Use of Life Cycle Assessment to determine the environmental impact of gasification of lignocellulosic biomass: preliminary results

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Abstract: The biomass is a promising energy source to replace fossil fuels. Lignocellulose is abundant in cheap and non-food materials extracted from plants such as wood and energy crops and second generation technologies allow to convert this material into fuels or building blocks for the chemical industry. These technologies are interesting in that they allow for the whole plant to be processed and for better yield per acre, and they imply less competition with food crops for land and water.

Second generation technologies are divided between biochemical and thermo-chemical conversion routes. The latter is considered more extensively, especially the gasification process. This process converts carbonaceous biomass into combustible gases (CO, H_2, CO_2, CH_4, and impurities) called syngas in the presence of a suitable oxidant. The syngas can be used directly to produce electricity and/or heat, or can be converted into a large range of products, such as diesel, via a Fischer-Tropsch process, or methanol, used for producing dimethyl ether, both of which can serve as fuels in engines.

In order to insure that, under the principle of sustainability, the use of lignocellulosic biomass is a viable alternative, its environmental impact must be quantified. The Life Cycle Assessment (LCA) methodology is used in this regard for the gasification process. As a first step, wood gasification is studied, for a downdraft, fixed-bed gasifier, based on the two-stage technology known to produce very low amounts of tar. The produced syngas is used for power generation or cogeneration (electricity and heat). The system boundaries includes biomass production and transport, pre-treatment, gasification and the syngas used in a cogeneration installation. The data is provided from industrial installations in Belgium. The environmental impact of the electricity production by biomass gasification is finally compared with fossil fuel based technologies.

This work is part of a wider study for quantifying the environmental impact of several uses of syngas and comparing them with each other and more conventional fuels. The aim is to develop a better assessment of the environmental performances of currently uncommon but promising technologies, and thus become a tool to help in the decision process.