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Preface

1. The nexus LCA, Bio-products and Biorefineries: LCA as a concept and methodology

The LCA as a concept was initially developed to evaluate the environmental effects of industrial products or activities throughout their whole life cycle. The concept was then transformed into a standardized methodology (ISO 14040 series). Several tools such as databases and assessment software were developed and applied to an increasing number of fields. In the last two decades, application to biofuels gained in importance especially boosted by policy obligations. Indeed mandates decided by several countries such as the United States of America and the European Union member states were constrained by environmental and social requirements. One of them is targets of CO_2 emissions reduction compared to a reference fossil fuel. LCA is used to verify the compliance of candidate biofuels to these targets. The controversies raised by number of assessments with contradictory results lead to a certain decline of confidence, even to skeptical scrutiny of LCA as a potential scientific methodology capable to serve the needs of policy. However, is there any alternative scientific methodology?

Technology Assessment (TA) that aims at "estimating the effect of new products and processes on operations of a firm, other firms, society and the environment" (www.businessdictionary.com), is sometimes presented as a possible alternative methodology. However, environmental effects of biofuels and bio-products not only comprise technological dimensions but also design and operation of the whole supply chain from agriculture stage to the use phase. Furthermore TA may comprise use of LCA.

Life Cycle Sustainability Assessment (LCSA) is another emerging methodology that attempts to extend LCA to Social Life Cycle and to Life cycle costing. While this new concept is theoretically attractive, its practical application will encounter difficulties related to unavailability of data. Hence LCSA worsens the critiques to LCA. Instead of searching an improbable alternative to LCA, it is preferable to enhance its holistic value and other required properties such as transparency, relevancy, consistency and improvement of the reliability of the databases.

2. The science of LCA applied to biofuels and other bio-products

The question emerges whether or not LCA is a scientific methodology. The importance of that issue is concerned with the policy efficiency regarding biofuels incentives. If LCA is not a scientific methodology, incentives given to biofuels on the basis of their LCA environmental performances may be discussible. But what is a scientific method? According to the "BusinessDictionary.com", that must consist in a six-step approach: "(1) identifying and defining a problem, (2) accumulating relevant data, (3) formulating a tentative hypothesis, (4) conducting experiments to test the hypothesis, (5) interpreting the results objectively, and (6) repeating the steps until an acceptable solution is found". That definition does not exclude ignorance or other uncertainties. The LCA in its ISO standardized form complies with that definition. However applications to biofuels sometimes fail to clearly define the problem of concern. The database used is not always defined and the ways other data are generated and combine to those from databases are merely often omitted. The hypotheses in the background of comparisons of biofuels with fossil fuels are not clearly stated. The methodology used to assess environmental impacts is not accessible to the readers. Sometimes the users work with mass and energy imbalances. Finally the practical evaluation process eludes the recursive approach that is required for confronting interpretation of results to hypotheses, assessment methods and problem setting.

The concern, in consequence, is not the "non-scientificity" of LCA but insufficiencies in various practitioning techniques. Issues concerning the definition of boundaries, choice of the functional units and allocation of burdens that can lead to results gaps are not symptoms of non-scientific character of LCA but call for the necessity to justify the relevance of the modeling choices and to make explicit the evaluation procedure.

3. Case of biorefineries

Biorefineries raise a particular problem to the application of standard LCA regarding the choice of allocation methods. Practitioners of LCA often choose between pure allocation and system expansion also referred to as substitution. The latter method is recommended by ISO 14040 in the case of conventional production where one principal product generates by-products. In the case of biorefineries, most of the by-products become co-products. Furthermore policy requirements in terms of reductions of burdens compared to fossil based products can be imposed in the future to several co-products. In that sense, a claiming based allocation can be utilized that makes use of both substitution and allocation methods. In that proposed approach, the choice of the reference system against which the improvements is brought out by the biorefinery is very challenging. Also the functional units must be adapted to each co-product and to the biorefinery as a whole. The energy based value approach used by various authors is not anymore relevant when the co-products comprise both energy and non-energy bio-products.

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4. Contributions of this special issue

This issue gathers contributions on LCA of different bio-products including algae, biofuels and chemicals. The diversity in methods used, products and results gives an idea of the potential of LCA to cope with environmental impacts of bio-products. It is expected that the issue will introduce the readers to the wide field of nexus LCA, bio-products and biorefineries. I take this opportunity to thank Prof Ashok Pandey, Editor-in-chief for inviting me to be the Guest Editor of this special issue and also thank the publisher and editorial team at Elsevier for their help and support in bringing out this special issue.

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