

Co-Product Function Expansion: A Methodology for Incrementally Considering the Effects of Co-Products in Multi-Product Systems

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An important component of Life Cycle Assessment (LCA) is the methodology by which energy and emissions in multi-product production systems, such as petroleum refining, are attributed to the production of the different products.

One approach is to allocate energy and emissions from the production and upstream stages among all products, co-products and by-products on the basis of mass, energy content, or economic value. In an LCA using such a method for a product such as gasoline, only a share of emissions from the crude oil extraction and petroleum refining stages is allocated to gasoline, and only the downstream effects attributable directly to gasoline are included. Co-products are placed entirely outside the system boundary. This is known as an *allocation* approach.

Another approach is to fully expand the system boundary, including all primary products, co-products, and by-products within the overall product system. All system downstream functions are included, and multiple functional units are defined. To compare alternative production systems and products, each system must be made equivalent by adding functions, from outside of the direct product system, if necessary. This is known as a *system boundary expansion* (SBE.)

This paper proposes an alternative methodology called Co-Product Function Expansion (CFE). CFE is an incremental approach in which selected co-products and a selected set of co-product functions are placed within the product system boundary, and the energy and emissions for upstream stages and co-product production are accounted for in the LCA. The downstream functions of the co-products are compared with alternative products serving the same functions, and the net energy and emissions, as either debits or credits, are assigned to the primary system products.

The objective of the CFE methodology is to allow the effects of individual co-products to be assessed without having to apply a full SBE. The methodology is particularly relevant for co-products that have a potentially significant impact on energy and emissions in production or downstream stages, and would not otherwise be accounted for by an allocation approach.

The scope of a CFE is defined with respect to market information and to a specific set of co-product functions. In some cases, only certain co-products are included, with the remainder allocated outside the system boundary. This occurs when market data indicate that no technically or economically feasible product alternatives exist for certain co-product functions.