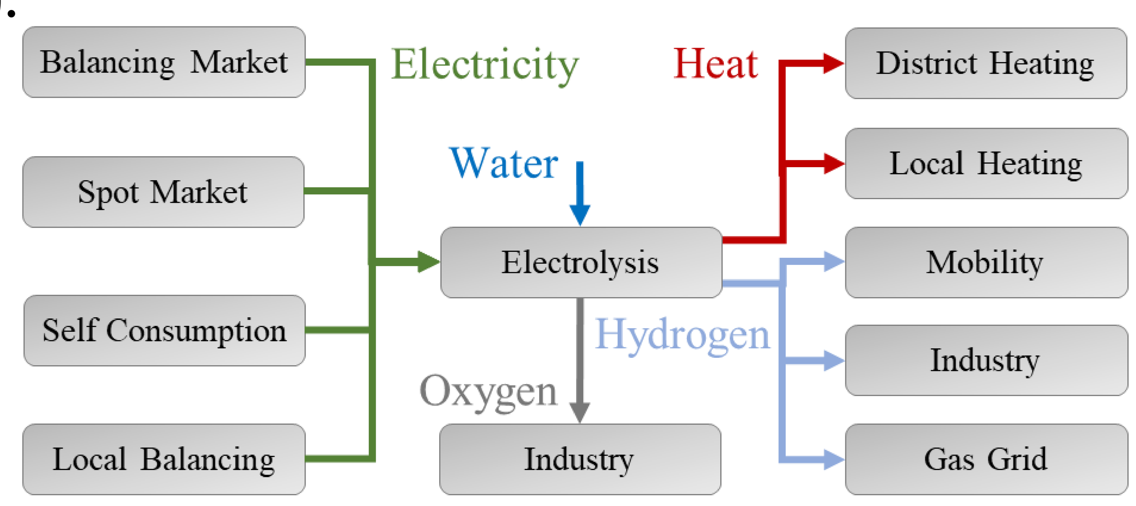
Contribution ID: 225

Flexible Operation of Electrolysis under Local Conditions and its Impact on the Medium Voltage Grid – A Study Case of an Industrial Area in the City of Ulm

Introduction

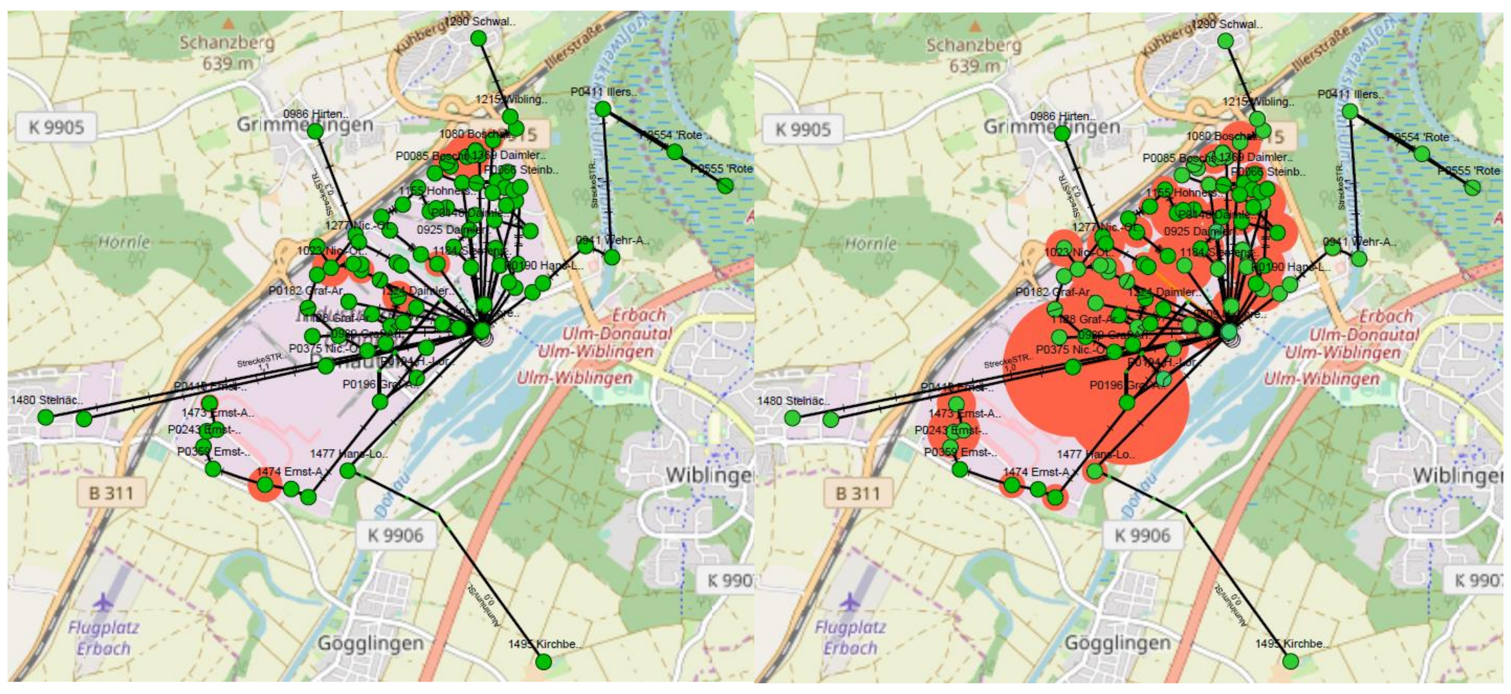
Various industrial processes need hydrogen (e.g. steel production), which is commonly produced by fossil energy sources and causes a high amount of greenhouse gases. Hydrogen made of sustainably generated electrical power (e.g. PV) with the Power-to-gas technology (PtG) can substitute fossil-based hydrogen. Urban areas in many cases include electricity, gas and heat networks for distribution, to meet demand and to accommodate generation. That makes them the optimal location to integrate decentral sector coupling points like PtG (**Figure 1**).



↑ **Figure 1**: In- and out-puts of the electrolysis

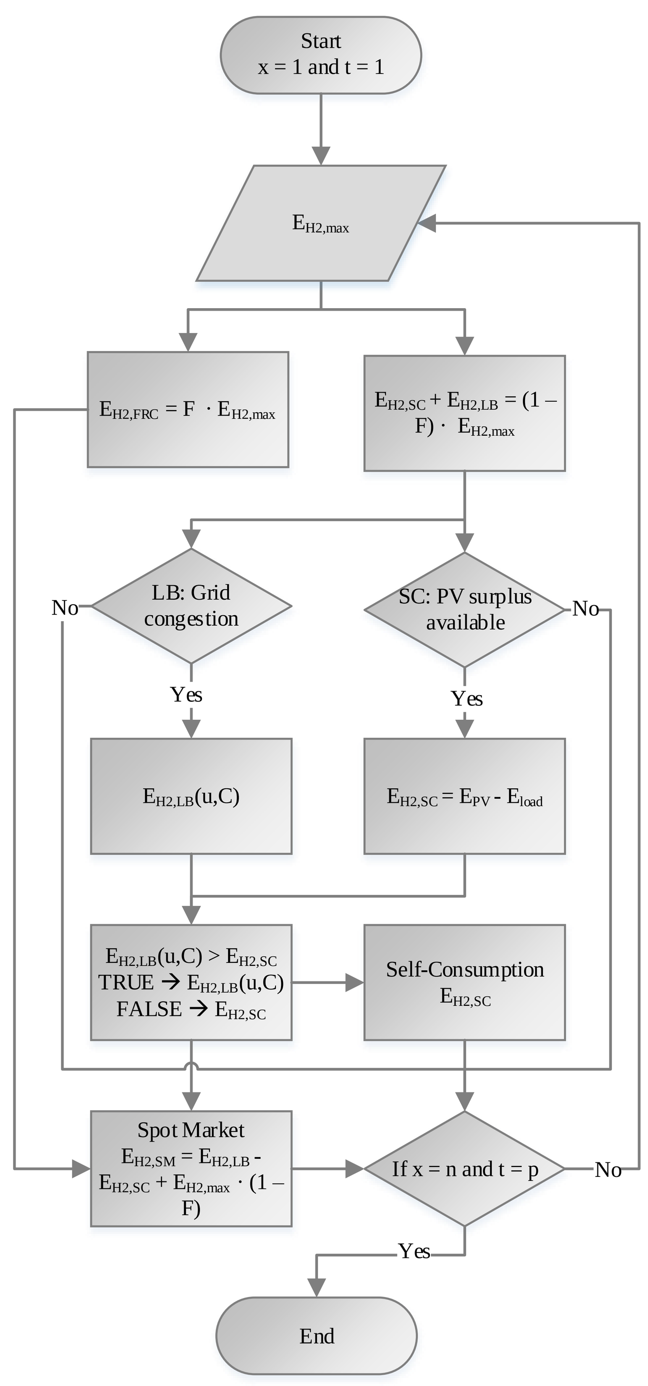
Methodology

The approach of this paper combines an economic analysis and the grid simulation method. The simulation for a whole year takes seasonal effects into account and allows extrapolation of the results to the economic lifetime of the assets. The focus on the MV grid allow results on the most relevant grid in the distribution grid. Local PV potential additional electrical generation taken into account (**Figure 2**). The detailed economic analysis of the PEM electrolysis all their input and output products (**Figure 1**). A reference scenario containing the economic costs for the grid reinforcement, as a common solution today for grid congestion, without considering flexible load management provides the basis for comparing the economic approach with a future scenario. The future scenario use flexible operation of PEM electrolysis to avoid grid reinforcement of the reference scenario.



↑ **Figure 2**: Maps for visualization of current PV power (left) and additional potential PV (right) as red circles. Gray area is the industrial area. Cable (black lines) and transformer stations (green dots) represent the MV grid in the simulation model.

Modelling the Economic Analysis

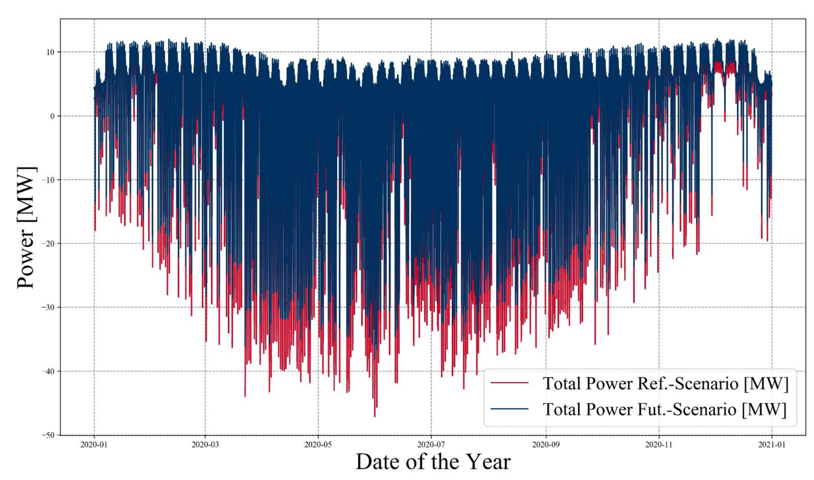


This paper investigates future scenarios and combine different business cases. The flow chart, depicted in **Figure 3**, couples the consumed energy of the electrolysis in the different markets. All Markets were analyzed considering their specific value, prices and their legal costs. The business model for the grid reinforcement of the reference scenario were assumed considering CAPEX, OPEX legal reimbursement of the Assets.

← **Figure 3**: Flowchart for prioritized business models

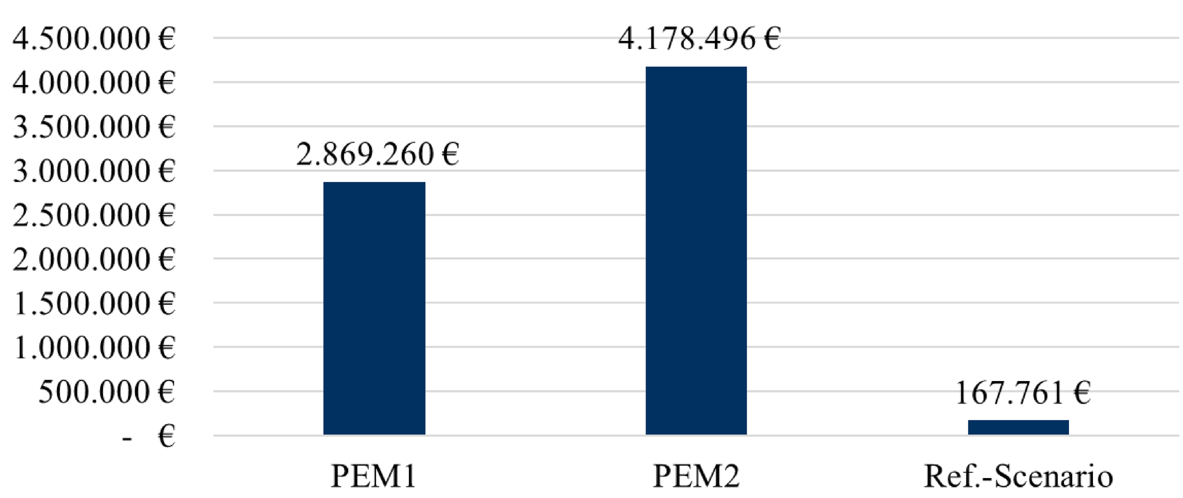
Results

In the reference scenario 2 TS were identified and in sum 3 transformer and 3 km lines were reinforced. In the future scenario 2 PEM at this 2 TS were included. The comparison of the future and the reference scenario showed a reduction of 19 % (9.0 MW) of the max reverse power during the year. The feed-in power increases up to 23 % (2.3 MW) (**Figure 4**). The voltage deviation in reference and future scenario were in the ±3 %, which is available in MV grids. Based on the economic analysis bough PEM electrolysis can be profitable compared to the reference scenario, since their have higher NPV. The reference scenario profit from the longer lifetime but achieve a much lower result than the electrolysis of the future scenario (**Figure 5**).



← **Figure 4**: Simulated annual total load flow at the slack element (i.e. HV/MV TS)

Figure 5 → Net present value (NPV) for the electrolysis of the future scenario and the reference scenario



Conclusions

This paper showed that PEM electrolysis can be economic viable especially when it is operated as multifunctional system with participate in several markets. Today (2022), gas and electrical prices increase more and more were development of electrolysis effect CAPEX and efficiency positive. Local balancing is affected by a price increase for grid reinforcement and a less availability of assets (e.g. cable and transformer) at market. This makes it even more important to use alternative approaches to tackle an ongoing installation process of generation units at distribution grids. FCR is good to increase operation hours of the electrolysis. This is possible if only negative power is provided. The electrolysis consumes the surplus power locally, whereas grid reinforcement enables the transport of power to higher voltage levels.

17. Internationale Konferenz für Erneuerbare Energiespeicher und Energiesysteme (IRES 2022)
Düsseldorf

Contribution ID: 225

The grid simulation part as well as the development of the grid analysis concepts has been developed in cooperation with the European project “Serendi-PV” (Grant Agreement No.: 953016)

David E. Langer [1,2,*], Basem Idlbi [1], Holger Ruf [2], Georg Kleiser [1]
[1] University of Applied Sciences Ulm, Germany
[2] Stadtwerke Ulm/Neu-Ulm Netze GmbH, Distribution System Operator, Ulm, Germany
*Corresponding author. david.langer@ulm-netze.de