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Chapter 1

Introductory Chapter: Life Cycle Assessment as a Fundamental Tool to Define the Biofuel Performance

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Additional information is available at the end of the chapter

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The widespread availability of inexpensive petroleum during the twentieth century, growing concerns of fossil fuel depletion, as well as stricter emission regulations and the search for alternative sources and economically viable substrates has been the main focus of researchers seeking to overcome the economic and environmental barriers to the renewable energy sector. The ideal source for production of biofuels mainly depends on its availability and cost. Thus, a need arises to address the current energy and environmental issues to produce biofuels [1, 2].

Biofuels have become an alternative source over the traditional energy sources. Therefore, the progress of knowledge through the establishment of more robust methods of analysis, such as the life cycle assessment (LCA), highlights the weaknesses of the systems, pressing the process engineering to develop sustainable solutions for application in production chains [3].

The life cycle assessment is a methodology to quantify the input and output streams of materials and energy throughout the production chain. Moreover, it is a useful tool to assess resource use and environmental burdens related to systems. According to **Figure 1**, four stages are used for conducting an LCA: (i) objective and scope definition; (ii) inventory analysis (LCI); (iii) impact assessment (LCIA); and (iv) interpretation [4].

The goal and scope definition stage includes the intended application, the reasons to carry out the study, the intended audience, and the use of the results. In addition, the system boundary and the functional unit should also be clearly defined. This stage is included in all the papers analyzed, although not always with the same level of detail. The system boundary defines the processes to be included in the analysis. The life cycle inventory (LCI) stage involves the compilation and quantification of inputs and outputs for each process included within the system boundary. The impact assessment categories are chosen to have an overview of the inventory data: energy balance, water footprint, global warming potential (GWP),

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potential of acidification, and eutrophication. The interpretation evaluates the inventory analysis results and impact analysis to select the favorite product or process, with a clear understanding of the uncertainties and assumptions used to generate results.

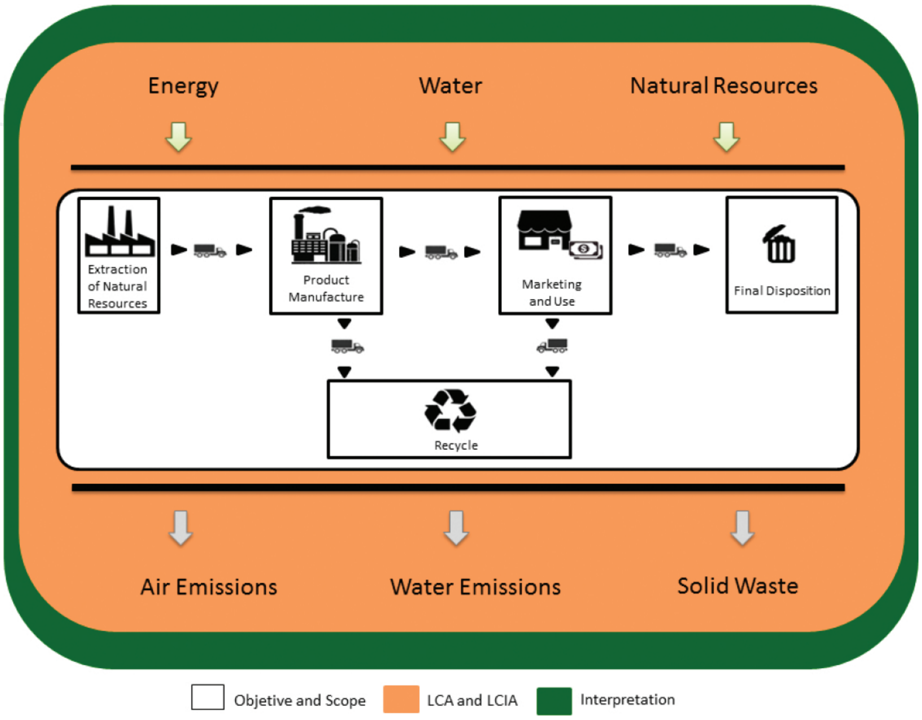

Figure 1. Stages for conducting an LCA.

The energy ratio (NER) is defined as the ratio of total energy produced (feedstock energy potential) over the energy content of construction and material, plus energy required for all plant operations. In case of the energy balance, the starting point for the economic and environmental viability of processes is the consolidation of a favorable energy balance (NER > 1) [5].

Moreover, water footprint (WF) of an enclosed area or process is determined by the sum of the water footprints of all processes. The blue WF refers to the amount of water incorporated in the product, which is determined by the evaporation rate plus incorporation and return flow. The green WF refers to the volume of water consumed in a production process, plus the water incorporated into the finish. The sum of all processes is determined per a volume of water per unit time [6].

Across the globe, there are two main public policy objectives driving the development of biofuel industries improving energy security and reducing global warming. Absorption capacity, concentration, and residence time of gases are used to evaluate the so-called global warming potential (GWP). The environmental impact generated by greenhouse gases, as well as the potential for acidification and eutrophication, in general can be quantified by the sum of the masses of the substances of gases (CO_2, CH_4, NO_x), multiplied by the characterization factors of these same substances. Once each of the factors will be different when related to the impactful gas to be measured [7].

Finally, including the life cycle assessment as a fundamental tool to define biofuel performance is a decision making that provides an understanding of the environmental impacts, and impacts on human health have traditionally not considered when selecting a product. This valuable tool should be used to expand the knowledge base of productive systems and their relationship with the environment, once can increase the efficiency of its processes, reduce the costs, and further promote marketing their products in such a sustainable way.

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