Integration of a Power-to-Fuel (PtF) plant model into the regional and supra-regional Energy System

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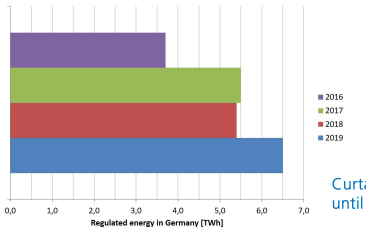
KEROSyN 100

Gefördert durch: Bundesministerium für Wirtschaft und Klimaschutz aufgrund eines Beschlusses des Deutschen Bundestages

High Curtailment of Renewables in Germany

Curtailing the energy of power plants is one of many option to prevent grid congestions in the absence of grid extensions. In Germany, the amount of curtailed energy from Renewable Energy Sources (RES) increased in the past years [1] and will continue to increase despite a small reduction due to grid expansions in 2018.

Curtailment of RES is an important issue for the federal state of Schleswig-Holstein due to the huge installed wind power capacities. Using the excess wind power to provide energy in the transport sector is a promising option to reduce power curtailment.

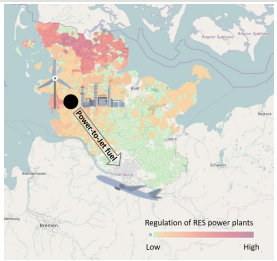


Curtailed energy in Germany from 2016 until 2019 (Source [1])

Power-to-Fuel Plant in Schleswig-Holstein

A Power-to-Fuel (PtF) plant is going to be realized in Heide (west of Schleswig-Holstein) to address the curtailed wind power and to effectively contribute to the decarbonization of the mobility sector by using the curtailed excess wind energy power.

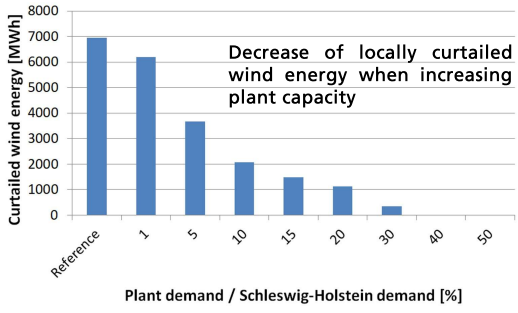
This work estimates the possible impacts of such a PtF plant on the regional and supra-regional power grid as well as on the energy system Schleswig-Holstein and in Germany. This work can be used in the future to assess the impact of similar plants in other regions.



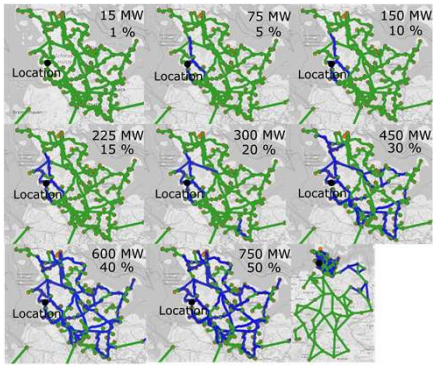
Extent of RES curtailment and planned location of PtF plant (black circle) in Schleswig-Holstein. Adapted map from [2]

Plant-size dependent impacts

Curtailed wind energy



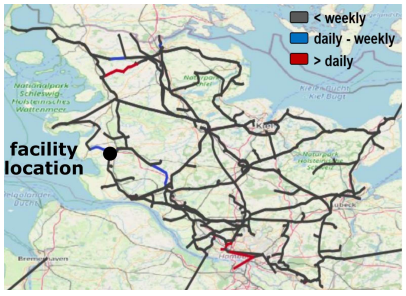
Average Line utilization



- Differences in average line utilization are analyzed with respect to a reference system without PtF plant [3]
- Deviations of average line utilization are classified as significant (blue; above 5% to the reference) and negligible (green; below 5%)
- Grid impacts remain regional for plant capacities up to 300 MW

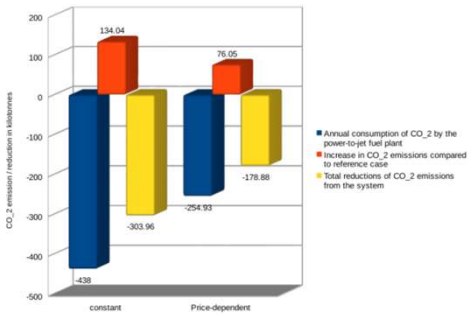
Operational impacts

Line congestion rate



Daily-constrained production can reduce grid congestions [3]

CO_2 savings



Plant consumes more CO_2 than required for power supply [4]

Outlook: PhD-project

Integration of large-scale power-to-hydrogen plants into the German power grid

- Location & size of electrolysis
- Investigate appropriate grid impacts
- Optimized electrolysis operation

Acknowledgements

We kindly acknowledge the German Federal Ministry for Economic Affairs and Climate Action (funding code: 03EIV051B) for funding the KEROSyN100 project.

We kindly acknowledge the OpenStreetMap contributors for the geographical maps and data.

[1] Bundesnetzagentur, Zahlen zu Netz- und Systemsicherheitsmaßnahmen - Gesamtjahr 2019, https://www.bundesnetzagentur.de/DE/Fachthemen/ElektrizitaetundGas/Versorgungssicherheit/Netzengpassmanagement/start.html
[2] Schleswig-Holstein Netz AG, Netzampel, https://www.netzampel.energy/historical
[3] Bartels et al., *Integration of water electrolysis facilities in power grids: A case study in northern Germany*, Energy Conversion and Management: X, 14, 2022.
[4] Rathod, Jaykumar, *Simulation and analysis of the integration of a power-to-fuel plant into the German power transmission system*, TU Berlin, Master thesis, 2020.