LIFE CYCLE SYSTEM DELIMITIATION - AN OPTION OR A MUST FOR EMA?

BY BO P. WEIDEMA, 2.-0 LCA CONSULTANTS,
WWW.LCA-NET.COM
Presentation for EMAN conference, Lüneburg, 2004.03.04-05.

Abstract

One of the most important developments of the methodology of Life Cycle Assessment (LCA) in the last decade has been the improved the understanding of how market information can provide a transparent procedure for unambiguous delimitation of the described systems? the product life cycles - i.e. what processes to include and what processes to exclude from the systems. The developments have also resulted in a general solution to the problem of allocation of exchanges among co-products from joint production processes. It is the suggestion of this presentation that the system delimitation procedures now applied for consequential LCA are also applicable to Environmental Management Accounting (EMA), also solving many contentious cost allocation issues. Two industry examples of life cycle system delimitation and cost allocation are provided to illustrate these points.

System delimitations

System delimitation is central to the scoping of any system analysis, be it Life Cycle Assessment (LCA) or cost accounting. Questions like ?What is the system that we study? Which activities/processes belong to what functions/products? How do we determine the boundaries in time and space?? cannot be avoided.

Important developments in the methodology for LCA during the last decade have focused on improving the understanding of exactly such issues. An important distinction has been identified between attributional LCAs of the accountancy type (Heijungs 1997, Frischknecht 1998, Hofstetter 1998) and consequential LCAs, which study the environmental consequences of possible changes between alternative product systems (Tillman 1998, 2000). The conceptual difference, illustrated in figure 1, resembles the difference between bookkeeping and budgeting: In bookkeeping we attribute each cost

item to its appropriate account, while in budgeting we seek to estimate how our planned activities will affect future costs. Just as a linear projection of last year?s accounts is likely to result in a misleading budget, the use of attributional LCA is not well suited for decision support.

In the past, LCAs have primarily been applied to consequential questions, and practitioners have sought to adjust their methodologies to reflect this objective. However, attributional methodologies have often been applied, because adequate consequential methodologies have been missing. Most data available have reflected the average operations, rather than the consequences of small changes in the operations.

Therefore, a break-through in consequential methodology came with the introduction of standard procedures for identifying how different suppliers are affected by changes in demand (Weidema et al. 1999, Weidema 2003), see figure 2.

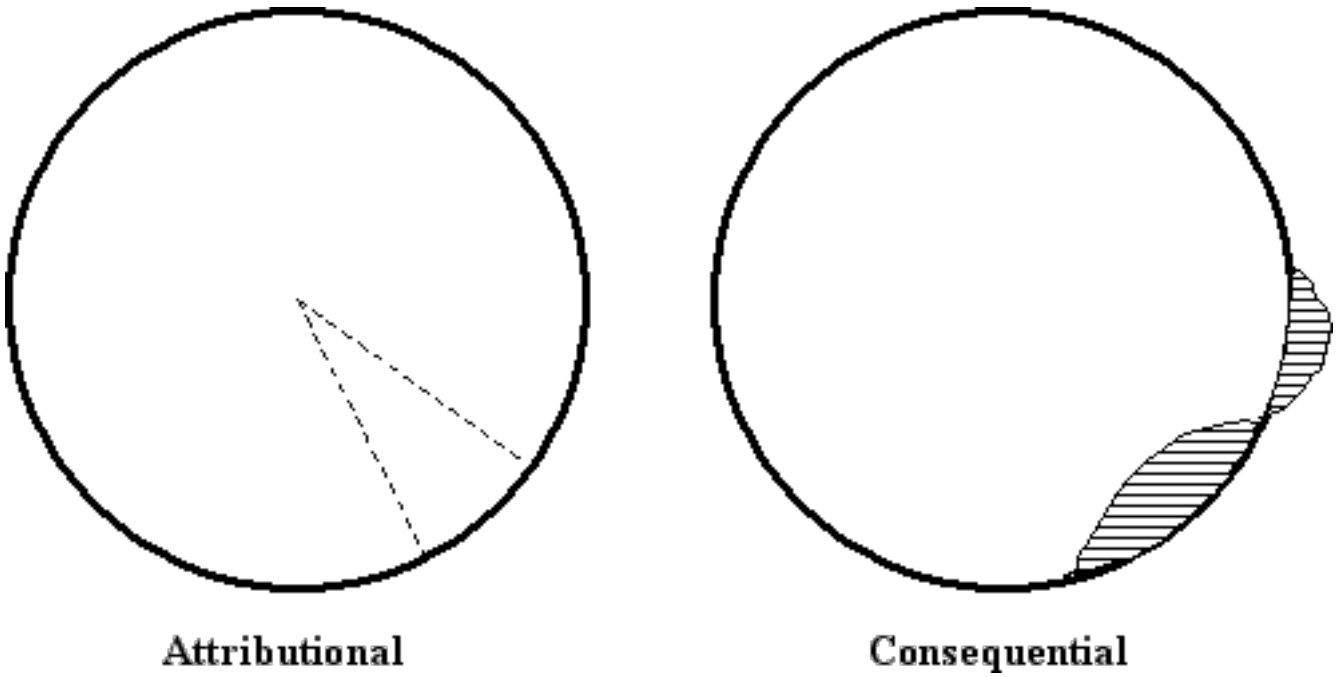

Figure 1. The conceptual difference between attributional and consequential LCA. The circles represent the total global environmental exchanges. In the left circle, attributional LCA seeks to cut out the piece with dotted lines that belongs to a specific human activity e.g. car driving. In the right circle, consequential LCA seeks to capture the change in environmental exchanges that occur as a consequence of adding or removing a specific human activity.

Co-product allocation

An important side-effect of this was a general solution to the problem of allocation of exchanges among co-products from joint production processes. This may best be illustrated with an example:

In a slaughterhouse, a major part of the wastewater load is due to the washing of the intestines (casings) to make them ready as sausage-skins. In traditional cost accounting, the cost of wastewater treatment is allocated to all products of the slaughterhouse, typically on an economic basis, i.e. mainly to the meat. In environmental accounting, as well as in traditional LCAs, the wastewater load would equally be allocated to all products, even though the only reason for washing the intestines is their use as sausage-skins. In this way, wastewater treatment shows up as a fairly minor cost item per kg produced meat.

In consequential LCA, the wastewater load would be allocated exclusively to the sausages, in response to the question: ?How would the amount of waste water change, if we change the amount of sausage-skins produced?? As the amount of sausage skins produced depend on the demand for sausage skins (the rest is discarded), and not on the amount of animals slaughtered, it is obvious that an allocation to the meat would be unjustified. By shifting the wastewater treatment to the sausages, they suddenly appear as a significant cost item, which may even question the economic rationale behind selling sausage skins. From an environmental point of view, the higher load on sausage skins should be compared to the environmental load of the alternative cellulose-based sausage skins.

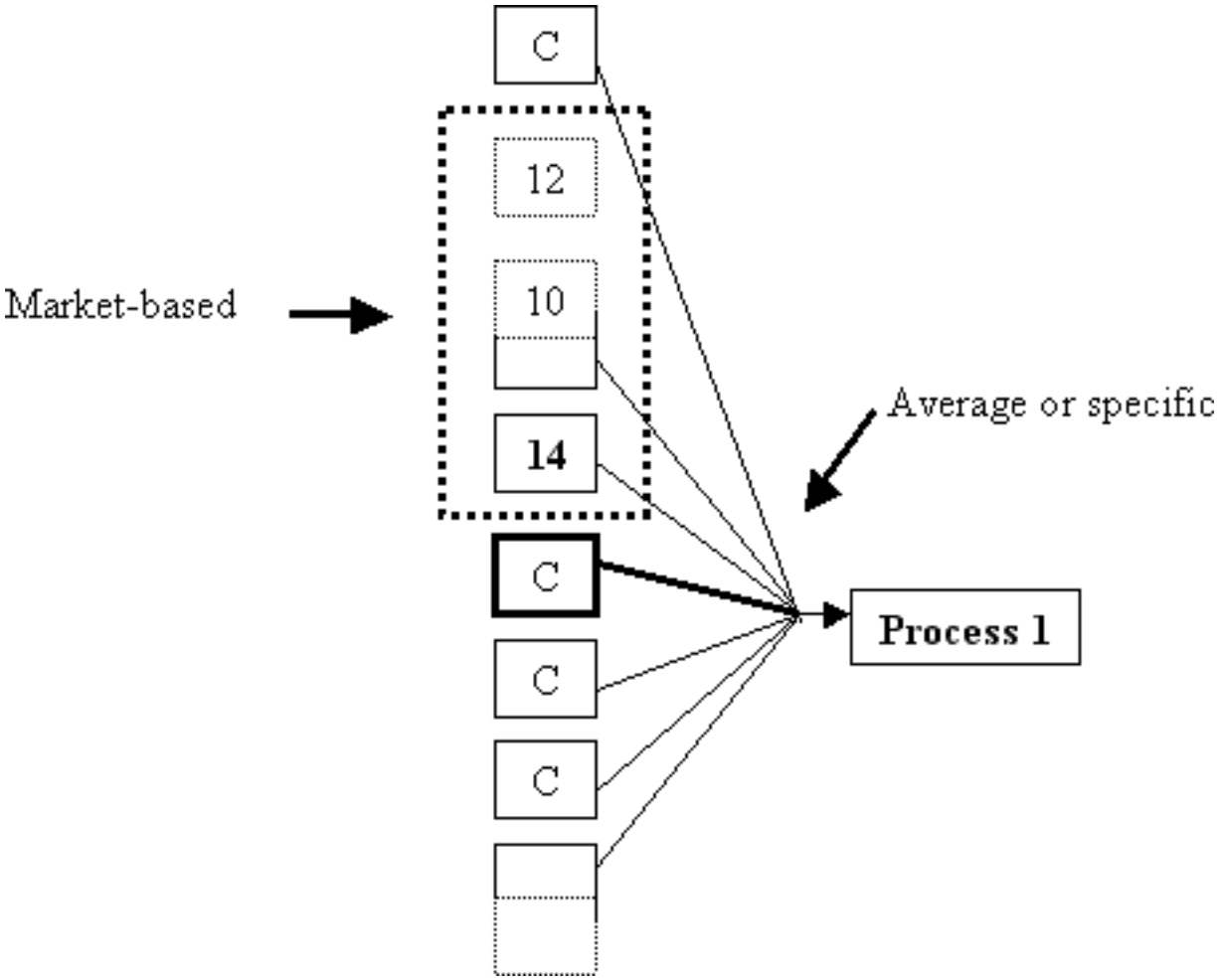

Figure 2. The difference between market-based and traditional system delimitation in LCA. Processes marked with C?s are included in the current average supply to the market, but are constrained in their capacity to change as a result of a change in demand from process 1, and therefore not included in the product system in consequential LCA.

Understanding the technologies/processes to be arranged in such a way that the most economical are at the top (this is often also the newest and most efficient ones, but this depends also on the cost structure, including the wage level) and the least economical at the bottom (often the older, less efficient), it will typically be either the upper or the lower unconstrained process that will be affected by a change in demand ? depending on whether the market is expanding or shrinking. Contrary to the average, we are rather concerned with the extremes here. If we focus on the situation with an expanding market, where the possible (non-C-marked) processes are found in the upper part of the figure inside the perforated box, market-based system delimitation will to look at the expected long-term marginal production costs

of these technologies/processes (the numbers in the boxes). With adequate respect for non-monetarised aspects (flexibility, quality, knowledge), the technology/process with the lowest expected long-term marginal production costs (marked with an arrow) is the one that will be affected by the change studied.

In addition to the allocation of the wastewater load, consequential LCA also operates with a concept of system expansion, which resembles the concept of alternative costs: While the meat is relieved of the costs of wastewater treatment, it should carry the cost of the alternative waste treatment of the intestines that would be necessary if they were not converted to sausage-skins. Following the same line of reasoning as above, this avoided cost is then credited to the sausage skins. The alternative waste treatment does not currently take place in the analysed system (hence the term ?system expansion? when this process is included). However, it is a process that will be affected by changes to the system, i.e. relevant for budgeting purposes.

I believe that the above example, being also an example of solving an in-house cost allocation issue, illustrates well the relevance of the market-based, consequential procedures for Environmental Management Accounting (EMA). Also in cost accounting, such allocation issues have been one of the more contentious issues for many years (Frischknecht 1998).

An even more interesting situation occurs when a by-product substitute processes external to the company in question. Take as an example of this a bakery, which has a certain amount of bread waste. This waste currently follows three streams. First, it is recycled internally, replacing a part of the raw materials in the bread recipe. Secondly, it is dried for breadcrumbs, sold to other food producers (e.g. for breading fish filets), here replacing dedicated breadcrumb production. Finally, the remaining bread waste is sold as animal fodder. In traditional bookkeeping, the internally recycled bread would not appear, while the two external waste streams would be accounted for on equal terms. But for budgeting purposes, only the part sold as animal fodder is relevant, as it is this part that will be affected by any changes in the amount of bread waste supplied. Further, to understand the full environmental impact of bread waste, it is necessary to expand the system to include the fodder replaced by the bread waste. From the perspective of the bakery, it then becomes an interesting issue whether it is possible to decrease the

amount of bread waste, so that all of it can be used internally or for breadcrumbs, thereby shifting the affected and avoided processes.

Conclusion

The above two examples suggest that the system delimitation procedures now applied for consequential LCA are also applicable to EMA, and could provide results that are better oriented towards decision making, both with respect to environmental and economic cost issues.

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