Technoeconomic study of cost driving factors of a gas greening system for steel making based on power-to-gas and biomass gasification

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1. Introduction:

The steel industry is one of the largest greenhouse gas (GHG) emitters in Europe (The Boston Consulting Group, 2013). In 2014, it accounted for 15.6 % of Austria's CO_2 emissions (Umweltbundesamt GmbH, 2016). However, due to the increasing steel demand, it is also one of the most important industry sectors.

To limit global warming to a maximum of 2 °C, the European Commission published a roadmap to a low carbon economy, which intends to reduce CO_2 emissions by 80 to 95 % till 2050, compared to the reference year 1990. As part of this roadmap, the industry sector has to reduce its emissions by 83 to 87 % (European Commission, 2011).

Since the conventional steel making process is highly developed, it can not be expected that a high GHG emission reduction is generated by optimizing operation parameters. Therefore, new technologies and energy carriers have to be used or implemented to reduce the carbon footprint of steel.

One possible implementation of new technologies, would be the utilization of carbon sources from the steel making process – mainly from steel gases, like basic oxygen furnace gas (BOFG), blast furnace gas (BFG) and coke oven gas (COG) – and upgrade them with renewable hydrogen to synthetic natural gas (SNG). This SNG could substitute the used natural gas and parts of the used PCI (pulverized coal injection) coal.

As part of this work, a potential gas greening system based on power to gas (PtG) and biomass gasification, which should provide renewable hydrogen for methanation of the existing steel gases, was analyzed. For the reference steel plant an annual natural gas consumption of 3 TWh and a steel production of 5 Mt was assumed.

2. Methodology, Results and Discussion

Three implementation and operation scenarios for the mentioned gas greening system were analyzed. One extreme value scenario and two constrained scenarios were defined. In the constrained scenarios, the nominal power of the biomass gasification plant was limited to a maximum of 100 MW_{th}.

All scenarios were included a carbon dioxide reduction potential analysis, a techno economic analysis and a sensitivity analysis. The focus in this work was on showing the potentials for carbon dioxide reduction and gas greening of the three scenarios and how the evaluated SNG generation costs are influenced by factors

such as operation time, cost of electricity input, etc.
The conducted sensitivity analysis has shown that the predominant cost driving factors are the electricity price, the biomass fuel price and the operation time (see Fig. 1).

Furthermore, GHG reduction potentials of more than 800 kt_{CO2} per year were quantified, in the constrained scenarios additional gas greening potentials of approx. 300 kt_{CO2} per year were quantified.

3. Conclusion and Outlook

As one essential statement of the evaluation, the currently expected costs of 4 to 10 cent per kWh SNG for 2050 are not competitive to current natural gas prices. As main influencing sources of the SNG generation costs, electricity price, biomass fuel price and operation time were determined.
Further, a possible GHG reduction of 813 kt_{CO2} per year was concluded. Future research should focus on further sources that can be substituted by SNG and optimized operation modes of the gas greening system components. Furthermore, a detailed assessment from a techno-economic and technological point of view on N separation implementation will be necessary. If SNG feed into the gas grid is considered as option, the assessment has to further include an evaluation of gas cleaning technologies that are necessary to reach gas grid quality standards.

4. References

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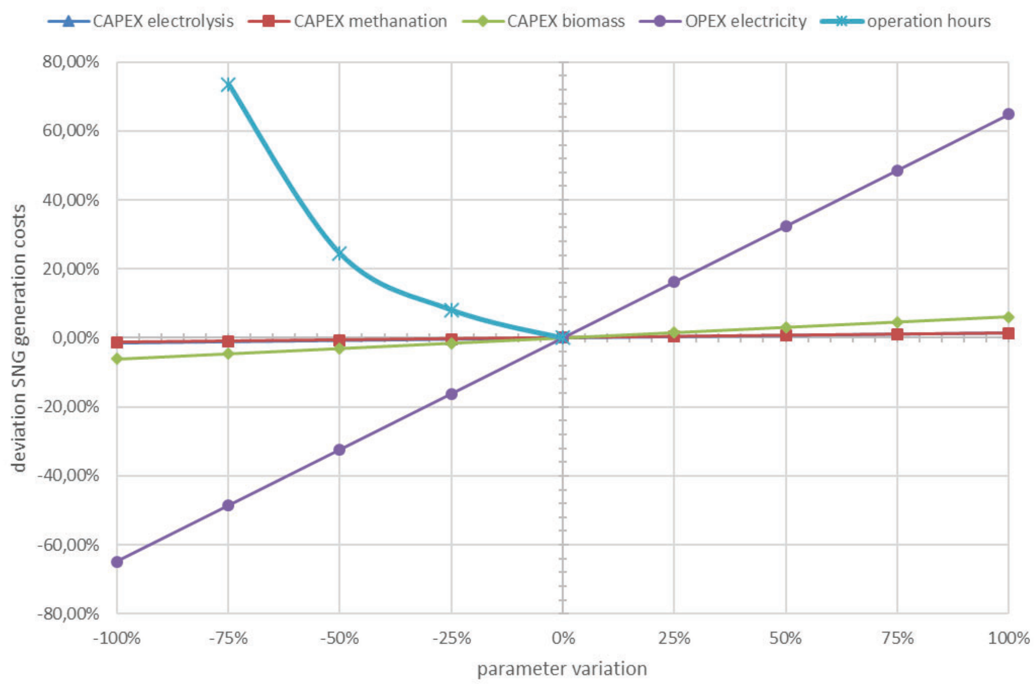

Fig. 1: Sensitivity analysis of one of the constrained scenarios