Social and environmental LCA of an ecolabeled notebook

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Abstract The presentation shows a study that analyses social, socio-economic and also environmental impacts of an ecolabeled notebook over its entire life cycle [1]. A social LCA (S-LCA) based on the UNEP/SETAC guidelines for S-LCA of products and an environmental LCA (E-LCA) based on the ISO guidelines 14040 and 14044 were conducted in parallel. The interpretation of the social inventory shows that social hot spots occur in every life cycle stage of the laptop. Particularly mining activities and the informal recycling are connected to serious societal problems. Also the production phase is relevant in terms of social issues, while the design phase and the formal recycling are in general uncritical. The environmental profile of the considered computer is strongly dominated by the production phase. Also transport and use have a noticeable contribution to the environmental burden, while packaging and disposal have a rather low contribution.

1 Introduction

Life cycle analyses are the tools to be used to apply life cycle thinking in a fact-based manner, with increasing use by industry and policy. While the consideration of environmental impacts of products in life cycle assessment (LCA) studies and the consideration of economic impacts in life cycle costing (LCC) studies are quite common today, the investigation of social effects in a life cycle perspective has been rarely done so far. This is the case despite a clear recognition that products have in addition to environmental and economic impacts many-faceted social impacts as well – not only on employees, but also on customers, suppliers, communities, and society. Main bottleneck was probably the lack of an accepted and thought-through method for analysing social effects across the whole life cycle until the publication of the “Guidelines for Social Life Cycle Assessment of Products” of the UNEP/SETAC Life Cycle Initiative in 2009 [2]. The guidelines de-

scribe the analysis of social impacts of a product along the entire life cycle, building on the ISO standards 14040 and 14044 for life cycle assessment (LCA).
In the presented study, social and socio-economic impacts of an ecolabeled laptop are analysed based on the UNEP/SETAC guidelines for S-LCA. Environmental effects are investigated based on the ISO standards for environmental LCA. Therefore a comparison between the social and the environmental performance of the computer is possible.

2 Goal and scope

2.1 Goal

General goal of the project was to apply the UNEP/SETAC guidelines for S-LCA of products on a complex case, as the approach was tested so far only in rather small case studies. In addition, the product system should reflect a value chain with high sustainability impacts and should have relevance to other products. Electronic products as a notebook meet these requirements, because they are causing numerous social and environmental impacts along their life cycles. A laptop computer contains many different metals, plastics, and chemicals, but also electronic modules. Beyond that, it has literally a global supply chain due to the globalised markets today.
More specific goal of the study was to identify social and environmental hot spots in the life cycle of the considered computer in order to improve and ensure respectively its sustainable performance. The investigated notebook is a recent laptop available in Europe and is certified according to the EU ecolabel - the flower. A comparison of different products was not part of the study.

2.2 Scope

2.2.1 Functional unit

Functional unit was one unit of an ASUSTeK UL50Ag notebook for office use. The notebook has a 15.6’’display with LED backlight. It weighs 2.3 kg and contains a 8 cell lithium-ion battery which has a battery life up to 12 hours. Integrated is an Intel® CoreTM 2 Duo processor with 2*1.3 GHz, 4096 MB RAM, and 500

GB hard drive space. The computer provides 3 USB 2.0 ports, an optical DVD drive as well as a 5 in 1 card reader. Further, it provides W-LAN, Bluetooth, and a 0.3 mega pixel webcam.
The relevant market segment is lightweight portable computers with a very long battery life, similar in size. The computers should be geared to be used in offices and have similar hardware specifications.

2.2.2 Considered life cycle

The analysed ASUS notebook is produced in China. In this modelled case it was ordered in Brussels, Belgium and delivered there. The computer is used in an office for 4 years. After the use phase the laptop is submitted to a collecting point. It is assumed that 20 % of collected laptops are reused; therefore it is modelled that 20 % of the notebook are transported for reuse to China and the remaining 80% are sent to a recycling site in Belgium. Further, it is assumed that the reuse phase takes 2 years [3-6]. The reused computer is recycled in China, because the laptop is out of reach for the ASUS´take back system, which covers only Taiwan, Europe, North America, and India [7].

2.2.3 System boundaries

The S-LCA considers the extraction of raw materials, the production of basic materials and intermediate products, and the assembly of the end product as well as the end-of-life phase. Out of consideration for the social dimension are packaging, energy generation, distribution, and transportation processes with upstream chains. It was assumed that these processes have mainly positive social impacts; thus there are no social hot spots expected. In addition, it was not possible in the frame of this study to analyse all background processes in detail.
Furthermore, the use and reuse phase were not considered for another reason: The UNEP/SETAC approach for S-LCA was developed to show the performance of companies and sectors respectively. Thus the indicators are not applicable to use phases. Aspects as consumer health and safety, transparency, and after sales services are comprised in the stakeholder group consumers.
Concerning the extraction of raw materials and the production of basic materials, further restrictions were made due to the time window of the project. The following processes were considered:

- Extraction of copper
- Extraction of cobalt under co-production of nickel
- Extraction of gold

- Extraction of tin
- Mining of bauxite
- Production of plastics
- Production of non-ferrous metals
- Production of glass

Regarding the E-LCA the product system covers raw material extraction, production of basic materials including product and mail packaging to production of pre-products through to manufacturing of the end product, its distribution, use, reuse, as well as disposal. The end-of-life phase comprises only a WEEE-conform disposal in Belgium. The informal recycling in China was not part of the environmental analysis due to lacking data. Out of consideration were also sundries as screws, speakers, webcam, and plugs as well due to lack of data.
Figure 1 summarises the investigated product system for the social and the environmental perspective.

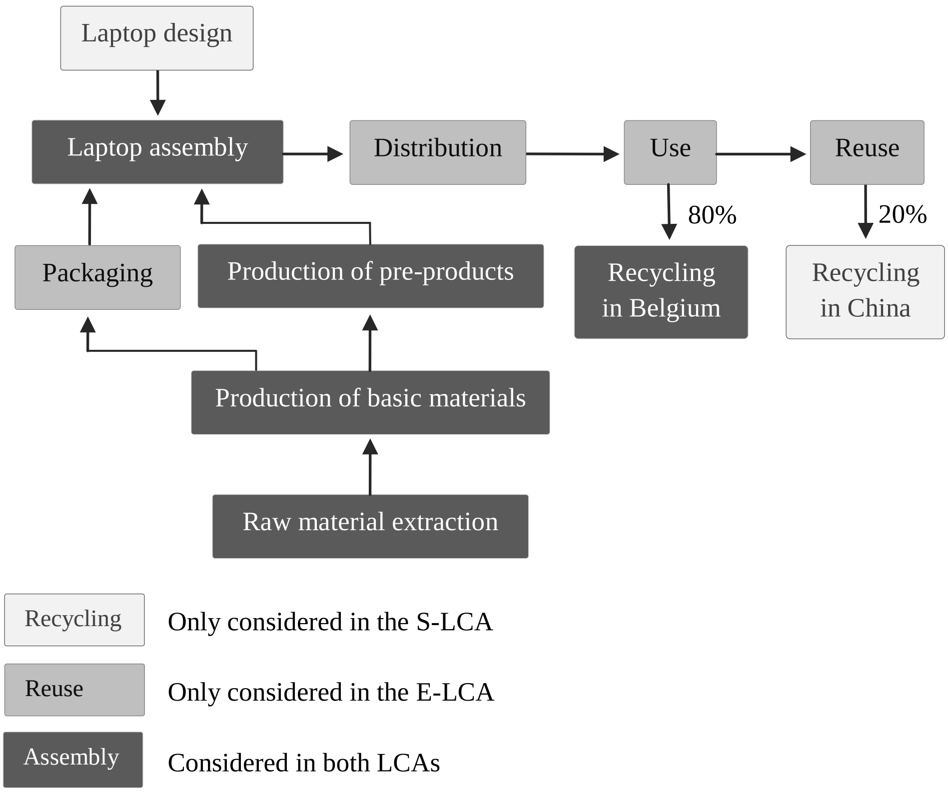

Fig.1: Flow chart of the product system for the LCAs

2.2.4 Data sources

Generic data for the S-LCA were mainly obtained from governmental and non-governmental organisations, internet research, and literature review. In respect to company- and site-specific data corporate reports, corporate websites, and reports from NGOs were additionally analysed. Beyond that, questionnaires were sent to all companies of foreground processes; in several cases interviews with workers were conducted.
For the E-LCA, the ecoinvent database [8] was used as a basis. Specific ecoinvent datasets were adapted with product-specific data concerning foreground processes. Rationale for the modification was obtained from an own disassembly of the note-book and also from information about the location of the process.
Datasets for background processes were not modified.

3 Inventories

3.1 S-LCI

Considered stakeholder groups and themes of interest (subcategories) are based on the UNEP/SETAC guidelines for social life cycle assessment of products. Indicators to measure the status of the subcategories were derived from the method sheets, which complement the guidelines [9].
To reduce complexity all process types in the product system were divided into foreground and background processes. Data for foreground processes cover all stakeholders of the UNEP/SETAC approach and are on country, region, sector, company, and site level. For background processes a simplified indicator system was applied. Not all stakeholder groups were considered and indicators cover only country- and sector-specific information.
Involved companies and production locations of foreground processes were identified by means of the disassembly. The origin of raw and basic materials was determined by trade statistics.

3.2 E-LCI

Starting point for the modelling of the product system of the E-LCA was the process network of the unit process “laptop computer, at plant” in the version ecoinvent v2.2 [8]. The modelling of devices and modules was adapted to case-specific characteristics. Mainly electricity and transport processes were exchanged to better reflect local conditions. The material composition of components was only modified in some cases, due to lack of data. For instance, printed wiring boards with lead solder were replaced by wiring boards with lead-free solder.

The amount of required components was calculated by weight. The ecoinvent datasets are a bit outdated, so that the weight/size of the modelled components does not reflect the current technical standard of a light weight laptop. It is assumed that the material composition by itself has not changed significantly.

The office use phase was calculated with 2200 h active use, 800 h standby, and 6600 h off. The reuse phase was modelled differently with 2550 h active mode, 1020 h standby mode, and 1530 h off mode. It is assumed that the laptop is reused in a private household, which entails a different way of use.

The underlying electricity consumptions in the different modes were measured or obtained from ASUS.

4 Impact Assessment

4.1 S-LCIA

To assess the social impacts of the considered notebook along its whole life cycle a social LCIAM developed by GreenDeltaTC was applied. This method is able to consider both quantitative and qualitative data. Due to the use of numerical factors it is also possible to summarise results on product, process, or stakeholder level.

The impact assessment method covers two assessment steps of each subcategory: In a first step the performance of the company/sector is assessed based on the inventory indicators and in a second step (potential) impacts of this performance are assessed in regard to six social impact categories (working conditions, health and safety, human rights, socio-economic repercussions, indigenous rights including cultural heritage, and governance). These impact categories are as well derived from the UNEP/SETAC guidelines.

4.2 E-LCIA

For the calculation of the environmental impacts, the method “ReCiPe” [9] in the hierarchist version was selected, as this version reflects a rational, natural based assessment perspective. ReCiPe is one of the most recent life cycle impact assessment methods and combines the midpoint with the endpoint approach. Both dimensions were used, because they have different advantages and disadvantages. A midpoint-based assessment allows a transparent analysis of environmental impacts with relative low uncertainties, but midpoint categories are rather difficult to interpret for laypeople. The consideration of endpoint categories is in contrast very easy to understand, but the results are less detailed and contain higher uncertainties.

5 Results

5.1 Interpretation of the S-LCA

Overall, social hot spots were found in every life cycle stage of the notebook. Particularly mining activities and the informal recycling are connected to serious societal problems. Also the production phase is relevant in terms of social issues. The design phase and the formal recycling are in contrast generally rather uncritical.

From a stakeholder perspective, workers are worst affected regarding investigated subcategories despite often implemented code of conducts. Frequently, these voluntary codes of behaviour are loosely worded and stipulate only minimal standards as no child labour, no forced labour, non-discrimination, or the payment of minimum wages, which are ordinarily already covered by local laws.

The stakeholders "local community" and "society" are as well involved in negative social impacts caused by specific economic sectors within the life cycle of the laptop. Especially in least developed countries and in emerging economies negative effects occur, but also in advanced economies issues regarding sustainability are ascertainable.

End consumers and value chain actors are not affected by social hot spots, although also here problems were detected, which do not have serious negative impacts with regard to considered impact categories, though. Anti-competitive behaviour as cartelization, patent infringements, and lacking transparency towards customers and society were identified as problem areas. Many of the investigated companies curtain poor working conditions under the guise of shining sustainability reports.

5.2 Interpretation of the E-LCA

The environmental profile of the considered notebook is strongly dominated by the production phase. Also transport and use have a noticeable contribution to the environmental burden, but the relevance of these groups is different in the midpoint and endpoint assessment. While use plays a larger role than transport in the midpoint assessment, in the endpoint assessment, transport is more important than use. Packaging and disposal have a rather low contribution in the midpoint perspective and hardly any contribution in the endpoint perspective.

The main impact of the entire environmental impact, independent of the life cycle stage, originates from the extraction of raw materials as hard coal and connected processes as the disposal of tailings from mining activities, the production of energy carriers as crude oil and natural gas, and processes linked to transport as the list of the top 20 process contributions reveals.

5.3 Comparison of both LCAs

The production of electricity and related processes has usually the highest environmental impacts in process networks, especially in terms of energy using products. This is also true for the investigated life cycle in this study, although the use phase contributes only marginally to the environmental burden. The social effects of electricity production were, however, not considered. Social hot spots in this sector are rather not expected aside from the (potential) impacts of the electricity generation by nuclear power.

Mining activities cause both negative social and environmental impacts. The social LCA shows that especially mining in LDCs and also often in EEs is responsible for a variety of social hot spots regarding labour conditions and local living conditions. While the society is affected due to a lacking engagement of mining companies in terms of the implementation of codes of conduct, the development of more ecologically compatible technologies and techniques respectively, or the prevention of conflicts. In particular countries with an informal mining sector are affected.

Further, transportation contributes noticeable to the environmental burden caused by the investigated computer. In a globalized world, the transport sector gains steadily in importance – also in an environmental perspective. From a social perspective, the transport sector is probably less relevant compared to considered industries.

Social hot spots were found in all life cycle stages. Mainly the extraction of metals in LDCs and EEs, the production of electronic components and devices in EEs, and illegal recycling activities are responsible for the negative social impacts of the notebook. As well environmental hot spots occur predominantly in the raw material extraction and production phase. Informal recycling operations could not be considered in the E-LCA due to lack of data, but it is assumed that this process shows up also an environmental hot spot.
The interpretation of the inventories shows that there are differences in social and environmental LCA, though environmental and social hot spots are partly congruent, for instance with respect to mining operations or the production phase. However, negative environmental effects do not automatically entail social hot spots and the other way round. Quite plainly, S-LCAs and E-LCAs consider different aspects. To some extent, social impacts are related to environmental impacts, but, for example, freedom of expression, discrimination, or high workload are out of the environmental scope. Likewise, there are environmental impacts without direct social impacts. As consequence it is important to have a look at both dimensions in order to get an entire picture of the situation.

5.4 Conclusions concerning the EU ecolabel

The results of the interpretation regarding the environmental impacts of the notebook show that the effects of the EU ecolabel are only middling. The focus of the label does not address all relevant life cycle stages, product characteristics, and process types.
Main responsible for the environmental burden caused by the laptop is the production phase, which is not targeted by the label. In order to improve the sustainable performance of the notebook, it would be crucial to improve production processes, what indeed can hardly be achieved by a product label. Environmental product declarations (EPDs) are here better placed to do this. Notwithstanding the ecolabel claims that used criteria are based on the results of LCA studies, but the criteria reflect this only to a limited extent. On the other hand the label is rather in a position to influence the end of life phase stipulating specific recycling rates for plastic and metallic materials, easy disassembly, and a free take back system for waste electronic equipment. Though, the label only regulates the take back in markets where the eco label is used. A free global take back system is not required.
Further, the label restricts the use of damaging substances as lead, mercury, cadmium, or brominated flame retardants. This reduces of course the negative environmental impacts of the notebook, but it does not take the use of non-hazardous

substances into account, which in turn cause a severe environmental load in their extraction or production phase. The consideration of such principally harmless substances would be a desirable extension of the label criteria.

Furthermore, the environmental impacts of the use phase are dominated by the active use of the laptop, but the criteria of the ecolabel concerning energy savings do not cover the energy consumption of the computer in active mode. They only restrict the energy consumption in the sleep and off mode, and the energy consumption of the power adapter, when it is connected to the electricity supply, but not the notebook. Thus, it would also be useful to stipulate for example a maximum tolerated energy consumption during the active use.

A general point of criticism in terms of the ecolabel is the lacking verification, whether products fulfil the required criteria. Manufactures must only declare the compliance with the label criteria.

6 References

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