TACKLING RECYCLING ASPECTS IN EN15804

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Abstract

With the current political focus on resource efficiency, the proper consideration of recycling aspects in LCA is becoming increasingly important. In this respect, two contrasting approaches are generally used: the recycled content approach and the end of life recycling approach. While ISO standards and ILCD handbook recommend using the second, at least for metal products, some national standards (e.g. NF-P01-010) use the recycled content approach, i.e. apply a cut-off rule on secondary material flows exiting the system at the end of life stage. In such a case, it is proposed to complete the LCA by an additional module where the environmental aspects of the net flow of secondary materials and secondary fuels leaving the product system can be assessed and reported. This principle has been developed within the new European standard EN15804 by utilising the so-called ‘module D’ information module, which allows the development of full “cradle to grave” or “cradle to cradle” LCAs. Whilst this module quantifies the net benefits of the end of life recycling of metal products which is already well established, it also provides a big opportunity for the “design for recycling” of building products and materials, and for selecting environmentally sound end of life scenarios and strategies for buildings.

1. INTRODUCTION

Considering the growing concern regarding resource efficiency and raw material supply, recycling is seen as key to move to a more sustainable European Union. In 2011, the EU adopted a second Communication on Raw Materials which sets out measures to secure and improve access to raw materials for the EU [1]. The strategy aims at improving access to Raw Materials for Europe through fair and sustainable supply from international sources; fostering sustainable supply within the EU and boosting resource efficiency and recycling. In coming years, the recently voted construction product regulation [2] will likely require in addition to technical information also environmental information related to building products as reported in its Basic Work requirement 7 addressing the “sustainable use of natural resources”. The expansion of the EU eco-design directive towards energy related products will also certainly affect several building products. From a market perspective, several building sustainability certification schemes, like LEED, BREEAM, HQE or DGNB has now a growing influence on the building market in Europe. The waste framework directive [4] is also targeting the building sector in a significant way, since article 11 requires that 70% of EU demolition waste shall be treated beyond 2020. All these legal and market developments show that it of prime importance to consider properly the recycling aspects of building products in the background LCA methodology which is used for assessing their environmental impact over their life cycle.

Metals are widely used in the building and construction sector. They are a first choice material for structures, reinforcements, cladding, roofing, window frames, plumbing, heating equipment and many other applications. Metals can be found in old and historic buildings as well as in new, modern architecture. Due to their high strength and high stiffness, metals can bear high loads with limited material, be used to reinforce other materials or can span great distances, allowing design freedom. Metal building products, with appropriate surface treatment when necessary, are weatherproof, seismic proof, corrosion resistant and immune to the harmful effects of UV rays, ensuring a very long service life without degradation.

In addition to the above technical properties, metal products have also a unique intrinsic characteristic which is their ability to be efficiently and economically recycled without altering their properties. Hence, grasping this specific environmental characteristic into environmental product declarations is essential.

2. RECYCLING OF METAL BUILDING PRODUCTS: THE “CRADLE TO CRADLE” LIFE CYCLE.

When a metallic building product reaches the end of its life, it is systematically recycled. Already, today, more than 95% of the metallic products used in buildings are collected at end-of-life. As example, a study [5] performed on several demolition sites in Europe has demonstrated that more than 96% of the aluminium-content of these demolished buildings was selectively collected and sent to recycling facilities. Fig.1 illustrates this “cradle to cradle” life cycle of metal building products, which saves significant resources.

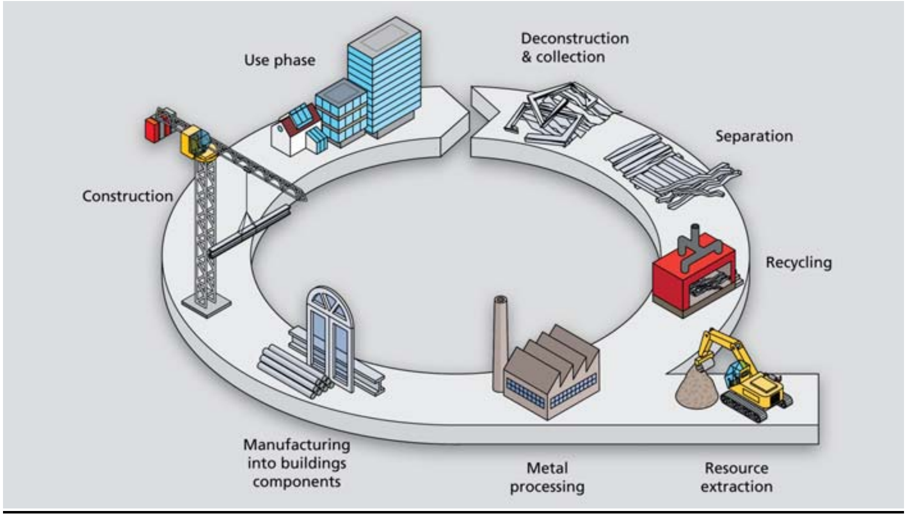

Fig.1. Typical “cradle to cradle” life cycle of metal building products

Small and medium-sized companies play a key role in the collecting and processing of metal-containing products, on their journey to metal-recycling installations. High economic value is the main driver for this systematic collection and recycling. As metal recycling provides energy savings of between 60% and 95% compared to primary production, depending on the metal and the metal-bearing product, metal recycling creates a win-win situation for both the environment and the economy.

3. CONSIDERING RECYCLING ASPECTS FOR METAL PRODUCTS

Today, two contrasting approaches are generally used to tackle recycling aspects: the recycled content approach and the end of life recycling approach.

On one hand, the recycled content approach looks at how much recycled material is used in the production of the product. Situated at the beginning of the supply chain, i.e. at the manufacturing stage of a product, this approach neglects the recycling performances of the studied product at the end of its life stage. The recycle content level depends not only on the end of life recycling performances of products but also on several other parameters like market growth, product life span and type of recycling schemes, e.g. open loop vs. close loop. Hence, this approach may make sense for assessing the environmental impact of the metal supply chain but it does not grasp the true recycling performances of the whole life cycle of the studied product.

On the other hand, the End-of-Life (EOL) recycling approach considers the recycling rate of the studied product as the key parameter for tackling the environmental aspects of recycling. The recycling rate corresponds to the actual amount of metals obtained from recycling with the amount of metals theoretically available at the end of the life of a product, including metal losses during use, collection, scrap preparation and melting. Considering that metal losses during the product use phase are negligible, it directly reflects the specific recycling performance of a metallic product independently from market growth or its lifespan. Within the corresponding LCA methodology, the recycling benefits are then calculated based on the proven end of life recycling rate, possibly with an attenuation factor in the case where intrinsic material properties are not fully maintained during recycling.

Hence, this approach is the most relevant for metal products in buildings in order to maximise and preserve metal availability for future generations as explained in the common Metals Declaration on Recycling [6], published in 2006. This end of life recycling approach is widely accepted in the scientific community as UNEP [7] and ILCD [8].

4. WHY RECYCLED CONTENT LEVEL DIFFERS FROM END OF LIFE RECYCLING RATE

Even if end of life recycling rate of metal building products is pretty high today, e.g. around 90%-95%, the recycled content in metal building product does not reach on average such a level. In reality, the recycled content is currently limited by the scrap availability which is the bottle neck of the metal supply from recycled metal sources. Indeed, the upper limit of what is recycled today is governed by what was produced in the past. The rapid growth in the use of metals over many years and the fact that metallic building products typically have a service life of decades means that there is an actual shortage of metal scrap coming from buildings. As there is insufficient recycled material to satisfy the growing demand, virgin material has to be introduced into the supply chain. So, in spite of an efficient collection and recycling of metal products at the end of their life especially in the building sector, the average recycled content in metal supply is still relatively low, usually between 30 and 50%. This discrepancy shows that the recycled content grasps inadequately the recycling aspects of metal building products. Thus, the recycled content should be used only to reflect the average share of recycled metal in the overall metal supply chain, i.e. from a “cradle to gate” LCA perspective.

5. RECOMMENDATIONS FROM STANDARDS AND LCA METHODOLOGIES

ISO 14044 [9] and the associated ISO 21930 [10] aiming at developing Environmental Product Declaration for building products recommend applying allocation rules or system expansion in case of recycling, i.e. recommends integrating the recycling benefits based on the end of life recycling approach. The ILCD handbook [7] is also in line with ISO standards. However, some alternative LCA methodologies have been developed on basis of the so-called “stock” methodology, e.g. the French standard NF P01-010 [11]. In this “stock” methodology, the benefits of recycling are only considered on basis of the recycled content estimated at the production stage and apply then a cut-off rule at end of life stage so that the environmental aspects of secondary materials leaving the building system are not assessed and not considered into the evaluation.

As a solution, it has been proposed to develop within prEN15804 [12], an additional module, the so-called module D, showing transparently the additional benefits which result from the recycling or energy recovery operations at the end of life of the building. Module D avoids any double crediting or counting since only the net benefits of recycling/recovery are reported, i.e. the recycling/recovery benefits at the end of life minus the recycling/recovery benefits already considered at the production stage. This module D is not restricted to metal scrap but it allows reporting the environmental aspects resulting from the net flow of any secondary material or secondary fuel which exit the building system at the end of life stage.

6. CALCULATING MODULE D OF EN15804

The next section shows the calculation rules governing such module D for an aluminium profile and a steel section. These rules can be applied to other materials like plastic products (decorative PVC sectional strip recycled in secondary PVC reused to produce tubes) or wood (energy recovery of wood products) as detailed in a guidance document developed by the French association of building materials (AIMCC) [13] in order to anticipate an integration of Module D in the French NF P01-010 standard.

6.1 Case 1: an aluminium profile from a window

Module D shall assess the net environmental aspects related to the generation (or consumption) of recycled aluminium resulting from the product life cycle. Provided that it can be demonstrated that the properties of recycled aluminium used at the production stage are similar to the recycled aluminium generated at the end of life stage, module D allows addressing directly the environmental aspects of the net flow of recycled aluminium.

In the aluminium window example reported in Fig.2, it is estimated that the recycled content in aluminium semi-finished products reaches 40% on average while the recycling rate of aluminium from such building product reaches 90% at the end of the product life cycle. If it is assumed that 10 kg of aluminium are needed for such product, the end of life recycling will generate 9 kg of recycled aluminium while only 4 kg of recycled aluminium has been used at the production stage. Hence, such product system is a net producer of 5 kg of recycled aluminium, i.e. 50% of the metal mass. This clearly shows that the recycling aspects of this metal product is only partly tackled by the recycled content indicator.

In this case, module D shall report the environmental aspects of 5 kg of recycled aluminium, i.e. 9 kg generated at the end of life minus 4 kg already used at the production stage. Loads and benefits should be assessed at the so-called point of functional equivalence, i.e. where the substitution takes place. In the case of aluminium, such point of equivalence is at the ingot level.

End of life metal products are usually selectively collected into specific containers which are sold to metal merchants and then directly leave the building system. Hence, module D needs to consider the environmental loads of the various recycling steps which are needed to reach the point of equivalence. In the case of aluminium, this means the scrap preparation, e.g. shredding, crushing and sorting, as well as melting and casting processes. The environmental benefits can then be calculated on basis of the equivalent avoided production of primary aluminium, possibly considering attenuation factors in the case of a full substitution is not possible. In the reported calculation, it is assumed that a full substitution is taking place, i.e. no alteration of properties through recycling.

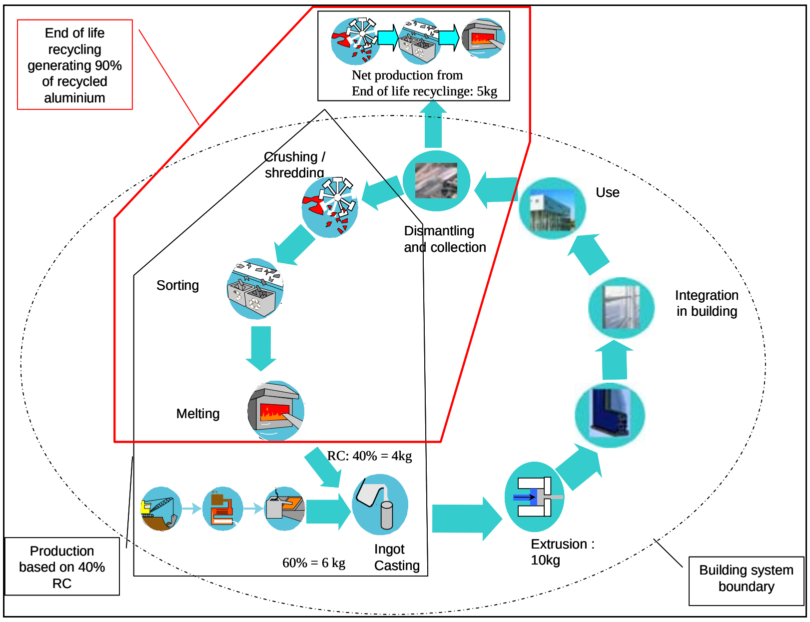

Fig. 2 Aluminium mass flow resulting from an aluminium window life cycle

Latest EAA LCI datasets developed for the European aluminium industry [14] estimates the green house gas emission of 9.7 kg of CO_2-equiv by kg of primary aluminium ingot produced in Europe while the production of recycled aluminium ingot from end of life product has been assessed to 0.5 kg CO_2-equiv by kg of ingot. According to these figures and the example reported in Fig.3, the GHG emission indicator for module A1 and module D of prEN15804 can be calculated as reported in table I.

Table I. GHG calculation of Modules A1 and D for the aluminium case

Module	GHG emission (kg CO_2-equiv)			Comments
	Recycling	Primary	Total	
A1	4*0,5 = 2	6 * 9.7 = 58,2	60,2	Metal ingot production based on 40% recycled content
D	5 * 0.5 = 2,5	- 5 * 9.7 = -48,5	-46	Additional benefits from EoL recyling based on 90% recycling rate

Assuming a recycled content of 40% in the ingot used at the production stage, the aluminium supply of 10 kg of ingot leads to a GHG emission of 60,2 kg. This GHG emission corresponds to the "cradle to gate" metal supply, i.e. without considering the end of life recycling scenario of the product under consideration.

Considering that a net amount of 5 kg of recycled aluminium is generated from the product system at the end of life stage, Module D calculation is based on the corresponding loads for the recycling operations minus the benefits from the primary aluminium savings. According to this calculation rule, this exiting flow has an equivalence of 46 kg of GHG emission savings.

6.2 Case 2: a steel section

The calculation of module D for the steel products necessitates to understand how steel is produced. Fig. 3 presents the two routes of steel production: the blast furnace (BF) route and the electric arc furnace (EAF) route.

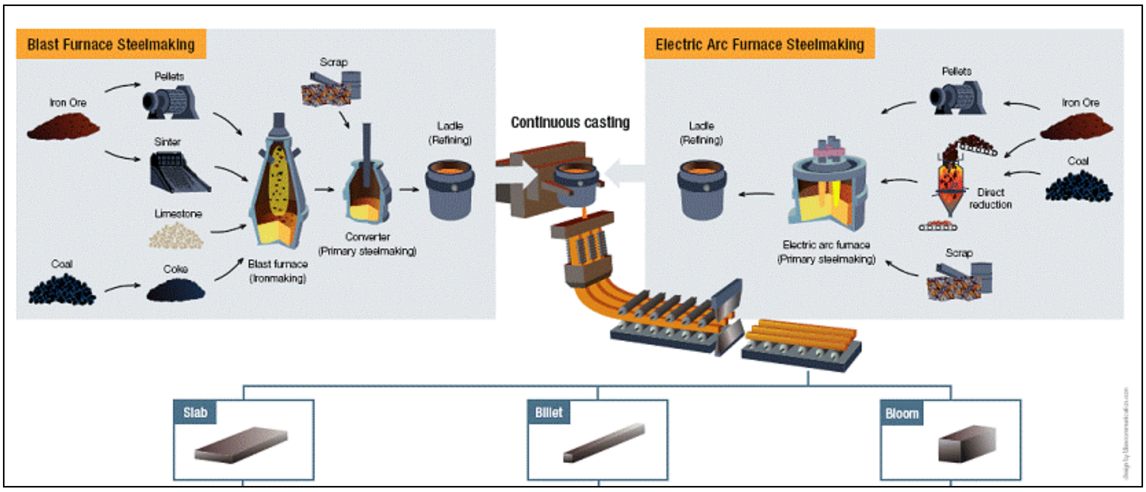

Fig. 3 the two routes of steel production

Each route is different and independent up to the point where they become common: at the continuous casting process which produces slabs, billets of blooms. As described in this figure, scrap is feeding mainly the EAF route, but it is also used in a smaller proportion (up to 20%) in the converter after the blast furnace. It is important to have in mind some characteristics of steel products:

- steel scraps are easy to collect and to sort due to its magnetic properties
- steel inherent properties are kept during the recycling process

In order to characterise the environmental footprint of steel products, Worldsteel association has been producing LCI data since 1995, to be used by LCA practitioners. In 2010, the third set of data has been released, together with a methodology report [15], which has been peer-reviewed by three independent experts this year. In this report, Annex 10 is explaining in details the recycling methodology. This version is fully compatible with the module D approach, since the principle of system expansion is applied. Before going into the calculation details of module D, it is important to understand how “cradle to gate” data are developed by Worldsteel. For section, data are coming from industrial sites of different producers, a majority of which being from EAF, and a minority from BF. As a results, the GWP of 1 kg sections has been calculated and amounts 1,15 kg CO_2eq. The quantity of scrap used as an input is 0,85 kg.

As explained in the AIMCC report [14], the calculation of module D is quite simple in the case of steel. Indeed, considering melting losses, 1,09 ton of scrap at the end of life, saves the production of one ton of slab made with 100% iron ore in a blast furnace (primary production) but it requests the production of 1 ton of slab through an Electric Arc Furnace (secondary production) from scrap. As explained in [14], it is translated into the following expression:

Avoided impact scrap = (Xpr – Xre)*Y, with

Y= 1/1,09, representing the yield of scrap in the EAF,

Xpr=LCI for primary production and Xre=LCI for secondary production.

It represents the LCI of scrap as demonstrated in [15]. For GHG emission, the value of avoided impact scrap is 1,61 kg CO_2eq/kg.

In order to calculate module D, we just have to apply this formula to the net scrap leaving the system, i.e. (RR-RC), with RR=recycling rate at the end of life and RC = recycled content.

In the case of sections, in Europe, the recycling rate end of life is about 95. Table II provides the details of calculation.

Table II. GHG calculation of Modules A1 and D for a steel section

	Module A1	Module D	Comments
Section production (kg CO_2eq/kg section)	**1,15**		From a mix of primary and secondary steel sites
Scrap input (kg/kg sections)	**0,85**		
Avoided impacts (kg CO_2eq/kg scrap)		**- 1,61**	See above for calculation
Scrap output		**0,95**	RR =95%
Net benefit for scrap recycling (kg CO_2eq/kg section)		**(0,95 – 0,85)* -1,61 = - 0,16**	

Because the recycle content of steel section is very high, the benefit represented by module D is limited. Nevertheless, it encourages decision maker to promote that scrap collection and recycling at the end of life of the product or the building.

7. CONCLUSIONS

With the current political focus on resource efficiency, the proper consideration of recycling aspects in LCA is becoming increasingly important. In this respect, two contrasting approaches are generally used: the recycled content approach and the end of life recycling approach. While ISO standards and ILCD handbook recommends using the second approach, at least for highly recycled metal products, some national standards (e.g. NF P01-010) adopt the recycled content approach, i.e. apply a cut-off rule neglecting the environmental benefits of secondary materials and fuels which exit the system at the end of life stage.

In order to report transparently the complete recycling aspect of building products, a complementary module has been developed within the new standard prEN15804. This so-called module D aims at reporting the environmental aspects of the net flow of secondary materials and fuels exiting the product system. In this way, recycling aspects of products are fully transparently reported and it is possible to generate full “cradle to grave” or “cradle to cradle” EPD by integrating module D into the assessment while avoiding any double crediting or counting issue. Hence, module D should be seen as a big incentive for promoting the design for recycling concept for all types of building products and not only for reflecting the recycling benefits of metal products.

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