# Life Cycle Assessment of substitute natural gas production from biomass and electrolytic hydrogen

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In recent years, renewable energies are increasingly gaining relevance towards the achievement of environmental, economic and political objectives and for a diversification of the energy mix. Nevertheless, one of the main problems in the exploitation of renewable sources lies in the need for a reliable energy storage system that can decouple production from energy demand, especially for those non-programmable sources such as wind and solar.
Generally, due to the use of a significant amount of power, electrolysis is an expensive process, but it could become cost-competitive and environmentally sustainable when powered by surplus electricity from renewable energy sources. Such a surplus could occur either because the grid is not demanding for additional power or because such an available power could create grid instability.
In previous papers [1, 2] some layouts were analysed to evaluate the energy balance and intermediate storage systems of the production of a substitute of natural gas starting from biomass and electrolytic hydrogen. Two alternative scenarios were considered: (i) only the substitute of natural gas (SNG) is produced (Fig.1) and (ii) SNG and power are cogenerated (Fig. 2). The efficiencies of the different analysed layouts range from 52.4% to 73.8% with chemical power (fuel) accounting for 75-100% of the total output.

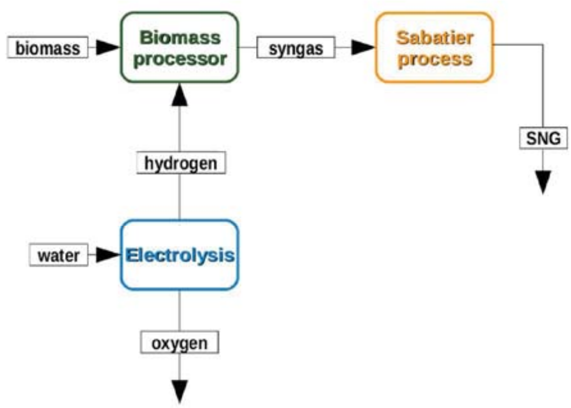


**Figure 1:** Simple fuel production

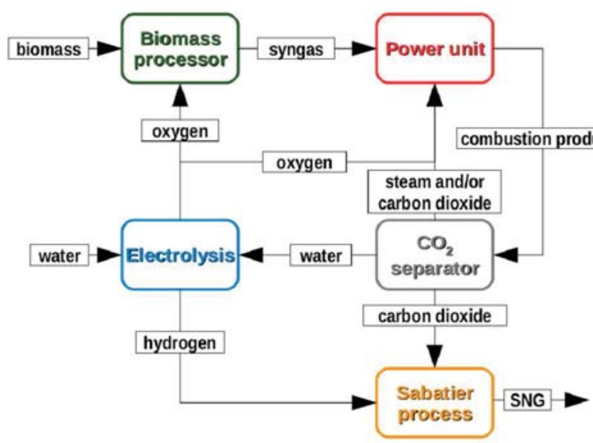


**Figure 2:** Fuel and power cogeneration

In the first scenario electrolytic hydrogen is used in a biomass hydrogasification process followed by a methanation one, to obtain a gas with a high calorific value. In the second scenario, instead, electrolytic hydrogen is sent to the methanation process, while electrolytic oxygen is used in part for the biomass gasification and in part for the production of electricity through a power unit. Different power units define different sub-scenarios, in particular the following have been analysed: (i) a gas turbine, (ii) a steam injected gas turbine, (iii) an internal combustion engine, (iv) a solid oxide fuel cell (SOFC) fed by syngas at 6 bar and combined with two gas expanders and (v) a SOFC fed by syngas at 30 bar. Electrolytic oxygen is used into the gasifier and the power unit to separate carbon dioxide from exhaust gases easier. Whereas in the previous paper an energy analysis was carried out, in this paper the same layouts are compared from the environmental point of view by means of Life Cycle Assessment methodology. The functional unit refers to 1 kg of SNG produced. Global Warming Potential, Cumulative Energy Demand and Acidification Potential have been selected as impact indicators for this analysis.

**References**

[1] Frigo S. and Spazzafumo G. "Comparison of different system layouts to generate a substitute of natural gas from biomass and electrolytic hydrogen", submitted to Int. J. Hydrogen Energy – Special Issue ICH2P-2019.
[2] Bargiacchi E., Frigo S. and Spazzafumo G. "From biomass and electrolytic hydrogen to substitute natural gas and power: The issue of intermediate gas storages", Int. J. Hydrogen Energy, Volume 44, Issue 38, 2019, 21045-2105.