

# Limitations of Consequential LCA

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# Two types of LCA are distinguished in this presentation

- Attributional LCA, which aims at describing the environmental properties of a life cycle and its subsystems.
- Consequential LCA, which aims at describing the effects of changes within the life cycle.

# Argument for consequential LCA

- Decision-makers need to be informed about the consequences of decisions [1]

This argument seems devastatingly strong.  
Can attributional LCA be defended?

# Consequential LCA has limitations...

- concerning the completeness,
- concerning the accuracy, and
- concerning the relevance.

# Limitations concerning completeness

Consequential LCA can never describe the full consequences of a change – for at least two reasons:

- The future is inherently uncertain. This uncertainty sets a limit to all attempts to describe future consequences of a change.
- LCAs typically have large data gaps of various types.

# Data gaps in LCA

LCAs typically have data gaps of various types [2], because the LCA practitioner...

- does not know that a process is included in the affected system,
- does not have any data on the environmental exchanges of the process,
- only has data on some of the environmentally relevant exchanges of the process,
- only has data on summation parameters (e.g., VOC, TOC, AOX) and not on specific substances,
- does not know that a parameter contributes to an environmental impact category,
- does not have factors for the modelling of the environmental impact of a parameter, and/or
- does not have weighting factors for all relevant parameters and/or environmental impacts.

# Limitations concerning accuracy

The effects of changes depend on economic mechanisms, that consequential LCAs only begin to model [3-4]. Models of such mechanisms might alleviate this problem:

- Dynamic optimising models can improve the knowledge on marginal effects in dynamic production systems [5].
- Partial equilibrium models can improve the knowledge of what product flows are affected by a change [6].
- General equilibrium models can give insights on rebound effects [7].

# Limitations concerning relevance

Certain decision-makers can be more interested in knowledge on environmental properties of systems (generated by attributional LCAs) than in knowledge on the effects of changes within the life cycle (generated by consequential LCA). There can be at least three motives for such interest:

- The decision-maker may feel responsible not only for the consequences of her actions but also for being associated with environmentally poor systems.
- A general methodological rule that LCA results should reflect effects of actions can, in some instances, reduce the likelihood of future, environmentally good systems.
- Consequential LCA results that reflect the effects of individual actions can, in some cases, be perceived as unfair.

# Responsibility beyond consequences

Consumers and other decision-makers may feel that it is right to refrain from certain actions even if they have no poor consequences. For example:

- buying a second-hand table produced from rainforest wood,
- buying products of child-labour, or
- selling weapons to countries at war

An alternative justification to refraining from these actions can be that the decision-makers do not want to be part of poor systems. The examples above are not from LCAs, but they are chosen to clearly illustrate the principle. This principle can, of course, also be valid to decisions inspired by LCA results.

# Likelihood of environmentally good systems

A general methodological rule that LCA results should reflect effects of actions can result in environmentally suboptimal systems. This can be illustrated through four cases from the Nordic electricity sector:

- Norwegian electricity,
- electricity at Thorskog Castle,
- the Swedish railway, and
- windpower of an environmental consultant

# Likelihood of good systems

## Case 1: Norwegian electricity

The Norwegian electricity production is environmentally good in the sense that it is dominated by hydropower. The Norwegian electricity grid is connected to the electricity markets of other Nordic countries, where coal power is on the (short-run) marginal. For this reason, Norway does not benefit from the environmentally good, national electricity in a consequential LCA - unless the grid connections to other countries are shut off! If this happens, excess hydropower from Norway would not be utilised. Hence, there is a risk that a widespread use of consequential LCA results in a suboptimised Nordic electricity system.

# Likelihood of good systems

## Case 2: Thorskog Castle

Thorskog Castle is a conference hotel near the Swedish west coast. They produce electricity in a small hydropower plant at the site. This electricity is more than sufficient for the hotel. Excess electricity is sold through a connection to the national electricity grid. Parallel to the Norwegian example, Thorskog Castle gets no credit from its small, environmentally good electricity system in a consequential LCA, unless the connection to the national grid is shut off. Hence, there is a risk that the excess hydropower from Thorskog Castle is not utilised if the use of consequential LCA becomes widespread.

# Likelihood of good systems

## Case 3: Swedish railway

The electricity contract of the dominating Swedish railway company, SJ, specify that the electricity used for their trains is produced from hydropower sites older than 1996, windpower, biofuels, or solar energy. This is used in the marketing of SJ [8]. The company would not get a credit for this in a consequential LCA, however. Nordic power companies already produce much more electricity from these technologies than is required to meet the commitments in contracts of that type. If the use of consequential LCA becomes widespread, SJ and other electricity consumers will not benefit from buying specified electricity. Hence, a widespread use of consequential LCA reduces the likelihood that consumer pressure forces power companies to produce more environmentally sound electricity.

# Likelihood of good systems

## Case 4: windpower

A Swedish environmental consultant invested in windpower. Since then, he claims that all his electricity is windpower. However, once the investment was made, his actual electricity use does not affect the windpower produced in that plant. Hence, the consultant would not benefit from his investment in a consequential LCA of, for example, his consulting services. There is a risk that investments in windpower are reduced by a widespread use of consequential LCA. This is probably true also for investments in other technologies with good environmental properties and low variable costs.

# Fairness

LCA results that reflect the effects of individual actions can be perceived as unfair. This can be illustrated by the same four cases from the Nordic electricity sector. Norwegians, the owners of Thorskog Castle, SJ, and the environmental consultant can all argue that the results from a consequential LCA are unfair – particularly if they are connected to other electricity grids, buy specified electricity, and invest in windpower because they care for the environment. In these cases, results from an attributional LCA would probably be perceived as more fair.

# Discussion

This presentation focuses on limitations of consequential LCA. My conclusion is not that attributional LCA is superior, because there are, of course, limitations to attributional LCA as well. The following conclusions can be made, however:

- The discussion on completeness points at the fact that the actual consequences of a change are never fully known.
- The discussion on accuracy hints at several options for improvements in the methodology of consequential LCA, if the aim is to generate as complete and accurate description of consequences as possible.
- The discussion on relevance demonstrates that the use of attributional LCA, alongside of consequential LCA, can be defended from a theoretical standpoint.

# References

1. Curran MA, Mann M, Norris G. Report on the International Workshop on Electricity Data for Life Cycle Inventories. Cincinnati, Ohio 45268 USA, October 23 – 25, 2001.
2. Technical Report No 8 - Data Gaps. In: Lindfors L-G, Christiansen K, Hoffman L, Virtanen Y, Juntilla V, Leskinen A, Hanssen O-J, Rønning A, Ekvall T, Finnveden G, LCA-Nordic Technical Reports No 1-9, TemaNord 1995:502, Nordic Council of Ministers, Copenhagen, 1995.
3. Weidema BP, Frees N, Nielsen A-M. Marginal Production Technologies for Life Cycle Inventories. *Int. J. LCA* 1999;4(1):48-56.
4. Ekvall T. A Market-Based Approach to Allocation at Open-Loop Recycling, *Resources. Conservation and Recycling* 2000;29(1-2):91-109.
5. Mattsson N, Unger T, Ekvall T. Effects of perturbations in a dynamic system – The case of Nordic power production. Manuscript in preparation.
6. Bouman M, Heijungs R, van der Voet E, van den Bergh JCJM, Huppes G. Material flows and economic models: an analytical comparison of SFA, LCA and partial equilibrium models. *Ecological Economics* 2000;32:195-216.
7. Ibenholt K. Materials flow analysis and economic modelling, In: Ayres RU, Ayres LW, editors. *Handbook of Industrial Ecology*. Cheltenham: Edward Elgar, 2002:177-184.
8. [http://www.om.sj.se/node/0,4452,540\\_1,FF.html](http://www.om.sj.se/node/0,4452,540_1,FF.html)