Production costs analysis of increased renewable methane output through CO_2 utilization

Themenbereich (6) Dekarbonisierung: Verkehrssektor
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Motivation and research question

Biomass is a limited resource due to land conflicts [1] and another issue is the competition between different sectors [2]. By the current biomass-to-energy conversion plants, only around 30-40 % of the carbon is utilized and converted to the fuel product. Carbon capture and utilization of biogenic CO_2 (BECCU) offers the opportunity to increase the production of energy carriers and reduce emissions in the transport sector. The core objective of this paper is to calculate the production costs for synthetic natural gas (SNG) and biomethane by adding hydrogen to the process chain and thereby increasing the carbon utilization.

Methodology

Literature analysis was conducted to analyze the potential for CO_2 capture from biomass-to-fuel conversion plants. Two types of technology were chosen for the calculation of renewable methane production. The first is biomethane production, which is a market-proven, available technology and the second is biomass gasification, for which only a few pilot plants could be established until now. The production costs (c_{fuel}) for SNG and biomethane were calculated with the formula (1). The investment costs (I_0) for biomethane plants vary depending on the type of feedstock, for example, organic waste, energy crops, etc. However, woody biomass is the main source for SNG plants.

$$c_{fuel} = \frac{CRF * I_0 + C_{OF} + C_{misc}}{FLH} + \frac{P_B}{LHV * \eta} + c_{var} \quad (1)$$

In the case of carbon capture and utilization, additional hydrogen is required to convert CO_2 into CH_4. The hydrogen costs are calculated additionally (2) with electrolyzer investment costs from literature and renewable electricity prices (c_{ele}). The hydrogen costs are then evenly distributed among the whole amount of CH_4 produced and therefore considered within c_{var} (1).

$$c_{H_2} = \frac{CRF * I_0 + C_{om}}{FLH} + \frac{c_{ele}}{\eta} \quad (2)$$

CRF = capital recovery factor, FLH = full load hours, LHV = lower heating value, η = efficiency

Results and conclusions

So far, the production cost of SNG and biomethane without additional hydrogen were calculated. This will serve as the benchmark for the economic assessment. These production costs were already higher than natural gas prices and it is expected that the addition of hydrogen in the process chain will have no opposite effect.

A sensitivity analysis showed that production costs react very sensitively to the number of full load hours in synthetic natural gas production, as seen in Figure 1. It is expected that the full load hours will also play a role in the economic assessment of an electrolyzer. However, when using renewable electricity this can be an issue in Central European countries.

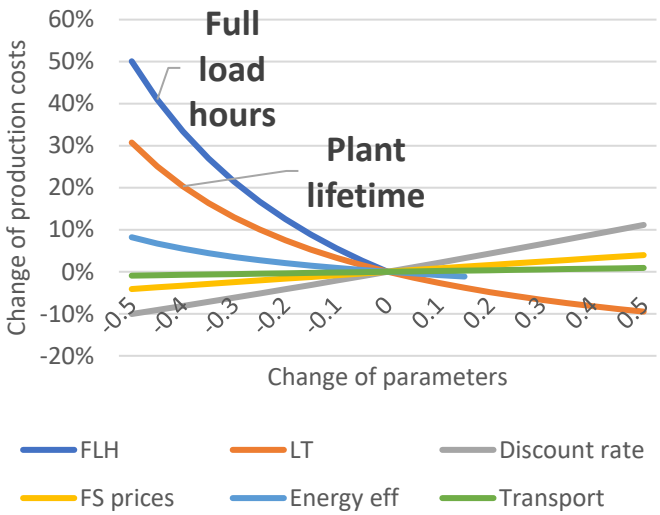

Figure 1. Sensitivity analysis of SNG production by residual wood utilization.

Literature

[1] A. Muscat, E. M. de Olde, I. J. M. de Boer, und R. Ripoll-Bosch, „The battle for biomass: A systematic review of food-feed-fuel competition“, *Glob. Food Secur.*, Bd. 25, S. 100330, Juni 2020, DOI: 10.1016/j.gfs.2019.100330.

[2] M. Baumann *u. a.*, „Erneuerbares Gas in Österreich 2040“, Wien, Juni 2021. Zugegriffen: 10. Juni 2021.[Online].Verfügbar unter: https://www.bmk.gv.at/themen/energie/publikationen/erneuerbares-gas-2040.html