Accounting based LCA of an ICT network product

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Summary

The life cycle assessment (LCA) method has been mentioned as one alternative to improve the quality of eco-design in companies but there are still many practical problems before the approach can be used in everyday environmental management of companies. An interesting approach inside the LCA framework, which could overcome most of the practical challenges, is the input-output life cycle assessment (IO-LCA). This study tests the suitability of the IO-LCA in screening the life cycle impacts of a sophisticated ICT network product by using readily available accounting data. The study found that the energy in the use phase dominated the results contributing the most of the life cycle impacts but also some manufacturing related processes were identified to be of significance. Based on the study, it seems that the IO-LCA approach clearly offers added value to the environmental management of companies. The IO-LCA could provide a very fast access to the key life cycle characteristics of the product while it produces results comparable with more detailed LCA studies.

Introduction

Electrical and electronics industries are a target for an increasing number of environmental policy measures. The Directive 2005/32/EC on the eco-design of Energy-using Products (EuP), especially, sets the eco-design requirements for the life cycle performance of energy using products. The directive is anticipated to have a major impact on the product design procedures in companies.

The use of the life cycle assessment (LCA) method has been suggested as an option to improve the quality of eco-design in companies. The traditional approach of doing an LCA has been based on system models [1]. The system under study is described by unit processes and input-output flows. The approach is called here a process based LCA (Pro-LCA). Unit processes are the smallest portion of the product system for which data are collected, and flows are material and energy inputs to and outputs from the unit process. In order to compile the whole system, the unit processes are interlinked, each of which, as an input, will be taking the output from an “upstream” operation and processing it into an output, which is then the input for the next operation “downstream”.

However, there are still many practical problems before the traditional Pro-LCA can be used in everyday environmental management of companies. Some of the major hindrances are listed below [2, 3, 4]. First, the approach is very laborious, which is a significant drawback for an organization operating in a cost-conscious business environment. Secondly, the systems included in the LCA should be determined in terms of energy and mass units (*i.e.* by MJ, kWh, kg, *etc.*). In practice, most of the material and energy inputs and outputs of the companies are primarily collected and expressed in monetary terms in the company records and accounting systems and not as energy and mass units. Finally, some other inputs, such as the purchased services and capital goods, are typically only expressed in monetary terms in the company records.

Another interesting approach for conducting an environmental life cycle assessment is the so-called input-output life cycle assessment (IO-LCA). The IO-LCA approaches the environmental issues by using an input-output analysis (IOA) [5]. The IOA is an economic discipline that concerns the inter-relationships between industries and households through producing and consuming commodities, and it makes use of “input-output” tables produced by statistical agencies. These tables, in the form of matrices, describe production activities in terms of the purchases of each industrial sector from all other sectors. This information is linked to the environmental data of each sector and can then be used to calculate the environmental impacts of products covering the full production chain.

The IO-LCA has some clear benefits from the perspective of environmental management in companies. Firstly, the purchased material, energy and services need to be defined only in the terms of monetary value. Secondly, the approach is very fast to use; the practitioner does not need to collect information from all processes in the supply chain because the information is already included through the use of IO-LCA tables. Thirdly, the IO-LCA always provides a full inventory (*e.g.* there is no need to make cut-offs in the supply chain) for the production phase of the commodity or service that is taken into account. Finally, the environmental interventions of goods and services produced within the economy are always assessed consistently. These are all important benefits in the case of electronics industry in which a significant amount of supply chain purchases are either minor amounts of material or services from other companies instead of major material or energy flows.

At the moment, the IO-LCA approach *per se* is still thought to be less adequate for detailed LCA studies [3, 6]. Thus, the IO-LCA is actively being developed as a part of so called “hybrid method” [7]. However, for some other purposes, the IO-LCA is perceived as even more suitable than process LCAs. For example, the European Commission’s Integrated Product Policy [8] is set to identify the products with the greatest potential for environmental improvement, and for that purpose, the European Commission [5] has determined that the IO-LCA would be the most suitable approach. If a similar model could be used to identify the environmentally significant aspect of a company, it would considerably reduce the resources needed for environmental supply chain evaluations in companies compared to traditional process LCA. In addition, in the present situation, it would also considerably improve the exactness of evaluating the environmentally significant activities of a company.

The purpose of this study is to test the suitability of the IO-LCA in screening the life cycle impacts of a sophisticated ICT network product by using readily available accounting data. The study uses IO-LCA to estimate the life cycle phases that contribute the most to the environmental impact of a product system from cradle to grave.

Research design

The study proceeded in the following steps:

1. The product system under study was defined
2. Primary accounting data were collected for all the life cycle phases of the product system.
3. The life cycle phases with the highest contribution were determined by using IO-LCA
4. More detailed data were collected for the life cycle phases with the highest contributions
5. The environmental impacts were recalculated by using the more specified data
6. The life cycle phases and processes with the highest contribution were determined

The scope of the study covers an estimated life cycle of 10 years of a new ICT network with both 2G and 3G elements. The primary data were collected as monetary flows from several data sources. The data for the product life cycle up to the use phase (sourcing, production, office work, delivery) could be retrieved directly from the company accounting systems. The costs for the operating energy were calculated based on the energy demand of the product, and those for the maintenance and end-of-life phases were estimated based on a similar product in use.

The secondary, the IO-LCA environmental inventory data, were retrieved from a US input output database using the sectors best describing the material, service or energy used in the actual processes. A total of 30 different industry processes were defined to describe the product. The environmental impacts were estimated up to the middle point impacts by using the eco-indicator 95 method.

Results

The environmental contribution of the main life cycle phases of the ICT network product studied is presented in Figure 1. As we can see, the use phase of the product seems to dominate the results. On average, it contributes more than 70% to the environmental impacts. In addition, it has the highest impact in all except one impact category. In the use phase, actually only one process, namely the energy consumption, causes the most of the impacts. If the operating energy is studied separately, it alone causes 74% of the climate change, 15% of the ozone depletion, 82% of the acidification, 71% of the eutrophication, 7% of the heavy metals, 83% of the winter smog, 19% of the summer smog, 65% of the energy resource impacts.

The life cycle phase having second most impacts, some 20%, is the sourcing. It has the highest heavy metal impacts, around 74% and it scores second in other impact categories. The rest of the life cycle phases have lower, less than 5%, environmental contributions.

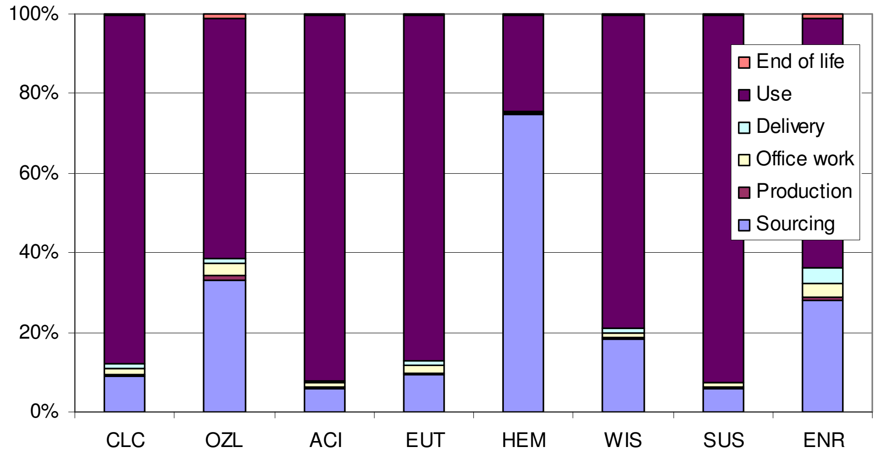

Figure 1. The life cycle contribution of an ICT network product. (CLC= Climate change, OZL= ozone layer depletion, ACI= acidification, EUT= eutrophication, HEM= heavy metals, WIS= winter smog, SUS= summer smog, ENR= energy resources).

Discussions

The study used readily available accounting data and the IO-LCA approach in estimating the life cycle contribution of a sophisticated ICT network product. The study found that the use phase, and to some extent the sourcing, contributed the most to the environmental impact. As could be expected, at the process level, the operating energy had the most impact but also sourcing from other manufacturing companies were recognized as important, especially in the ozone depletion and summer smog impact categories.

The results of this study are consistent with the results of the other process based LCA studies on ICT networks. Malmodin [9] has reported that the operating energy in the use phase dominates the result of a 3G network system with around 80% contribution in the climate change impact, here 74%. Emmenegger *et al.* [10] have reported that the use of a base station causes approximately 85% of its life cycle impacts, here 77%.

It appears that the IO-LCA approach can be used to identify the environmentally significant life cycle phases of an ICT network product by using readily available accounting data. The IO-LCA approach produced similar results as the traditional Pro-LCA approach. The use of energy in the operating phase seems to be the dominant process throughout the product life cycle but the impact of some manufacturing activities in the supply chain can be expected to be noticeable, as well.

In addition to the main result, some practical benefits of using the IO-LCA were recognized: the approach was very fast to use and would thus allow a wider environmental testing of products in companies, the subjective cut-offs of minor processes were avoided by having the full inventory of the supply chain. Finally, as the approach uses monetary flows, it would allow the testing of new products already in early conceptual design phase in which typically only the cost estimates of the new product are available.

Overall, the IO-LCA approach was found clearly to offer added value to the environmental management of companies. The IO-LCA provides a very fast access to the key life cycle characteristics of the products while it produces results comparable with more detailed LCA studies.

References

1 Consoli F., Allen D., Boustead I., Fava J., Franklin W., Jensen A., de Oude N., Parrish R., Perriman R. Postlethwaite D., Quay B., Seguin J., Vigon, B. 1993. Guidelines for life-cycle assessment: A "code of practice", 1st ed. SETAC. Brussels, Belgium.

2 Wong, M. T. N. 2004. Implementation of innovative product service systems in the consumer goods industry. Dissertation. University of Cambridge, Cambridge, UK.

3 Suh S., Lenzen M., Treloar G., Hondo H., Horvath A., Huppes G., Jolliet O., Klann U., Krewitt W., Moriguchi Y., Munksgaard J., Norris, G. 2003. System boundary selection in life-cycle inventories using hybrid approaches. ES&T 38(3) 657-664.

4 Junnila 2006 Empirical Comparison of Process and Economic Input-Output Life Cycle Assessment in Service Industries. ES&T, in Print.

5 European Commission, 2004, Questions and Answers on the Evaluation of Environmental Impact of Products (EIPRO) Study. http://europa.eu.int/comm/environment/ipp/, accessed 26.1.2005.

6 Treloar G., Love P., Faniran O., Iyer-Raniga U. 2000. A hybrid life cycle assessment method for construction. Construct Manag Econ18, 5- 9.

7 Helias A. Udo de Haes, Reinout Heijungs, Sangwon Suh, and Gjalt Huppes. 2004. Three Strategies to Overcome the Limitations of Life-Cycle Assessment. JIE 8(3) 19-32.

8 IPP, 2003, Communication from the Commission to the Council and the European Parlament, COM(2003), 302 final, http://europa.eu.int/comm/environment/ipp/ippcommunication.htm, accessed 1.8.2004

9 Malmodin J. 2004. Summary of the study “Life cycle assessment of a third generation (3G) system at Ericsson”. Ericsson, Stockholm, Sweden.

10 Emmenegger M., Frischknecht R., Stutz M., Guggisberg M., Witschi R., Otto T. 2004. Life Cycle Assessment of the Mobile Communication System UMTS. Int J LCA(OnlineFirst): 1 – 12.