Benefits of the implementation of flow indicators in LCA

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1. Introduction

Due to new regulations such as the ETS[2] directive (2009/29/EC) in Europe, Grenelle laws including environmental labelling in France, the increasing demand on performance proofs from public bodies, contracting authorities, purchasers and end users motivates manufacturers to communicate on the global environmental performance of their products using type III environmental declarations.

From a European point of view, FDES[3] and IBU[4] formats are examples of type III declarations programs relating to building products. Swedish EPD system[5] is dedicated to all kinds of products supported by the Swedish Environmental Management Council. Mostly developed in France, PEP Ecopassport® program[6] is finally managing the scheme for EEE[7] environmental declarations.

All these programs have a common approach in compliance with the ISO 14025:2006[8]. This standard establishes the principles and specifies the procedures for developing Type III environmental declarations and Type III environmental declaration programs, based on the use of the ISO 14040 series of standards. However, on the contrary of classical Life Cycle Assessment (LCA), lots of Type III environmental declaration programs are introducing the calculation of complementary indicators such as design indicators (e.g. recyclability) or flow indicators (e.g. total primary energy).

Nowadays, a harmonization concerning the choice of LCIA[9] calculation methodologies is ongoing thanks to the ILCD[10] recommendation handbook. Besides, Life Cycle Inventory (LCI) dataset formats are specifically adapted to allow the calculation of environmental impacts directly within LCA software. On the contrary, most of the time, the calculations associated with flow indicators have to be performed outside the existing Life Cycle Assessment tools. Indeed, LCI datasets do not contain sufficient information to simplify such calculation.

The objective of this paper is to present the benefit of implementing the calculation of flow indicator directly within LCA software. Besides, this paper initiates a reflection on how the implementation of such calculation will impact existing LCI dataset format.

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[2] Emissions Trading System
[3] « Fiches de Déclaration Environnmentales et Sanitaires » standing for Environmental and Health Declaration Formats
[4] "Institut Bauen und Umwelt" standing for Institute Construction and Environment
[5] Environmental Product Declaration
[6] Product Environmental Profile
[7] Electronic and Electrical Equipment
[8] Environmental labels and declarations - Type III environmental declarations - Principles and procedures
[9] Life Cycle Impact Assessment
[10] International Life Cycle Data

2. Impact and flow indicators

There are mainly two types of indicators in usual sets of indicators recommended by type III environmental declaration programs: impact and flow indicators.

On the one hand, impact indicators aim at describing a particular phenomenon and quantify it. The ILCD system recommends characterisation methodologies to calculate them. A sub-classification for impact indicator characterization exists depending on the chosen level of impacts: mid-point and end-point indicators. The first ones aim at assessing environmental impacts as problems. The purpose is to give a reference value from which two products can be easily compared. On the contrary, end-point indicators aim at assessing impacts in terms of damages and consequences. Namely, the consequence of climate change by the resulting damage on human health is an end-point indicator.

On the other hand, a flow indicator aims at quantifying a physical flow (consumed energy and water, waste production or used material). They transcribe a consumption, a production or an emission of substances. Unlike impact indicators, they don't lie on characterization models, but are a compilation of elementary and intermediary flows. They are thus representative of a physical reality.

3. Gap analysis for the calculation of flow indicators

The large number of environmental declaration programs worldwide spreads more complexity in this particular context. They differ from the way they are conducted, their scope, and also from their sets of indicators. It appears more relevant in a particular situation to deal with such or such indicator.

Due to their intrinsic characteristics, impact and flow indicators are not calculated the same way. Nevertheless, both of them rely on the same crucial element: LCI[11] data sets. Their format is guided by ILCD recommendations. It must ensure that the information is provided in a systematic, detailed and well-structured way. However, this information does not seem to be sufficient as it does not allow calculating flow indicators.

The list of flow indicators recommended by EN 15804 could be divided into five categories which are primary energy resources indicator, waste indicators, use of secondary resources indicators, water consumption indicators and design indicators. This repartition **Erreur ! Source du renvoi introuvable.**highlights the specificity and the complexity of taking into account such consideration.

The first category - primary energy resources - is gathering the following indicators: use of renewable primary energy excluding renewable primary energy used as raw materials, use of renewable primary energy resources used as raw materials, total use of renewable primary energy resources, use of non-renewable primary energy excluding non-renewable primary energy used as raw materials, use of non-renewable primary energy resources used as raw materials and total use of non-renewable primary energy resources.

In order to be able to calculate such indicators, missing information within the current LCI datasets formats is requested:

[11] Life Cycle Inventory

First, there is currently no difference between primary and secondary energy flows. In this way, no difference is made between wood burned to produce heat for the considered manufacturing process whether issued from waste collection, or wood shavings issued from the internal sawmilling.

Secondly, no distinction is made between the use of renewable and non-renewable energy. Keeping the example of wood, if it is originated from a sustainably managed forest, then, the source of energy is considered as renewable, otherwise not.

Moreover, the recovery of energy and materials that are derived from the product system is now to be informed. These notions were barely dealt with before, as only the pourcentage of reused materials had to be tackled.

Finally, EN 15804 addresses waste quantities generated during the product life cycle. Waste has now and then to be quantified and classified in a certain category depending on its dangerousness: hazardous, non-hazardous or radioactive.

As a consequence, there is additional data to be informed to allow the calculation of flow indicators. Besides, a strong revision of how to feed these indicators must be carried out.

4. Direct integration of flow indicators in LCA calculations

The purpose of this chapter is to give a comprehensive overview of the implementation of flow indicators in LCA calculations. The example of the primary energy flow indicators recommended by EN 15804 is to be tackled.

4.1 Development of additional data

Previous chapters highlight the fact additional data is needed in order to calculate energy flow indicators.
Within most LCA software, energy flow indicators are currently calculated through the compilation of primary energy flows (feedstock/fuel energy and total renewable/non-renewable energy) for each LCI data set. The approach proposed by EN 15804 is different and that's why new flows must be created to feed the corresponding flow indicators.

Moreover, a same resource can undergo different treatments depending on the situation. Let's take the example of wood to illustrate this idea. If wood comes from a sustainably-managed forest, then it is considered as a renewable raw material; otherwise not. Besides, if wood is used as a raw material, then it is a primary resource; otherwise not. Last but not least, wood can be either used as a construction material or can be burned into a furnace to produce energy.

As a consequence, the problem of classification of resources depending on their nature or use (materials/process – renewable/non-renewable – primary/secondary) must be addressed.
Another problem to address is the feedstock energy also called the primary energy resources used as raw materials that has to be differentiated from the primary energy resources used as process. In order to consider this energetic content, Lower Heating Value of a material can be used and consequently has to be available within the LCI dataset.

LCA software developers should implement a new way to transcribe this additional data to the former ones. They do not conflict with ILCD recommendations but they should instead be considered as an improvement of the methods.

4.2 Completion of LCI datasets

Now the list of needed complementary data is settled, LCA developers must find a way to transcribe them in LCA software. There are several options.

The simplest solution is to call upon the use of checkboxes that have to be ticked by LCA practitioner each time a dataset is used. As a consequence, the handling of this solution may be time-consuming and tedious for LCA practitioner.

Secondly, a second level of categorization for LCI data sets can be created: the “family” level. Three types of families can be implemented: renewable material, non-renewable material, process. Each family will induce a specific treatment of the data within the flow indicator calculation algorithm. Even if it is a database matter, LCA practitioner will have the ability to change the family of an LCI data set in a particular situation.

Another solution would be to add reminder flows directly corresponding to the different flow indicators within LCI data sets or during the LCA modeling. In fact, LCI data sets are in simple words a compilation of inputs & outputs (mainly the reference flow and associated elementary flows) and metadata[12] (e.g. nomenclature, location, documentation of sources...). The idea is then to implement a new type of flow with specific attributes and metadata: the reminder flow. It will be mostly characterized by its physical properties: energetic content, recyclability, computed weight and so on.

4.3 Definition of a calculation algorithm

Previous developments are interesting as they set a solid basis from which calculations are made possible. Nevertheless, they can easily be tedious if they are to be performed by hand. The final solution would be to automate these developments so that they are directly integrated in the calculations made by LCA software.

The introduction of the classification of LCI data sets allows automation and simplification especially regarding the calculation of use of primary energy resource indicators. Minor changes in term of database are essential to get access to such major results.

5. Conclusion

The present paper gives a hint regarding the benefits of the implementation of flow indicators in LCA. They indeed provide an undeniable source of additional information that can be valuable for LCA practitioners. They are representative of a physical reality, which give information on more concrete aspects for end user.

First, the differences between impact and flow indicators have been pinpointed. The choice for flow indicators has now evolved so that it is widely developed, in particular the ones proposed by the EN 15804 standard. However, the calculations of these indicators and the subsequent changes they imply in terms of LCA software are still blurry.

As a consequence, new data has to be developed. It concerns the very own nature of resources as it is related to the renewable/non-renewable, primary/secondary, material/process behavior of resources. It also

[12]Metadata: data providing information about one or more aspects of the data

concerns their physical properties: recyclability, recycled content and lower heating content. Once this data has been identified, it has been necessary to integrate them in the calculations. Different tools and methods have been developed in this purpose. The objective is also to reduce as much LCA practitioner handling to avoid resulting mistakes. That’s why an automation of the calculations has to be performed through the development of algorithms. An illustration of these ideas will be given thanks to the detail of the calculations for energy flow indicators set by EN 15804.

This topic is quite new and unexplored. The same reasoning could be extended to all indicators set by EN 15804 but also other programs.