ASSESSING THE NATURAL AND ECONOMIC VALUE-CREATION OF INNOVATIVE BIOBASED PROCESSES

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Abstract:

Industry is confronted with systemic environmental problems such as limited fossil resources, sustainability concerns of renewable resources, toxicity of end products and waste accumulation. This triggers the pursuit of new processes and business models. New pathways are being developed together with authorities and academia. For instance, the agro-industrial and chemical sector define pathways including biorefineries, material production from organic waste and sustainable chemistry.

Will this help the transition towards a sustainable economy? Several authors indicate various principles as a prerequisite for such a sustainable economy: (i) virgin fossil resources should be banned from use, (ii) the utilisation of man-made toxic products should no longer be allowed. (Robèrt, 2000), (iii) materials should be cycling in fully closed circuits. (Braungart et al., 2007). The above-mentioned scenarios are interesting, because they are based on organic natural resources and develop a fully cycled economy. Furthermore, the production processes are mostly natural processes, based on the actions of living organisms, such as bacteria, fungi, worms or algae. This eliminates several systemic problems. Also industrial energy needs can be reduced drastically, as natural processes are far more energy and material efficient, when considering all externalities. Not only the process needs to be changed, the economic characteristics of these new companies need to be adapted accordingly. Within a fully cyclic economy, all output products of a production process should be valorised or recycled. At company level, production will be optimised for joint production of multiple products. And the economy as a whole will become more complex and intertwined. This is a major challenge for policy makers in their aim to support such sustainable industrial activities.

The ambitions of these new industries are high, and the promises of these innovations should be verified. Will the innovative processes be more sustainable than the present state-of-the-art in industry? And will these new processes produce enough economic value for society ? Which policy options can promote such an economy in a structural way?

The current research investigates these questions in conjunction. The interactions within these innovative industrial systems are becoming almost exclusively governed by natural processes. These processes being subjected to nature's principles, one can see these new installations as a particular extension of the surrounding ecosystem itself, rather than an artificial industrial economic system. This allows the methodology to start from an energy and material balance analysis of the entire ecosystem, including the industrial process. Several authors assess the energy and material efficiency of ecosystems and living organisms in terms of exergy. (Jorgensen and Svirezhev, 2004) Similar methodologies asses the efficiency of industrial processes in terms of exergy or exergy cost. (Szargut, 2005). Various applications have further developed the method by integrating all major environmental effects in the equation and linking industrial life cycle analysis with the input from ecosystems. (Dewulf et al., 2007).

Based on these developments, we propose a methodology to assess the exergy cost of the industrial output starting from the ecosystem it is related to. This is compared to the economic cost and value of the same industrial outputs. Through a life cycle perspective, the methodology compares both natural value and economic value-creation of an innovative industrial process. Built on value assessment and total factor productivity analysis, we delimit the steps to assess these values on an equal basis. The methodology is applied to a case study. The results show the potentials and limitations of such a methodology. For instance, the choice of the ecosystem interacting with the process is of high importance. But also the contribution of ecosystem services requires more research.

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