4.2 Environmental impacts of bioenergy

EFFECT OF LAND USE CHANGES ON THE SUSTAINABILITY ASSESSMENT OF BIOREFINERIES USING DYNAMIC LIFE CYCLE ASSESSMENT

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ABSTRACT

The bottleneck of LCA method is rooted in the assumption that values for the impact categories remain constant, that is assuming a constant marginal impact or that no other sustainability information changes the overall system, and thus also the individual impacts. This means, no matter how "good" or "bad" is the score at the end for LCA, the score in the beginning for environmental impacts does not change.

A simplified example of fishes and a fisherman will illustrate possible consequences of this assumption. In the situation that we have a full lake of fishes and the fisherman catches one fish, the stability of ecosystem is not compromised, the fish population recovers. On the other hand, if we only have two fishes left in the lake and the fisherman catches one fish, the population cannot recover anymore. This, of course, is caricatured example, but it shows that having the same impact in the environment (in both cases caching only one fish), can result in two different scores at the ecosystem level (in one case the LCA score should show a sustainable situation, in the other case – extinction of species). In order to obtain different scores for the same impact, simulation model should be dynamic, that means to have information feedback loops. These feedback loops are proposed in this research.

Therefore, in this research feedback loops are proposed to be included in the LCA model using system dynamics methodology, thus creating dynamic LCA. Since the land use and land use changes is much debated issue regarding sustainability of biorefineries. **The aim of the research is to compare the impacts created from biorefinery process in the case land use is accounted in dynamic manner and to compare obtained impacts with "classical" LCA approach.**

In this study the modelling approach used will include coupling of life cycle assessment (LCA) with system dynamics methodology. System dynamics methodology would enrich possibilities of LCA, since this tool depicts interrelations of components in the systems studied.

Firstly, preliminary results show that there might be much larger consequences on the environmental quality if the dynamic effects are included. And secondly the dynamics of these changes have clear non-linear nature. That means that there are some benchmarks, when crossed environmental quality can decrease in much higher rate than ever before. As given in the example with catching the last fish in the lake, ecosystem cannot recover any more. Using the findings of this study, firstly, novel methodology for sustainability assessment is developed and tested and, secondly, the developed benchmarks can be used for scientists and policy makers to evaluate sustainability of various biorefineries.