Methodological progress to meet the needs of users

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Abstract

Market-based system delimitation may reduce the need for data collection in life cycle assessments (LCAs) without compromising reliability. Rather than including all potential suppliers and customers (e.g. in a weighted average), the market-based procedure allows the data collection to be reduced to those suppliers and customers, which are actually affected by a studied product substitution. Furthermore, the uncertainty on the market data will most often determine the level to which the overall uncertainty of the LCA can be reduced, thus providing a limit for what process data it is meaningful to collect.

Keywords

Simplification, Market-based system delimitation, Uncertainty, Data collection strategy.

Introduction

Four years ago, in an invited lecture [1] to the 2nd International Conference on Ecobalance held here in Tsukuba, I outlined the necessary improvements to the performance of LCA, if this technique was to realise its full potential. I argued that three simultaneous demands were at play: for simplicity, for comprehensiveness, and for reliability, and that simplicity was the key to manage the demands for comprehensiveness and reliability. Some of my suggestions were to develop and apply standard procedures and assumptions,

and to improve the understanding of uncertainties and their causes, thereby reducing the time spent for performing an LCA, especially in data collection, while at the same time improving reliability.

Since then, these suggestions have been realised through a number of methodological developments, which I shall summarise in this presentation:

- Market-based delimitation of the product systems, following stepwise procedures, prevent unnecessary data collection while improving reliability of the result,
- An improved understanding of uncertainties and their causes makes it possible to identify the data that determine the uncertainty of the overall result, and to limit the data collection to those data which can contribute to a reduction of this uncertainty.

Market-based system delimination

Careful system delimitation is the best way to prevent unnecessary data collection. The better the precision and justification in determining what processes to include, the less time is spent in data collection. The market-based system delimitation [2, 3] is a procedure for identifying the processes affected by a potential product substitution under study. The procedure implies that processes, which are not affected by the studied substitution, are excluded from the studied product systems.

The market-based procedure requires the explicit use of market information (information on market boundaries, production constraints, trends in market volumes, relative prices, and decision-making processes), which is often ignored in traditional system delimitation, in spite of its importance to the LCA results. Rather than including all potential suppliers and customers (e.g. in a weighted average), disregarding their technology and ability to react to a change in demand or supply on the specific market, the market-based procedure allows the data collection to be reduced to those suppliers and customers which are actually affected. The identified processes will typically have a specific technology and/or be located within a specific geographical

area. In [3], default assumptions (to be used when market information is missing) and a default list with examples of affected processes are provided. The affected suppliers are often very different from the corresponding average supplier to the market. Thus, only in exceptional cases can average data be used as proxy data, when market-based data are not available.

Uncertainity-based data collection strategies

The objective of a data collection strategy is to prioritise the data collection so that the necessary data is obtained in an adequate quality with the least effort. Therefore, a natural target for the data collection strategy is to reduce the overall uncertainty of the life cycle inventory to the level necessary to obtain a result upon which conclusions can be based. Uncertainty, its causes, and ways to reduce it, are therefore natural objects of interest when designing a data collection strategy.

- Uncertain identification of the process as the one to be included in the product system. This may mean that completely different processes are to be included, and is thus a major source of uncertainty. The importance increases in proportion to the possible variation in the technologies and processes that may be substituted, i.e. variation between different possible markets as well as variation within the same market, especially the variation between the least and the most competitive technology/process.
- Technological mismatch between the desired data and the available data. This may mean that data have to be extrapolated from data representing a different technology, with different environmental exchanges. The resulting uncertainty decreases with decreasing difference between the desired and the available data.
- Uncertainty in the available data as such. This is the least important of the three sources of uncertainty, since it involves only uncertainty within the process in question, and not across different processes.

Based on this distinction, a procedure for identifying the most important uncertainties can be outlined:

The first step in the procedure is to perform an error analysis of the initial system model, roughly identifying and ranking the processes, according to their influence on the output. Only the processes with strong influence need to be considered in the further uncertainty analysis.

The second step in the procedure is ñ for the important processes identified in the first step - to quantify any uncertainty in market-based system delimitation described in the previous section, i.e. any uncertainties in the identification of the processes to include. This uncertainty is likely to be the dominating uncertainty for a process, except when the process can be unambiguously identified (due to a low uncertainty in the underlying market data) or when the variation between the possible processes is low (i.e. not likely to affect the result of the life cycle study). Only for these exceptions, there is a need to consider the further steps in the procedure.

The third step in the procedure is to quantify the uncertainty due to mismatch between the desired data and the available data. This uncertainty will dominate any uncertainty within the available data. Only for data, which are truly the desired data, it will be relevant ñ as a last step - to quantify the uncertainty within the available data.

Uncertainties can often be reduced by obtaining data of improved quality. This is the case when the cause of uncertainty is lack of data, a mismatch between the available and the desired data, or inadequate sampling procedures. However, in some cases, the uncertainty is inherent to the data, and cannot be reduced by further data collection. This is especially the case:

- For forecasted data (both market data and process data), where the uncertainty is a reflection of the fundamental unpredictability of the future.
- When the actual geographical or temporal position of a specific process is unknown (and unknowable) and therefore has to be simulated by the use of an average covering a larger geographical area or time span.

- When the variation at the site specific level has unknown causes or is caused by uncontrollable phenomena, such as climatic variation.

It follows from the above, that the minimum uncertainty of a life cycle inventory will most often be determined by the uncertainty involved in forecasting market data. Only when the most important processes can be unambiguously identified or when the variation between the possible processes is low, the minimum uncertainty may be determined by the uncertainty in forecasting process data, or ñ when forecasting is not relevant ñ the uncertainty of average data. When identified, this minimum uncertainty can be used as a boundary below which it is futile to quantify uncertainties further.

Conclusions

The market information applied in the system delimitation of prospective LCAs contributes not only to an increased reliability of the LCA results, but will most often also determine the overall uncertainty of the result. In data collection, this shifts the attention from the process data as such to the market data by which the relevant processes are identified. Data collection can be reduced to those processes that the market data reveal as being affected by the potential product substitution under study, and the precision of the process data can be limited to the boundary determined by the uncertainty by which the processes are identified.

References

1. Weidema B P. (1996). Improving the performance of LCA. Pp. 247-252 in Proceedings of the 2nd International Conference on EcoBalance, Tsukuba, 1996.11.18.-20. (pp. 210-213 in Japanese editon).
2. Weidema B P (1999). Some important aspects of market-based system delimitation in LCA - with a special view to avoiding allocation. Pp. 33-46 in Report of a Danish-Dutch workshop on LCA methodologies, 1999.09.16-17, CML, Leiden.

(http://media.leidenuniv.nl/legacy/Danish-Dutch%20workshop%20on%20LCA%20methodologies.pdf)

3. Weidema B P (forthcoming). Geographical, technological and temporal delimitation. København: Danish Environmental Agency. (Technical guidelines for product life cycle assessment no. 3).