Economic Evaluation of Implementing Power to Gas in a Sustainable Energy System

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INTRODUCTION AND PURPOSE

In a future energy system integrating more renewable sources while simultaneously reducing the use of fossil fuels in the energy as well as the transport sector will be one of the biggest challenges. The possibility to produce renewable gas by using surplus electricity can help tackling both problems. With a high share of volatile electricity generation like wind power the need for energy storage in order to balance production and demand increases. Via electrolysis hydrogen can be produced in times of high generation and low demand, taking advantage of lower electricity prices. The hydrogen can either be used directly or further be converted to methane gas, which can be utilized as a renewable alternative to natural gas, in the mobility or heating sector or for converting the gas back to electricity in times of high demand and low generation. [1]

METHOD AND RESULTS

The aim of this ongoing master thesis project is to analyze the economic value and the effects on the power grid of implementing power to gas (PtG) in the Danish energy system. A mathematical model is developed to investigate the optimal dispatch of existing power generation units in combination with power to gas, taking into account power flows and network constraints. Also the existing gas infrastructure and the economics of selling synthetic methane (or hydrogen) are considered.
The total system costs and the sensitivity to different parameters are modelled for various scenarios resulting in conclusions on:

- The impact of the implementation of PtG on the total system costs, including effects on reduced fuel and start-up costs of generation units.
- The possibilities to increase integration of renewables by using PtG in order to avoid congestion and/or investment in new required transmission lines.
- The effect of different locations and capacities for a PtG unit on total costs and power flow.

ENVIRONMENTAL IMPACT AND REALIZATION

For a target of a fossil fuel independent Denmark in 2050 PtG could play and important role. Since alkaline electrolysis and chemical methanation already are mature technologies and research on biological methanation and other techniques for electrolysis are promising, it is essential to investigate the economic and technical aspects in order to find the most efficient usage of power to gas in a sustainable energy system. [2]

REFERENCES

[1] C. Baumann, R. Schuster, & A. Moser. (2013). *Economic Potential of Power-to-Gas Energy Storages.*
[2] Lukas Grond, Paula Schulze, & Johan Holstein. (2013). *Systems Analyses Power to Gas: A technology review (Deliverable 1: Technology Review)*. DNV KEMA Energy & Sustainability.