The feasibility of integrating biomass steam gasification and syngas biomethanation to store renewable energy as methane gas

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Abstract

Biological methanation (biomethanation) of biomass-derived syngas can be a promising alternative to catalytic methanation, due to its lower complexity and milder operating conditions, and can play an important role in future Power-to-Gas and syngas upgrading systems. However, to the authors' knowledge no published study has yet assessed the feasibility of using biomethanation, along with electrolysis, as a downstream process to steam biomass gasification. In this study we carry out the techno-economic analysis of such integrated system and we compare it with the production of pure hydrogen from the same syngas stream. The results indicate that the two processes could produce 0.44 Nm^3 of biomethane or 0.07 kg of pure hydrogen per kg of biomass, respectively. The cold gas efficiency of biomethane is estimated at 58%, with a 97.5% input hydrogen utilization efficiency. For pure hydrogen, the cold gas efficiency is 37%, with 85% hydrogen utilization. The minimum selling prices (MSP) of the two products are 2.37 €/Nm^3 for biomethane and 15.45 €/kg for hydrogen. Although the MSP of hydrogen is relatively closer to currently valid industrial prices, its production on small gasification plants is challenged by the additional storage and delivery costs. Instead, biomethane production for grid injection could be a more feasible alternative under appropriate incentive schemes.

Keywords

Biomethanation, Steam gasification, Hydrogen, Techno-economic assessment