Power-to-Gas Integration can increase the importance of WWTPs as green service supplier to society by utilising smart energy buffering. During overproduction of green electricity from hydro, wind and solar power, the Power-to-Gas system can convert and store this energy. In times when energy demands exceed sustainable supply, treatment plants can convert chemical energy using otherwise emitted carbon dioxide to electricity. This provides a flexible bioenergy-based renewable power production.

Methods

Following two main process alternatives of biological methanation are considered:

- In situ biological methanation - takes place in the digester so no additional methanation reactor is needed. The CH₄ concentration can practically only be raised up to a 75% volume fraction (= 52% mass fraction).
- Separate biological methanation - CH₄ concentration up to 97% volume fraction (92% mass fraction) possible and thus a direct use without a separate CO₂-removal process. Better control as process conditions can be optimised in the separate reactor.

The economic model considers the operative profitability under different operative conditions. The analysis is performed with the help of a dynamic model, using realistic input data from Himmerfjärden WWTP in Sweden.

Conclusions and Outlook

The price of electricity and methane determines the profitability of Power-to-Gas and biological methanation at WWTPs.

Considering static efficiencies of 67% for the electrolyser, 76% for methanisation and a biomethane sell price of 0.7 €/kg, the operational break-even point for electricity cost is here 23.1 €/MWh. However, the dynamic model, using Himmerfjärden WWTP data, estimates that the operative break-even point for electricity cost would be around 37 €/MWh during the time period June 2016 - May 2017 if benefits from by-products can be obtained and the electrolyser is operated optimally.

For the case of biological methanation in a separate reactor, an increased electrolyser capacity can increase the operational profit. The main reason for this is that biological methanisation in a separate reactor can increase the CO₂-consumption in a higher level than in situ biological methanisation.

A CHP unit will not give additional operational profit. Furthermore, for in-situ biological methanisation, a CH₄-upgrading unit should be considered if upgraded CH₄ can directly be sold whereas biogas of low quality only can be used in a CHP unit.

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