**Techno-economic analysis of direct biogas methanation: assessment of Minimum Selling Price under different process configurations and depreciation schemes**

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In the last decade, the transition to a low-carbon energy system has renewed interest in CO2 methanation as a promising power-to-gas (PtG) route for synthetic methane production. However, the main barrier to the widespread adoption of this technology remains its high OPEX cost, particularly the one related to green hydrogen. At the same time, anaerobic digesters are increasingly popular and produce biogas streams containing a significant fraction of CO2, which is typically removed using conventional upgrading technologies such as basic scrubbings. Considering direct methanation not as a simple synthetic route but as an upgrading strategy offers the potential to "kill two birds with one stone": it allows both the valorization of the CO2 fraction, the production of grid-quality biomethane and an improved economic feasibility.

In this work, we present a techno-economic assessment of direct biogas methanation across various process configurations. All scenarios were derived from optimized process simulations developed in Aspen Plus. The analysis was extended over different time scenarios, incorporating projected cost trends for key reagents and products, including hydrogen and methane. Minimum selling prices (MSPs) were estimated using discounted cash flow analysis, under both linear and MACRS depreciation methods. Furthermore, a preliminary non-deterministic analysis was introduced to explore the influence of uncertain parameters, such as hydrogen prices. By incorporating stochastic elements in the economic assessment, the study provides a more realistic range of expected MSPs values, offering valuable insights for investment decisions and policy design. Our results show that under certain conditions it’s possible to reach MSPs relatively close to the one of traditionally upgraded biomethane, the profitability of methanation-based upgrading remains extremely sensitive to the price of hydrogen. Additionally, hypothetical operating conditions were tested considering grid injection specifications that allowed higher residual hydrogen content in the final methane stream. This approach enabled a reduction in purification and compression requirements, offering insights into potential cost savings in more flexible regulatory frameworks.

**Keywords**: *CO2 methanation, power-to-gas, techno-economic assessment, minimum selling price, biomethane*

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