Sustainable resource management for technology: features of thermodynamics

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A recent paper of Huijbregts and colleagues (Huijbregts et al., 2010) demonstrates that a number of emission impacts by all kind of technologies are strongly related to the resource intake, in particular energy input. Definitely, sustainable process design should rather start with energy and resource needs than emission considerations. In this contribution, it will be demonstrated what thermodynamics, and especially exergy analysis (EA) and exergetic life cycle analysis (ELCA) can offer here. This will be illustrated with work recently published or to be published in the journals Environmental Science & Technology, Green Chemistry, and Resources Conservation and Recycling.

First, all technology in the end or - even better- in the cradle, rely on resources derived from our planet: renewable resources (solar, wind, tidal, technical and food biomass …), land, water, minerals and mineral aggregates, metal ores, and nuclear and fossil energy (Dewulf et al., 2007). It will be shown how resource fingerprints of commodities can be made. Second, it will be illustrated how technology "metabolizes" resources (in)efficiently into services that all have added value. Here, the EA and ELCA framework encompasses both energy and material needs going beyond single issue approaches as for example with total material requirement (Dewulf et al., 2008). Further on, it will be illustrated what ELCA can offer in the identification of the challenges and opportunities but also potential resource cost shifting by the introduction of so-called green alternatives (Van der Vorst et al., 2009). Finally, resource management should go beyond the management of natural resources and should encompass anthropogenic resources as well, whether they are called (end-of-life) product, by-product or waste. The advantages of this 'metabolic thinking' as brought forward by the industrial ecology theory can be substantiated with hard quantitative numbers through EA and ELCA (Van der Vorst et al., 2010).

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