# Allocation in Recycling – Online LCA Forum discussion Oct. 2007

[typo's edited in square brackets]

Subject: Allocation for recycling
From: Gaya Gamage <gaya_gamage@yahoo.co.nz>
Date: Wed, 10 Oct 2007 11:36:10 +1300 (NZDT)

Hi,
I am working on a project that involves aluminium.
E.g.:
Product 1 uses 100% recycled aluminium
Product 2 uses 50% recycled aluminium
Product 3 uses virgin aluminium

I am trying to find an acceptable method of allocation for recycling the aluminium at end of life. As you are most probably aware, the outcome of the LCA, especially when considering aluminium, is highly dependent on how flows are allocated at end of life. I.e. we can use (as found in literature):
1. the avoided burdens method (e.g. through system expansion, substitution, etc.)
2. the partitioning method (i.e. splitting the process into sub-processes)

Both of the above methods lead to different impact results.

I was wondering if anyone has come across a case study for metals that caters to this rather complicated problem of allocation...

Thanks,
Gaya

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Subject: Allocation for recycling
From: Bo Weidema <bow@lca-net.com>
Date: Wed, 10 Oct 2007 10:23:16 +0200

Dear Gaya,

The allocation for recycling of aluminium is not more complicated than any other allocation issue.

The issue you have to ask yourself is: What happens when a product uses more recycled aluminium? Since the global aluminium market is increasing, all aluminium collected for recycling will already be used, so your additional demand will not affect the amount of aluminium recycled.

The simple answer to your question is therefore that all your three products will affect the virgin aluminium production in proportion to the amount of aluminium (virgin+recycled) that they use.

For more justification of this, please see *B P Weidema (2003)* · Market information in life cycle assessment. Copenhagen: Danish Environmental Protection Agency. (Environmental Project no. 863).

Sincerely

Bo Weidema

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Subject: Sv: Allocation for recycling
From: Tomas Ekvall <tomas.ekvall@ivl.se>
Date: Thu, 11 Oct 2007 2:14:26 +0200
X-Message-Number: 3

Dear Gaya and Bo,

Allocation for recycling has been debated for a very long time. Bo and I have discussed it on several [occasions]. I agree that the issue you should ask yourself is: What happens when a product uses more recycled aluminium? However, I have a different hypothesis regarding the answer to this question. By demanding recycled aluminium you might contribute to keeping the price of aluminium scrap high. This would stimulate marginal collection of aluminium scrap and, hence, affect the amount of aluminium recycled. We are currently testing this hypothesis in a research project.

The consequences of the hypothesis, if it is correct, are described in Ekvall T. (2000) A market-based approach to allocation at open-loop recycling. Resources, Conservation and Recycling 29(1-2):93-111.

Kind regards,
Tomas

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Subject: Re: Allocation for recycling
From: Rolf Frischknecht <frischknecht@esu-services.ch>
Date: Fri, 19 Oct 2007 10:47:31 +0200

Dear Gaya,

unlike some answers suggested, the allocation problem is not solved in a straightforward way, because ISO 14044 is not clear with respect to the problem you describe. I discussed the two main approaches of modelling metals recycling in a recently held key note lecture at the International Conference R'07 in Davos, Switzerland. Please find the abstract below. You may contact me directly in case you like to get the complete text of the extended abstract.

Kind regards

Rolf Frischknecht

**LCI Modelling approaches applied on recycling of materials in view of environmental sustainability, risk perception and eco-efficiency**

Two ISO-compatible approaches on modelling the recycling of plastics and metals are frequently applied in life cycle assessment case studies and intensively debated: the recycled content or cut-off approach and the end of life recycling or avoided burden approach. This paper discusses the two approaches from three different perspectives: 1) the kind of

sustainability concept served, 2) the risk perception involved and 3) the eco-efficiency indicators resulting from the two approaches. The analysis shows that the *recycled content* approach serves the strong sustainability concept. It is based on a risk aversive attitude and results in higher eco-efficiency of metal scrap recycling as compared to primary metal manufacture. The *end of life recycling* approach serves the weak sustainability concept (losses in natural capital can be compensated by man-made capital). It corresponds to a risk seeking attitude and results in higher eco-efficiency of primary metal manufacture as compared to secondary metal production. It is concluded that a harmonisation of the approaches is hardly possible and even not necessary due to the value choices involved. It is the task of (private and public) LCA commissioners to decide on the appropriate modelling approach according to their perspective. National authorities may have a rather long-term and risk aversive perspective while industries may prefer a short term perspective leading them to select the recycled content and end of life recycling approach respectively. Life cycle inventory databases need to be flexible to serve such opposing perspectives and to enable practitioners to adapt the modelling approaches according to the needs of the commissioner. Flexibility is served best by providing unit process LCI data.

Herzliche Gruesse / Kind regards

Rolf

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Subject: Re: Allocation for recycling
From: "Dubreuil, Alain" <dubreuil@NRCan.gc.ca>
Date: Fri, 19 Oct 2007 13:58:23 -0400

Dear Rolf and Gaya,

This is an interesting discussion indeed.

In order to apply LCA, the ultimate references are ISO 14040: 2006 Environmental management - Life cycle assessment - Principles and framework, ISO 14044:2006 Environmental management - Life cycle assessment - Requirements and guidelines and ISO/ TR 14044:2000 Environmental management - Life cycle assessment - Examples of application of ISO 14041 to goal and scope definition and inventory analysis.

In regard to the LCA ISO standards 14040 and 14044 there is no reference to the recycled content. In order to address the issue of recycling, the most important parameter is maintaining the properties of the material.

If the material in a product is recycled in the same product system, the production of virgin (primary) material is avoided. The important message from ISO 14044 is that when the inherent properties of the material are maintained during recycling a closed loop allocation is granted. Recycling activity avoided the need for primary production.

The point being that the recycled content of the material (100% recycled, 50% recycled or 100 virgin) is irrelevant. If the properties of the material are such that it cannot be recycled after the use phase, them the product system will be accountable for an equivalent production of primary material.

If you drink a beer, you should not be worried on the recycled content of the aluminium can. Your concern should be that the aluminium can has an extra life by recycling.

For some materials, it is not practical / feasible to recycle them in the same product system. For example, magnesium alloys are used automotive application. After the end-of-life of the vehicle, it is technically difficult and not environmentally sound to purify the magnesium to the same purity as the primary metal. Recycling the magnesium alloys for structural automotive application may require more energy that the production of the alloys from primary production.

On the other hand, primary magnesium is an essential alloying of you aluminum can. The use of the secondary magnesium from the end-of-life vehicle will alleviate the primary production of magnesium for alloying purpose in aluminium. In such case the closed allocation procedure shall be granted.

Conclusion:

The recycled content is not discusses in ISO 14040, 14044 and 14049. According to those LCA standards, if the properties of the material are such that after recycling the recycled material can offset the production of virgin material, them a closed loop allocation shall be granted.

From ISO 14044:2006

4.3.4.3.3 Several allocation procedures are applicable for reuse and recycling. The application of some procedures is outlined conceptually in Figure 2 and is distinguished in the following to illustrate how the above constraints can be addressed.

a) A closed-loop allocation procedure applies to closed-loop product systems. It also applies to open-loop product systems where no changes occur in the inherent properties of the recycled material. In such cases, the need for allocation is avoided since the use of secondary material displaces the use of virgin (primary) materials. However, the first use of virgin materials in applicable open-loop product systems may follow an open-loop allocation procedure outlined in b).

b) An open-loop allocation procedure applies to open-loop product systems where the material is recycled into other product systems and the material undergoes a change to its inherent properties.

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**Date:** Sat, 20 Oct 2007 12:20:21 +0200
**Author:** Bo Weidema <bow@lca-net.com>
**Subject:** ISO 14044 on recycling

Dear Rolf,

Re. allocation for recycling the following statements from ISO 14044 applies:

"4. 3. 4. 3. 1 The allocation principles and procedures in 4. 3. 4. 1 and 4. 3. 4. 2 also apply to reuse and recycling situations. Changes in the inherent properties of materials shall be taken into account. In addition, particularly for the recovery processes between the original and subsequent product system, the system boundary shall be identified and explained, ensuring that the allocation principles are observed as described in 4. 3. 4. 2. "

and

- "4. 3. 4. 2. The study shall identify the processes shared with other product systems and deal with them according to the stepwise procedure presented below.
a) Step 1: Wherever possible, allocation should be avoided by
1) dividing the unit process to be allocated into two or more sub-processes and collecting the input and output data related to these sub-processes, or
2) expanding the product system to include the additional functions related to the co-products. . . "

(no need to cite the following steps of the procedure, since Step 1a is always possible)

Although you could always wish for an even clearer wording, I find the above clear enough for all practical purposes. I can understand if you may not like or agree with the ISO 14044 standard, but I think that to say that "ISO 14044 is not clear with respect to the problem" requires some further justification from your side.

Best wishes

Bo Weidema
2. -0 LCA consultants

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**Date:** Mon, 22 Oct 2007 07:47:53 +0200
**Author:** Rolf Frischknecht <frischknecht@esu-services.ch>
**Subject:** Re: ISO 14044 on recycling

Dear Bo,

thank you for your comment that includes parts of the original ISO 14044 text regarding recycling. It leads me to two remarks:

1. system expansion does NOT avoid allocation
2. ISO is not clear in its statements

Ad 1. : System expansion as applied in many LCAs is suitable to identify the SIZE of the environmental credit due to avoided production (primary material extraction etc. ). However, system expansion does NOT answer the question, HOW MUCH of this credit shall be attributed to the two product systems involved. Because recycling always requires (at leas) two actors, namely the one delivering the scrap and the one making use of the scrap, these two parties need to [negotiate] how much of the credit they get. Otherwise it becomes very likely that the full credit is given twice.
The "credit automatism" currently [applied] in many LCAs may be suitable from a political economics point of view (identify the environmental benefit for society as a whole) but not from a business economics point of view (claiming that this benefit is solely caused by one of the two involved product systems).

Ad 2. : the clauses 4. 3. 4. 3. 3 and 4. 3. 4. 3. 4 further elaborate on the allocation in reuse and recycling. 4. 3. 4. 3. 3 deals with the distinction between open-loop and closed-loop recycling. System expansion is not even mentioned in these two paragraphs. Hence, the ISO standard leaves the question at stake without any clear answer.

"4. 3. 4. 3. 3 Several allocation procedures are applicable for reuse and recycling. The application of some procedures is outlined conceptually in Figure 2 and is distinguished in the following to illustrate how the above constraints can be addressed.

a) a closed loop allocation procedure applies to closed-loop product systems. It also applies to open-loop product systems where no changes occur in the inherent properties of the recycled material. In such cases, the need for allocation is avoided since the use of secondary material [displaces] the use of virgin (primary) material. However, the first use of virgin materials in applicable open-loop product systems may follow an open-loop allocation procedure [outlined] in b).

b) An open-loop allocation procedure applies to open-loop product systems where the material is recycled into other product systems and the material undergoes a change to its inherent [properties].

4. 3. 4. 3. 4 The allocation procedures for the shared unit processes mentioned in
4. 3. 4. 3 should use, as the basis for allocation, if feasible, the following order:
- physical properties (e. g. mass)
- economic value (e. g. market value of the scrap material or recycled material
in relation to market value of primary material); or
- the number of subsequent uses of the recycled material (see ISO/TR 14049). "

Kind regards

Rolf

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Subject: ISO 14044 on recycling
From: Bo Weidema <bow@lca-net.com>
Date: Mon, 22 Oct 2007 10:08:47 +0200

Dear Rolf,

You write: "The clauses 4.3.4.3.3 and 4.3.4.3.4 further elaborate on the allocation in reuse and recycling. 4.3.4.3.3 deals with the distinction between open-loop and closed-loop recycling. System expansion is not even mentioned in these two paragraphs. Hence, the ISO standard leaves the question at stake without any clear answer."

The fact that the ISO standard elaborates on allocation and recycling in the clauses that you quote, is not a justification for ignoring the statements right above (in clause 4.3.4.3.1) that "The allocation principles and procedures in 4.3.4.1 and 4.3.4.2 also apply to reuse and recycling situations" (4.3.4.2 is where system expansion is one of two procedures required whenever possible). It is not necessary for the validity of this statement that the standard should repeat this reference for every other statement on recycling.

Additionally, the clauses that you quote give reference to ISO 14049 where examples are given of system expansion and how to identify the processes to use in a system expansion (ISO 14049, clause 6.4).

I agree with you that ISO 14044 is only concerned with identifying "the environmental benefit for society as a whole", and that from a "business economics point of view", you may of course agree on any allocation that serves your purpose. However, in the latter case, you cannot reference ISO 14044, nor its alleged unclarity, as a justification.

regards

Bo Weidema
2.-0 LCA consultants
www.lca-net.com

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Subject: Re: ISO 14044 on recycling
From: Rolf Frischknecht <frischknecht@esu-services.ch>
Date: Mon, 22 Oct 2007 22:45:38 +0200

Dear Bo,

thank you for the opportunity to be more precise in my statements regarding.

a. stepwise allocation procedure
b. ISO 14049
c. Iso 14044 and business economics

Ad a. Indeed 4.3.4.2 describes the well-known stepwise procedure.
However I do not read any procedure to be "REQUIRED whenever possible". It states that "allocation SHOULD be avoided wherever possible", not "SHALL be avoided". This is a very important difference in wording with respect to the statement what to consider ISO compatible and what not. Hence, the individual procedures of the step-wise porcedure as outlined in ISO 14044 are SUGGESTED, and certainly not REQUIRED.

Ad b. ISO TR 14049 is not a standard but a technical report (TR). Technical reports are by definition of entirely informative

nature, thus NOT normative.

Ad c. According to the Introduction of the ISO standard 14044, ISO 14044 deals with the environmental assessment of products (including services).
The first purpose listed in the Introduction chapter is:
"LCA can assist in identifying opportunities to improve the environmental performance of products at various points in their life cycle".
None of the purposes listed in the Introduction talks about "identifying or quantifying the environmental improvement potentials on a national, regional or global level by means of product LCAs". Thus product LCAs compliant with ISO 14044 indeed [address] the level of business economics rather than political economics.

Kind regards

Rolf

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Date: Tue, 23 Oct 2007 10:23:49 +0200
Author: Arthur Braunschweig <abraunschweig@e2mc.com>
Subject: Re: ISO 14044 on recycling

Hi Bo & Rolf
thank you very much for your intensive discussion which I have followed with great interest. I get the following impression on how to do allocation in the case of recycling:
-- Bo argues that the standard is clear to you, and you support your argument by quoting the relevant sections of the standard.
-- Rolf argues that the standard contains some suggestions but does (a) neither prescribe but rather suggest, and (b) is not clearly stating what to do in order to allocate potential gains thru recycling to the recycler vs. to the user-of-recycled-material.

When reading and trying to understand all this, it seems to me that, while the standard is actually "strongly suggesting" ("should" is between "shall" and "may"), the whole text of the sections Bo quoted (4.3.4.xx) is not clear to me in the sense that it does not clearly indicate how the benefits of recycling shall be attributed to recycler and "recyclee". As in certain situations THIS is the key question (which cannot always be evaded by systems expansion), the unclarity of the standard remains.

If, however, you Bo can clarify your understanding of the standard, I am eager to read. (And I am of course looking forward to the discussions at the upcoming Swiss Discussion Forum in Lausanne, which will center around this issue.)

Arthur Braunschweig

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Subject: Sv: Re: ISO 14044 on recycling
From: Tomas Ekvall <tomas.ekvall@ivl.se>
Date: Tue, 23 Oct 2007 11:04:50 +0200

A good comment, Arthur!

I think there are two issues involved in this discussion. One is the choice between cut-off, as suggested by Paul Koltun, and system expansion. Here I think the standard is clear and adequate: system expansion is the only step-1-method that is applicable to recycling. Since step-1-methods should be used wherever possible, and system expansion is always possible in recycling cases, ISO strongly advices against all other methods. Rolf Frischknecht would=20= probably disagree since he describes cut-off as ISO-compatible. Not having read his text in full, I do not know the basis for his statement.

The other issue concerns what is included in the expanded system. Here, Bo Weidema and Alain Dubreuil agree in that the system should include 100% primary aluminium regardless of the scrap content in the product. I regard this as a hypothesis and have presented another hypothesis, based on the concept of balance between scrap supply and demand. To resolve this issue, we need to analyse the scrap market. We have recently started such an investigation.

Sincere regards,
Tomas

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Tue, 23 Oct 2007 12:45:19 +0200
Author: Bo Weidema <bow@lca-net.com>
Subject: ISO 14044 on recycling

Dear Rolf,

Fascinating to see your liberal interpretation of the ISO 14044 requirements on allocation.

The relevant statement is: "The study shall identify the processes shared with other product systems and deal with them according to the stepwise procedure presented below." In the old pre-cursor ISO 14041 this was worded "the following stepwise procedure shall be applied" which was perhaps even more clear.

It remains obscure to me how you can not read this as the procedure to be "REQUIRED whenever possible". But this clearly shows that however well you try to write a standard, there will always be options for misinterpretation. Your interpretation that the allocation procedure as not a required procedure, i.e. that you can do whatever you like, implies that by choosing the right allocation factors you may obtain any desired result. This would completely invalidate the entire standard, since why would you need a standard, if you can use it to justify any result you may fancy? I think it should be obvious that this is not the intention of the standard.

Bo Weidema
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Subject: Antw: Sv: Re: ISO 14044 on recycling
From: "Hans-Joerg Althaus" <Hans-Joerg.Althaus@empa.ch>
Date: Tue, 23 Oct 2007 14:18:30 +0200
X-Message-Number: 8

Dear Bo and all

In order to decide if cut-off in modelling recycling systems is in accordance with ISO 14'044, one should (or shall ;-) look at the section on "System boundary" / "cut-off criteria":

In 4.2.3.3.3, the cut-off criteria for "initial inclusion of inputs and outputs" are
a) Mass.
b) Energy.
c) Environmental significance.

In systems where recycling is an issue, the material to be recycled usually can't be neglected by neither of the 3 criteria and thus, from this point of view, shall not be cut-off.

Consequently, scrap to recycling has to be modelled as an output of the system, causing the system to yield several outputs. Then the issue of allocation comes up. The cut-off approach factually corresponds to allocation factors 0% for the scrap and 100% for the intended function of the product system. If this is in accordance to ISO is debatable. In case of closed loop recycling it clearly is not in accordance since in these cases system expansion actually avoids allocation. In open loop recycling systems however, allocation can not be avoided by system expansion. And there ISO states that allocation should be based on physical properties, economic values or the number of subsequent uses. Thus ISO does not explicitly forbid an allocation factor of 0 in open loop recycling systems, but an allocation factor of 0 stretches the room of interpretation to the limit (at least if the economic value of the scrap is not 0 or below) ...

Best regards,
Hans-Joerg

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Subject: Sv: Antw: Sv: Re: ISO 14044 on recycling
From: Tomas Ekvall <tomas.ekvall@ivl.se>
Date: Tue, 23 Oct 2007 14:30:16 +0200

Dear Hans-Joerg,

Thanks for your input. I agree that the cut-off criteria add to the arguments that cut-of is not an option in this recycling case.

However, you state that allocation in open loop recycling systems cannot be avoided by system expansion. We frequently do this. What is the basis for your statement?

Kind regards,
Tomas

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Date: Wed, 24 Oct 2007 10:13:01 +0200
Author: Tomas Ekvall <tomas.ekvall@ivl.se>
Subject: Sv: Re: ISO 14044 on recycling

Thanks for the clarification, Rolf. Perhaps Hans-Joerg Althaus has the same basis for stating that system expansion does not avoid allocation at open-loop recycling?

I, on the other hand, see no important difference between system expansion at recycling and at multi-output processes: it eliminates the allocation problem, but the challenge is to expand the system to include the processes actually affected. Isn't it a bit disheartening that we do not even agree on this piece of terminology after 15 years of debate on allocation?

A sidenote: an unreflected use of system expansion might result in double counting of the credit for recycling; however, none of the approaches proposed by Bo Weidema, Alain Dubreuil, or myself result in such double-counting. For example, Bo and Alain do not give any recycling credit to the use of scrap-based aluminium.

On cut-off: I agree that "should" in ISO does not mark a requirement. But it is a recommendation and not a mere suggestion. Would you agree that cut-off is consistent with ISO requirements, but not with ISO recommendations?

Kind regards,
Tomas

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Date: Wed, 24 Oct 2007 15:34:23 +0200
Author: "Hans-Joerg Althaus" <Hans-Joerg.Althaus@empa.ch>
Subject: Antw: Sv: Re: ISO 14044 on recyclingDear Thomas

The question is not always "What happens when a product uses more recycled aluminium?" as you and Bo stated in the beginning of this discussion. The question might also be: "What are the environmental consequences of a product's service"

Provided we want to know the environmental consequences of a product's service, we need to establish a (descriptive) model of the product's life cycle. A product that is recycled at the end of it's life, should always be modelled as a multi-output system. One output is the product's service, the other is the scrap to be recycled. Thus we have an allocation problem. Expanding the system by including the recycling process still leaves us with a multi-output system (product's service and recycled material).

In a closed-loop recycling system, the recycled material can be directly substituting the input material in the production. Thus system expansion annihilates one of the outputs (the recycled material) and we get a result for the product's service.

In an open-loop recycling situation however, the recycled material can't substitute the input material. Thus we need to further expand the system until all outputs except the product's service are annihilated. This would lead to a model including most human activities, since with every system expansion we are introducing other allocation problems asking for further system expansion. This is not feasible and thus system expansion does not solve the allocation problem in open-loop recycling systems.

Best regards,
Hans-Joerg

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Subject: Antw: Sv: Re: ISO 14044 on recycling
From: Tomas Ekvall <tomas.ekvall@ivl.se>
Date: Wed, 24 Oct 2007 17:41:33 +0200
X-Message-Number: 5

Thanks for this clarification, Hans-Joerg. The discussion is enlightening to me in that I understand better the difference between our perspectives.

Your basis for stating that allocation is not avoided by system expansion is apparently different from Rolf's . I agree in part with what you are writing, but, again, I would phrase it differently: the allocation problem at hand is avoided by system expansion, but new allocation problems might be introduced in the expanded system . I agree that, in theory, you could end up with endless system expansion; however, the new allocation problems are often much less significant than the one solved . It is fairly clear that this is the case here, with open-loop recycling of aluminium . In such cases, it is a fair approximation to neglect the new allocation problems or to solve them with a more simplistic approach. No endless system expansion is required in practice .

I also agree that the question need not always be "What happens when a product uses more recycled aluminium?" . However, if you ask "What are the environmental consequences of a product's service?", and compare options with different scrap content, I see no other option than to investigate the consequences of using more or less recycled aluminium .

It is a slightly different matter if you ask "For what environmental impacts is this product's service responsible?" This is an attributional question rather than a question of consequences . Since attribution is a subjective process, this question gives no guidance regarding how to deal with the allocation problem . Choosing an approach that reflects the consequences of using

more or less recycled aluminium, is just as good as any other option . Hence, asking "What happens when a product uses more recycled aluminium?" is an adequate way to select allocation procedures in attributional as well as consequential LCA .

Further reading to avoid inventing the wheel again:
- Ekvall & Tillman (1997) Open-Loop Recycling: Criteria for Allocation Procedures . Int J LCA 2(3):155-162 .
- Ekvall & Weidema (2004) System Boundaries and Input Data in Consequential Life Cycle Inventory Analysis . Int J LCA 9(3):161-171 .

Sincere regards,
Tomas

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Subject: Re: Sv: Re: ISO 14044 on recycling
From: Rolf Frischknecht <frischknecht@esu-services.ch>
Date: Thu, 25 Oct 2007 07:15:48 +0200

Dear Tomas,

please do not bother about 15 years of debates on allocation (or avoiding allocation). Economics did not solve the allocation issue in more than 150 years. However, economists realised that there is NO unique, defensible and thus objective approach to this problem (how much of the noise made by clapping your hands would you attribute to your left one?).

Double counting: It is not about "not giving any recycling credit to the use of scrap-based metals to avoid double counting". It is "charging an additional environmental dept (from the past) on scrap-based metals". This might work with short living products such as packaging materials. It gets however difficult to convince our grand-children 50 years from now to take the environmental load of primary materials when recycling building materials for new products. They would use the "sunk costs" argument (impact for primary material supply already happened and can no more be influenced, thus the material to be recovered is free of any burden) and take it for (nearly) free. And they are right!

Thus, applying avoided burdens in an unreflected way, we would create a strong imbalance (environmental credit on one side but no counter-balancing environmental dept on the other) and thus miss substantial impacts (actually occurring year per year) in all the LCAs being carried out in the years to come.

System expansion helps to determine the environmental benefit (or in some cases surcharge) of joint production or recycling. System expansion does not prevent from answering the question, how much of this overall benefit (or surcharge) may be attributed to the two product systems involved.

The ISO standard, being very strict regarding value choices in impact assessment, urgently needs improvements with regard to admit and highlight value choices in inventory analysis. In my paper mentioned the other day, I attribute the two recycling approaches to the two sustainability concepts, the strong and the weak one, as well as to risk perception regarding uncertainty of the future. Consider this as a first attempt.

It took quite some time until it became common understanding that there is not the one and only impact assessment method and that value choices are inevitable. I think it is time now to admit that inventory analysis is not free of value choices either.

More on this topic on November 22, 2007, at the 33rd discussion forum in Lausanne, Switzerland (contact lcaforum@epfl.ch for more information).

Herzliche Gruesse / Kind regards

Rolf

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Date: Thu, 25 Oct 2007 9:44:34 +0200
Author: Tomas Ekvall <tomas.ekvall@ivl.se>
Subject: Sv: Re: Sv: Re: ISO 14044 on recycling
Body: Hi Rolf -

Oh, I did not expect us all to agree on the allocation approach (unfortunate for Gaya Gamage, whose question initiated this debate). But I thought there was a general agreement on key concepts in this debate, such as the meaning of "avoiding allocation".

I do agree, of course, that there are value choices in the approach to allocation. The paper I mentioned yesterday (Ekvall & Tillman 1997) is based on the old SETAC recognition that the procedure should be consistent with the study goal. I think the distinction between consequential and attributional LCA is really helpful here. A consequential LCA (CLCA) aims at describing consequences. If the study of Gamage is a CLCA, the question automatically becomes "What happens when a product uses more recycled aluminium?". We have analysed the extent to which different allocation procedures reflect consequences in several papers (Ekvall & Tillman 1997, Ekvall & Finnveden 2001, Ekvall & Weidema 2004). Even the mystery of the clapping hand can be reasonably solved in a consequential study...

An attributional LCA (ALCA) aims at describing the environmental impact for which the product is held accountable. If the study of Gamage is an ALCA, the question becomes "What allocation procedure is fair/good/effective?". Here, the selection of criteria (fair, good, effective, etc.) is value-based. The perception of fairness is subjective (Ekvall & Tillman 1997). But it is, of course, possible to investigate what key stakeholders perceive to be the fair or good allocation procedure. And I would guess that your discussion on weak and strong sustainability criteria enters here.

The choice between ALCA and CLCA is value-based (Ekvall et al. 2005).

Double counting: you will always have double-counting of burdens or credits if different allocation approaches are used in different studies. And since the choice of allocation procedures is value-based, this is likely to be the case now and in the future. This holds for system expansion as well as for other approaches. And it holds for packaging materials as well as construction materials. My point is that double-counting is not inherent in system expansion. Alain, Bo, and I would all agree to use the same approach regardless of the age of the metal (nicht wahr?). And a hypothetical, consistent use of any of these approaches would avoid double counting. (Admittedly, my consequential solution to the clapping-hand mystery does involve double counting...) I understood that the 33rd discussion forum in Lausanne will be held in French and German. Is this correct? I do hope that the forum will not "invent the wheel" again, but build upon relevant parts of the substantial literature on allocation in LCA.

References:
- Ekvall T, Tillman A-M, Molander S. (2005) Normative ethics and methodology for life cycle assessment. J. Cleaner Prod. 13(13-14):1225-1234.
- Ekvall T, Finnveden G. (2001) Allocation in ISO 14041 * A Critical Review. J. Cleaner Prod. 9(3):197-208. - Ekvall T, Tillman A M. (1997) Open-loop recycling: criteria for allocation procedures, Int. J. LCA 2(3):155-162. - Ekvall T, Weidema BP. (2004) System Boundaries and Input Data in Consequential Life Cycle Inventory Analysis. Int. J. LCA 9(3):161-171.

Sincere regards,
Tomas

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Date: Thu, 25 Oct 2007 09:45:23 +0200
Author: Arthur Braunschweig <abraunschweig@e2mc.com>
Subject: Re: Recycling etc.

Hi all
without having read all the documents you have made reference to, I think it might be interesting to note the question we have at hand and which started our discussion as far as I see it: In Switzerland, we have a government sponsored system of environmental assessment of construction elements, called eco-bau. The information contained leads to statements about which construction element types, e.g. window frames of plastic, wood, wood-aluminium or aluminium, are to be favored from an environmental point of view. The system has been developed before the current EPD developments, does not meet all current standards and has its advantages and shortcomings. One specific issue is - you have guessed it, right? - how recycling of such elements should be treated in the assessment. The discussion is not mainly a methodological one, but it [contains] value choices:
-- One may argue methodologically and state that whereever recycling is feasable today, it should be considered in the assessment (of, say, a window frame which a builder will choose today). The way being e.g. by some system expansion, or by the value corrected consideration of scrap as a resource (resulting in a env. load reduction due to the recycling possibility).
-- Other people, however, say, that we have no basis to assume that recycling processes in the far future, say 50 years from now, will be done as today. They mention the case of Asbestos or PVC to support their argument that the assessment of apparently unproblematic materials may change. Secondly, they say, considering recycling in today's assessment will probably be forgotten in 50 years, leading to double counting (first today, then again in 50 years - not a big deal, as nobody will remember it :-), but a methodological flaw).
On the side, the financial means of eco-bau are limited; any method to be applied should therefore be reasonably simple to implement.

The question is thus what arguments we can find supporting which concrete methodological approach, be it system expansion (which has not been proposed to my understanding in this very case), be it value-corrected load attribution (as developed by Hans-Joerg's group), be it cut-off (as implemented now).

All the best, and thanks for your interesting comments
(See you in Lausanne, on Nov.22nd?)

Arthur

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Date: Thu, 25 Oct 2007 11:55:11 +0200
Author: Bo Weidema <bow@lca-net.com>
Subject: System expansion for recycling
Body: Dear Hans-Jörg and Rolf,

I would like to add three [comments] to your contributions to the debate:
1) On value choices in LCI
2) On the "passing on environmental [debts] to our grandchildren"
3) On why system expansion does not result in endless loops

ad 1) On value choices in LCI:
I agree with Rolf that there are value choices in LCI and that it is good to make these explicit. It should be obvious that sustainability, which is at the heart of LCA, is a political goal, based on utilitarian ethics. It should also be obvious that consequential LCA, of which system expansion is a logical part, is based on a utilitarian ethics, as so often pointed out by Tomas Ekvall. This could also be expressed as "the Polluter Pays Principle": The additional emissions shall be allocated to the product system that causes the additional emissions. This is in very simple terms what consequential LCA is about. One could of course imagine other ethical foundations, that could result in other types of LCAs. Tomas Ekvall made an attempt at this some years ago, but concluded, as I recall, that it was difficult to find a practicable implementation of other ethical systems in LCA. I guess that Rolf's suggestion, that the allocation factors should be agreed on by the stakeholders, could be seen as a kind of deontological, contractarian ethics. However, the practical implementation of this is still evasive.

ad 2) On the "passing on environmental [debts] to our grandchildren":
Rolf writes "It is 'charging an additional environmental dept (from the past) on scrap-based metals'. This might work with short living products such as packaging materials. It gets however difficult to convince our grand-children 50 years from now to take the environmental load of primary materials when recycling building materials for new products. They would use the 'sunk costs' argument (impact for primary material supply already happened and can no more be influenced, thus the material to be recovered is free of any burden) and take it for (nearly) free. And they are right! Thus, applying avoided burdens in an unreflected way, we would create a strong imbalance (environmental credit on one side but no counter-balancing environmental dept on the other) and thus miss substantial impacts (actually occurring year per year) in all the LCAs being carried out in the years to come."

As far as I understand Rolf's logic it is: A consequential LCA performed today must make some assumptions about whether and how the product will be recycled at the end of its life, and that these assumptions may involve a recycling credit for the assumed future avoided virgin production, which may then be used as part of the argument that this product system is environmentally superior. A future LCA that uses the recycled product could then use a different rule, saying that the recycled input comes free of environmental burden, in which case the credit in the first LCA "looses" its counterbalancing impact.

I think there are at least two flaws in this logic: First, the consequential LCA performed today is still a correct reflection of the consequences of the current actions and current assumptions about the future (which we can of course only assume to be true). These consequences (that when recycled in the future, the recycling will displace future virgin production) will happen (if they happen) disregarding how any future LCA may be modelled. That future LCA "experts" may decide to use a different modelling principle cannot possibly be an argument for using a wrong modelling principle today, i.e. a modelling principle that does not aim to reflect the consequences as good as we can. Secondly, it appears strange to assume that our grandchildren should decide to use a different LCA modelling principle than the one we would use: Then why would we not already do this, i.e. why should we not assume that the recycled inputs we use today have already been extracted and therefore should come for nearly free? Well, I guess the answer is: Exactly because we cannot influence the past, and therefore cannot take the credit ("sunk" benefits) for an extraction that happened in the past, just like our grandchildren cannot with any reason take the credit for our current extraction. The only thing we can influence, and therefore be responsible for, is the present and the future, and this is what we seek to model in our LCA, hoping that our grand-children will be at least as wise as we.

ad 3) On why system expansion does not result in endless loops:
It is correct, as pointed out by Hans-Jörg that the expanded system (the avoided production) may itself need system expansion and one may fear that this could go on forever, thus making system expansion impossible. However, as already pointed out by Tomas Ekvall, for each system expansion, the amount and value of the avoided production will be lower (exactly because it is a dependent, i.e. low value, co-product that is dealt with by system expansion) and the expansion series will therefore converge to a fixed value. This proof, and examples of this, are given in *B P Weidema (2003)* · Market information in life cycle assessment. Copenhagen: Danish Environmental Protection Agency. (Environmental Project no. 863), which I also can recommend as a general introduction to system expansion, procedures for identifying the avoided systems and consequential LCA in general.

I will not be present at the 33rd discussion forum in Lausanne, so I would like to hear if anyone will be able to present the above arguments in the foreseen discussions there?

Best wishes

Bo Weidema
2.-0 LCA consultants

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