methods for impact assessment: Type 1 is by reference scale and Type 2 is by impact pathway. Type 2 is the most similar to the method of LCA, and thus the most relevant for eco-social LCA, but it is less methodologically mature and applied so far. Finally, the final stage of results and interpretation is common to the two assessments, as done in LCSA.

The methodology has been applied to an Integrated Circuit, a case study where the social assessment constitutes an almost unexplored domain. This allowed us to validate the common analyses and data between the two assessments, while the eco-social LCA of the circuit still constitutes a work in progress because of the difficulty in accessing reliable and specific data and the induced modelling challenges.

III. Conclusions

This work constitutes a first step towards eco-social design applied to the domain of electronics. Although some elements must be explored further (as the assessment by impact pathways), one of the main benefits of the proposed eco-social LCA is to facilitate the social assessment by sharing data and analyses with the environmental counterpart. This will hopefully accelerate the development of the social pillar of sustainability, which has already happened to the environmental pillar in the last years.

IV. References

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