Letters to the Editor: Comment and Reply

Marginal Production Technologies for Life Cycle Inventories

by Weidema, B.P.; Frees, N.; Nielsen, A.-M.
Int. J.LCA **4** (1) 48-56 (1999)

Comment

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Introduction

In the article "Marginal Production Technologies for Life Cycle Inventories" by Bo Weidema et al. [1] it is argued in favor of the use of marginal production technologies as a general principle for prospective LCA studies. Examples from the European electricity production and pulp and paper industry are used as case studies to back up the statement that this is a more valid approach in such situations than the traditional use of average data across an industry.

In the article reference is made to the aluminum industry argument that hydroelectricity is the dominant power source for primary aluminum production and questioning the validity of this for new production facilities. Further, there is also a reference to the use of this marginal principle for electricity production applied to a Danish LCA study of packaging systems for beer and soft drinks.

The use of the marginal production technology principle in this particular study leads to the original result of aluminum being produced in Denmark using electricity generated by coal, although no aluminum producer would even consider locating an aluminum smelter in Denmark under current framework conditions.

Factual Situation

This, in effect, shows the problem of using this principle for a global commodity. The marginal increase principle is well known from economic theory, but it is also well known that this has limitations in an open market and that one has to be careful about making sure that this principle is valid for the situation studied.

For a global commodity like aluminum, a small increase in use will not require the building of a dedicated new smelter to cover this increase. This will be covered by a combination of capacity creep at existing smelters, start up of idle capacity and the general capacity increase covered by the building of new smelters, all of which is required to account for the world-wide aluminum consumption increase of 2-3% per year spread out over a whole range of sectors and products.

The building of new smelters occurs all over the world. Typically, over the past 5 years, new smelters have been built or major capacity increases in Europe, North America, Africa, Australia and the Middle East. The sources of electricity supplying these smelters are hydroelectric, coal and surplus gas from oil fields. The IPAI statistical data (2), which has recorded energy sources for electricity used in primary aluminum plants since 1980, shows that the percentage of hydroelectricity used in 1990 was 55.6 and it was 55.9 in 1997 for Western World smelters. The production increase in this period has only changed the distribution between some of the fossil fuel energy carriers.

This shows that it is meaningless to try to link a production increase to one specific energy carrier.

There are two examples related to electric power production listed in the article: One example with reference to the hydropower used in the aluminum industry states that this will be produced and used anyway due to low production costs, irrespective of the aluminum production. The other example is from the European electricity production scenario. The examples listed overlook one simple point.

Hydroelectricity is mainly produced at locations far from the main population centers where general demand is high. Because of limitations in transfer networks, apart from in some areas of central Europe, it is impossible to transfer large amounts of electricity from Northern Norway or Siberia just by the flick of a switch.

The use of the marginal approach in general has not been encouraged because of the difficulty in portraying the realities of global commodities, such as aluminum, fairly. This because it is impossible to state that the specific production you are looking at will be supplied with metal from a specific new smelter with a defined energy source and raw material supply. Even when buying the metal from a specific supplier, this could come from a number of sources, all depending on the type of metal and quality required. It could also come from recycled metal even when it is supplied from a primary smelter.

Conclusion

In such a situation the only approach possible, even for a prospective LCA study, is to aggregate data from the possible sources of delivery and to use this as an input to the study. Weidema states in his article that actual average data is more difficult to collect than data for a marginal situation. But this is no argument against using average data when this is what most correctly portrays the actual situation. We would argue that this is also the only correct approach for a global commodity, since this will be the real situation for any new product. The material going into it will potentially be an average of the existing material on the market.

References

[1] Weidema, B.P.; Frees, N.; Nielsen, A.-M. (1999): Marginal Production Technologies for Life Cycle Inventories. Int. J. LCA **4** (1) 48-56
[2] IPAI Statistical Summary, International Primary Aluminum Institute, 1998

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Reply

A Reply to the Aluminium Industry: Each Market Has Its Own Marginal

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Small changes in demand will not lead to adjustments in capital equipment on a short term, since existing capacity is typically not used fully. However, the combined effects of many small increases is that additional capacity will be needed. Therefore, the long-term effect, which is the one relevant for most LCAs, is the effect of additional new plants or additional capacity at existing plants.

In the Danish LCA study of packaging systems for beer and soft drinks (Ekvall et al., 1998), we assumed the existence of a European market for aluminium, implying that an additional demand for aluminium in Sweden would lead to an increase in European production capacity. The aluminium industry has pointed our attention to that there is no such thing as regional markets for aluminium, i.e. that aluminium should be regarded as a global commodity, and the marginal aluminium production therefore should be determined on a global market.

This highlights a very important part of the procedure of market-based system delimitation (earlier referred to as 'the marginal approach'), namely the determination of what market is affected. In our 5-step procedure (Weidema et al., 1999), the first three steps deal with this issue: the temporal delimitation of the market, the question of market imperfections (bonds between market actors), and the question of the current trend in the market (expanding or decreasing). What is not adequately described in Weidema et al. (1999) is the geographical delimitation of the market, which is obviously as important as the other aspects mentioned. In fact, the mentioned aspects may all be different for each geographical market.

This is exactly the case for the electricity source of the aluminium industry. While aluminium markets are global, electricity markets are regional.

In the Danish LCA study of packaging systems for beer and soft drinks (Ekvall et al., 1998), we pointed out that there are at least two markets in Europe: The central European UCPTE-market, where the marginal fuel source appears to be coal and the Nordic electricity market, where the long-term marginal appears to be natural gas (although the current surplus capacity in this market may make it relevant to use the short term marginal which is coal based). However, as a main scenario, the Danish packaging study (PS) used a future scenario where the European market was regarded as one market, due to planned expansion in transmission capacity and market liberalisation. In this case, only one marginal is relevant, and again coal based technology appears to be preferable from an economic point of view, while natural gas may play a role to the extent that emission ceilings are reached.

For a global commodity such as aluminium, the electricity marginal will be composed of several regional marginals, one for each regional electricity market in which capacity is being adjusted, while for a commodity that is traded in a relatively isolated market coinciding with or smaller than the regional electricity market, it will be relevant to use one electricity marginal. This is currently the case for commodities like ammonia and general-purpose steel in Europe, while other commodities like bricks are sold in even more locally delimited markets.

The aluminium production is unusual in being so electricity demanding that the localisation of the production plants is to a large extent determined by the availability of cheap sources of electricity. Thus, new smelters are typically placed in areas with unutilised hydropower and unutilised natural gas, which is currently flared in connection to oil extraction. For example, a recent expansion in smelter capacity has taken place or is planned in Iceland (hydropower and geothermic energy) and in Africa and the Middle East (hydropower and waste natural gas from oil extraction).

Both the historical statistics published by the International Primary Aluminium Institute, and the projections for 2004 (Aluminium Association, 1999), show that the high share of hydropower (56%) for primary aluminium production is surprisingly stable over time. Out of the publicly announced new plants, 57% is expected to be based on hydropower, 14% on natural gas and only 29% on coal (Aluminium Association, 1999).

Thus, the overweight of hydropower that we have seen in the average LCA-data for aluminium production will also be reflected when using the new market-based LCA-data for aluminium.

In conclusion, the market-based system delimitation is also able to yield satisfactory results for such a global commodity as aluminium, when correctly taking into account the actual market situation, as shown above.

It should be noted that also when applying an average, the result can be seriously affected by the delimitation of the market on which the average is taken. For example, it will make a large difference whether you regard the Nordic electricity market as one (relatively closed) market, so that a Danish electricity consumption is calculated as an average of Danish, Finnish, Swedish and Norwegian electricity production, or whether it is assumed that Denmark is a market in itself (which is often seen in life cycle assessments). If we choose to look at the average for Denmark, which is *not* a closed market, it is decisive whether the average is calculated from the Danish production alone or whether you take into account the exchanges with the neighbouring markets, and *how* you take this into account, e.g. whether you calculate with Danish production plus import-mix (in periods with much available water-power in Norway and Sweden), with Danish production plus import-mix minus export-mix (in periods with little water power available) or just Danish production plus net import/export (thus disregarding transit-trade). For Switzerland, having a large degree of transit-trade, Ménard et al. (1998) have shown how such different assumptions affect the average from 21 g CO_2 (Switzerland's own production) over 140 g CO_2 (Switzerland plus import minus export) to 500 g CO_2 (UCPTE average, in that UCPTE can be regarded as a relatively isolated electricity market like the Nordic). The recommendation of Ménard et al. (1998) is to use the model that disregards transit-trade (48 g CO_2) with the argument that this best reflects the actual market conditions. It should be clear from this example that averages can be highly debatable, and possible arguments for preferring one average over the other is actually often market-based. This may in itself be regarded as a serious argument for taking the full consequence, and use a truly market-based system delimitation instead of the average approach.

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JLCA Corner

The Progress of the Database Study Committee in the National LCA Project of Japan

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The National LCA Project of Japan has previously been introduced in this corner [1,2,3]. There are mainly three study committees (Inventory, Database and Impact Assessment Study Committees) in this project. The Progress of Impact Assessment Study Committee [2] and Inventory Study Committee WG2 [3] have been reported. In this article, I'd like to introduce the activity of the Database Study Committee.

The Database Study Committee is made up of LCA practitioners and LCA software developers as its members and is actively working with the aim of completing an LCA public database system in Japan which might accomplish the following tasks with ease:

(1) Construction of a database for data to be accumulated by the Inventory Study Committee,
(2) smooth supply of the data to users through the Internet,
(3) appropriate maintenance and management of data including updating.

In 1998, a study on data format and development of the LCA database system was started.

In the field of data formats, an LCA data format suitable for this project was studied in consideration of data formats proposed for existing LCA software, an SPOLD format, requirements under ISO 14040 and 14041, and proposals made by the other study committees. As a result, the basic specification of the data format was determined. This format will be refined further, incorporating new proposals discussed by the other study committees and the data format studied by the ISO.

The LCA database system has data input software, a database server and a data supply server as its main components. The data input software was developed to support the data input by LCA practitioners based on the LCA data format mentioned above. This software has the following functions:

(1) Data input functions: input data to express the product system configuration and inventory data.
(2) Dictionary maintenance function: with respect to official names assigned to certain industry classification codes; this system registers the original name used by each industry and company as an alias.

The database server stores the collected LCA data and returns results in response to requests for search and data supply via the data supply server mentioned below. The basic functions as a database server were developed and the functions were verified in 1998. The data supply server is accessed directly by LCA data users when collected LCA data is published through the Internet. In 1998, the interface with the database server was developed. Construction of an interface with database users and of functions for database managers is scheduled in 1999. After completing the foregoing design, the database test manufacture and test run, will be used as a prototype of the LCA database system for use in work to enhance completeness after 2000 where test runs using actual data will be employed.

One system development challenge for the proposed database system is the necessity for ideas to meet specification changes flexibly since LCA data format changes are anticipated and the possibility of changes in the specifications of the entire system is very high. Furthermore, a development schedule must be made for data input software so that software adjusted to the progress made by the Inventory Study Committee can be supplied.

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