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SESSION T2-7 LCA of Biomass- and Non-Fossil Conversion-Technologies for Liquid Fuels
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Life Cycle Assessment of TCR-PSA-HDO integrated system to produce biofuels from sewage sludge

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Introduction

TO-SYN-FUEL - The Demonstration of Waste Biomass to Synthetic Fuels and Green Hydrogen project (grant agreement no. 745749) is a H2020 project that runs from 2017 to 2021. It aims to validate the conversion of sewage sludge into biofuels, building a pre-commercial plant with a nominal dry feedstock capacity of 500 kg/h. The project implements a new integrated process combining Thermo-Catalytic Reforming (TCR©), with hydrogen separation through pressure swing adsorption (PSA), and hydrodeoxygenation (HDO), to produce a fully equivalent gasoline and diesel substitute (compliant with EN228 and EN590 European Standards) and green hydrogen for use in transport.

The sustainability of the TCR-PSA-HDO integrated system is being analysed by means of LCA and calculation of Greenhouse gases (GHG) emission savings.

Materials and methods

The goal of the TCR-PSA-HDO integrated system is twofold then two different approaches was defined: 1) process oriented, 2) product oriented. The first approach considers the integrated system as an alternative sewage sludge (SS) management, where the function is to dispose the sewage sludge. Then, the integrated system will be compared among three different scenarios SS management, which are: 1) agricultural use of SS, 2) incineration of SS and 3) landfilling. They represent the three main methods of European SS management, as reported by Eurostat3. The functional unit chosen is 1 ton of sewage sludge ready to be treated (water content 99 %w/w). The second approach considers the integrated system as a suitable system to produce biofuels, which replace the conventional fuels. The function is the fuel production then, the system will be compared with: 1) standard gasoline and 2) standard diesel. Then, the functional unit chosen is 1 MJ of HHV in the produced fuel.

The system boundaries of the TCR-PSA-HDO integrated system include the following processes: thickening, dewatering, drying, TCR-PSA-HDO, distillation. Thickening, dewatering and drying are included also in the alternative scenarios of the process-oriented approach since the sewage sludge is managed differently in according to each scenario. The alternative scenarios regarding fuels production include: oil extraction, refining, biomass production and biofuels production since standard fuels include a percentage of bio-component.

Regarding allocation methods, system expansion is used in process-oriented approach whereas, energy allocation for diesel and gasoline and system expansion for the other co-products are used in product-oriented approach.

Regarding the inventory phase, the data of the TCR-PSA-HDO integrated system derive from the design and engineering phase of the demonstrator plant because it is the focus of the project instead, those of thickening, dewatering, drying, distillation and alternative scenarios derive from literature and LCA dedicated datasets.

The realization of the LCA model has been carried out utilizing GaBi software and Gabi Professional and Ecoinvent databases. ILCD recommended characterisation methods have been applied.

Results

Current LCA results are based on the design phase since the pre-commercial plant is being built and, presumably, no data will be available before 2020. In the presentation of LCM conference, results related to process-oriented approach will be shown and environmental performances of the TCR-PSA-HDO integrated system will be compared to the alternative sewage sludge management systems. Preliminary results appear encouraging in particular respect to some impact categories such as acidification, climate change and particulate matter formation.