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Toward more sustainable biochemicals – Applying techno-economic and life-cycle assessments to target substances

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Studies assessing the environmental performance of biochemicals, with life cycle assessment (LCA), show that in comparison to functionally equivalent fossil-based chemicals there are obstacles that need to be overcome to make them more sustainable. Sustainability claims for biochemical production are mostly based on lowering the global warming potential, when compared to fossil-based chemicals but assessing other impacts, such as, land use and eutrophication, are often ignored. This simplification leads to overseeing an important impact category, which might imply imminent environmental problems pertaining to the biochemical production (Ogmundarson et al.[1] and Hottle et al. 2013).

Since many of the environmental impacts are related to cultivation of the biomass, large investment has been put into assessing the opportunities of utilizing side-streams from agriculture and non-cultivated biomass, such as, macro-algae. The problem with trying to assess possible increased sustainability of biochemicals produced with alternative feedstock is that the data is scarce and production yields are based on lab-results, which is not representative for large-scale production.

In the past decade, Techno-economic assessments (TEA) has emerged as a benchmark for process optimization, used by the chemical industry to investigate viability of potential investment. Applying TEA sheds light on the economic and technical hurdles in the research and development stage encountered by the industry while transforming sugars to various chemicals. Applying TEA also helps overcome the hurdle of scaling up of laboratory results to theoretical production yields needed to make biochemical production economically viable. The above schematic illustrates major stages involved in the production of chemicals based on various generations of bio-based feedstock.

In our recent work, it was observed that when applying TEA and LCA on products, the data inventories for TEA could be readily adapted to the LCA's inventory framework, thereby, warranting the application of both assessments, simultaneously, on early stage development of new target chemicals. Basing decisions on both TEA and LCA ensures that the results are more robust and provides insight into a more holistic scenario than only basing decisions on either of the two methods.

[1] Paper in review