# ENERGY CONTROL OF A SELF-SUFFICIENT MICROGRID BASED ON A COMBINED ELECTRICAL AND HYDROGEN DISTRIBUTION GRID

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## Abstract

For the success of energy turnaround, the distribution and storage of electrical energy within the framework of a microgrid plays an essential key role in the future energy supply. A purely capacitive network expansion in Germany is only one element of the energy transition and must be expanded to include the conversion of the current central network, with a central control system, to a decentralized network with intelligent control units. With an increasing share of renewable, decentralized units for power generation, such as photovoltaic or wind power plants in the energy mix, location-based island grids that function as microgrids can make an important contribution to security of supply. Excess electricity is regulated more variably and better even at the smallest location-related level. The remaining fluctuations from the microgrid are steadily decreasing over the distribution network to the transmission network. Wherever possible, the microgrid can also be used as an autonomous and self-sufficient system for regional district supply. Microgrids are independent supply areas that have special operational management requirements and a connection to the public grid. In the context of this article, the microgrid provides the interface between the electrical network and the network with a liquid or gaseous energy source, mainly based on hydrogen. Currently, it can be estimated for the near future that energy production from renewable energy sources cannot be stored in the power grid. So a energy carrier is required, easy to store and, if necessary, further convertible. The associated problems, such as the holistic view of a microgrid based on an electrical part and a hydrogen network, are part of this article. This is based on the ERDF project "Wasserstoff – grünes Gas für Bremerhaven", in which a microgrid is being set up to be able to supply the Lune Delta area with self-sufficient energy in the future.

The microgrid in Figure 1 is fed exclusively by renewable energy sources from photovoltaic systems and wind turbines and, as a "topological power plant", it is also able to deliver services for system stability to the higher-level power grid. The active and reactive power control is also mapped. Such system services help to partially replace conventional power plants. For this purpose, the performance of the renewable energy producers can be reliably forecast, intelligently planned, and controlled via the control technology. Two central points of the system are the production and storage of hydrogen as a chemical energy carrier with the help of renewable energy carriers and the reconversion of hydrogen into electrical energy by a fuel cell. This is initially done on a small scale and is later scaled up to the energy requirements of the Lune Delta industrial park. The power grid of the microgrid consists of three voltage levels. Starting with the 24 V direct current level for the sensors, the 48 V direct current level at the output of the fuel cell for the battery storage and the 400 V three-phase level for feeding in renewable energies. The grid connection point is a switchable connection between the microgrid and the higher-level power grid. The 48 V direct current is converted by a DC-AC inverter and a rotating converter. The hydrogen is produced with a PEM electrolyser. Power is supplied via a 400 V or 48 V rail. The hydrogen produced leaves the electrolyser at 16 bar and is temporarily stored in a low-pressure storage tank. The hydrogen from the low-pressure storage tank is compressed to 200 bars with a hydrogen compressor and then fed to the high-pressure storage tank. Intermediate storage is necessary because with the

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same electrical power data of the electrolyser and fuel cell, the hydrogen produced is not sufficient to achieve the same power by reconversion electricity at the output of the fuel cell.

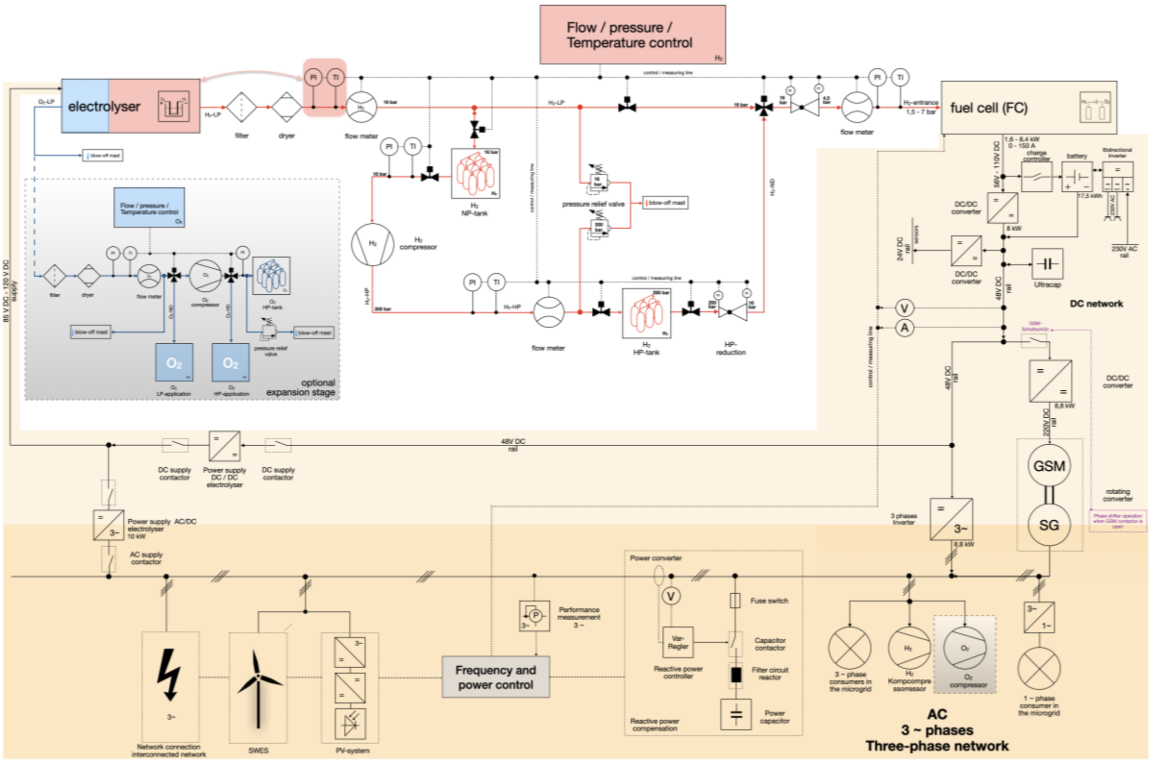


*Figure 1: implemented microgrid in abstract representation*

At this point, the effects of the feed-in of fluctuating renewable energies on the electrolyser and the associated pressure fluctuations in hydrogen production are investigated. The extent to which decoupling of feed-in energy sources is possible is being researched. The microgrid was mapped in advance with a simulation program, then all components were ordered and set up (Figure 2).


*Figure 2: front view of the microgrid container*

## References


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