**Life Cycle Assessment of a Biomass-to-Liquids process**

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**Highlights**

* LCA of Biomass-to-Liquids (BTL) process
* Environmental impact assessment of biomass-derived fuel
* Comparison of LCA results to RED and to REDII
* Bio-fuels sustainability

**1. Introduction**

Reducing the environmental impact of technologies, processes and products is nowadays an important scientific challenge. In particular, the substitution of fossil fuel with biomass-derived fuels helps towards reaching this goal.

The scope of this work is to assess the environmental impact of the Biomass-to-Liquids (BTL) diesel. The Biomass-to-Liquids process (BTL) is a thermo-catalytic pathway to transform biomass to liquid fuels, in particular to middle distillates including diesel cuts.

The main steps of this technology include thermal gasification of biomass, followed by syngas clean up, Fischer-Tropsch synthesis and hydrocarbon isomerization to produce suitable synthetic fuels [1], [2].

The environmental impact of biomass-derived fuels has been calculated following the LCA methodology reported by the Renewable Energy Directive. The result must be compared to the limits imposed by RED (2009/28/EU) [3] and by the most recent RED II (2018/2001/EU) [4].

This study confirmed that the environmental impact (in term of Global Warming Potential, GWP) of BTL diesel is lower than the one of fossil diesel and respects the emission reduction suggested both in RED and in RED II framework.

**2. Methods**

The methodology followed is the LCA (Life Cycle Assessment) based on the International Organization for Standardization standard procedures (ISO 14040 – ISO 14044 series) [5], [6]. The tool used for evaluation is the software GaBi (property of the company Thinkstep).

The Life Cycle Inventory (LCI) for the LCA come from the BTL model simulation, developed internally during a project related to biofuel production. It is worth to noting that the LCA results are strictly affected by site characteristics and scenario definition.

In *Goal&Scope* definition, the Functional Unit (FU) is defined as 1 MJ of produced diesel and the System Boundaries are extended from raw biomass to bio-fuels products (diesel, naphtha). Starting from the available input data, a *Life Cycle Inventory* (LCI) has been built up and a model for the system has been defined and inserted in the software GaBi for simulation. The results have been expressed in terms of Global Warming Potential (GWP) using a 100-years timeframe according to CML2001–Apr.2013 method [8]. These results give the *Impact Assessment* related to the BTL process. Each one of the three LCA phases (Goal&Scope, LCI and Impact Assessment) is subject to interpretation for results improvement.

**3. Results and discussion**

This LCA study describes a competitive path to produce fuels via BTL process. The assessment has been applied to different species of biomass in input. Each kind of biomass causes a different environmental impact. These differences could be related to cultivation procedures, water and fertilizers consumption. Usually, considering the RED, the cultivation phase (CO2 capture by the biomass) balances the use phase of the fuel. In present study both phases are considered separately, in order to perform a sensitivity analysis related to the biomass.

The comparison between the environmental impact of BTL-diesel and of conventional fossil fuel defined by the RED and the REDII points out the environmental advantages by using BTL-fuels in the direction of reducing global greenhouse gas emissions.

**4. Conclusions**

The environmental impact of BTL-diesel is biomass dependent. In many cases analyzed it is plenty lower than the impact due to fossil fuel reference both as reported in RED and in REDII datasets and it respects the reduction of GHG higher than 60% as requested in RED (plant in operation after 6th October 2015) and than 65% as reported in REDII (plant in operation after 1st January 2021).

**References**

1. Perego C., Bianchi D., Bua L., Biomass catalytic conversion to fuel and energy, La chimica e l’industria, Marzo 2010; 90-97.
2. Zennaro R., Ricci M., Bua L., Querci C., Carnelli L., d'Arminio Monforte A., Syngas: The Basis of Fischer-Tropsch (Book Chapter), February 2013
3. DIRECTIVE (EU) 2009/28 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EU and 2003/30/EU
4. DIRECTIVE (EU) 2018/2001 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 December 2018 on the promotion of the use of energy from renewable sources
5. SO 14040: Environmental Management\_Life Cycle Assessment\_ Principals and Framework; International Organization for Standardization: Geneva, Switzerland, 2006a.
6. ISO 14044: Environmental Management\_Life Cycle Assessment\_ Requirements and Guidelines; International Organization for Standardization: Geneva, Switzerland, 2006b.
7. GaBi Software, ThinkStep: http://www.gabi-software.com/software/gabi-software/
8. CML2001-Apr.2013: http://cml.leiden.edu/software/data-cmlia.html