ETF DispElec

Techpaper #3 – DISPELEC final results

This techpaper summarises the conclusions of the ETF project 'DISPELEC'. The project was executed by Entras R&D experts Jens Baetens and Filip Tysebaert and Entras software developers Stijn Bernaer, Dimitris Nasikas, Ali Cesur and Hirotoshi Ubata. The project period ran from 2022 Oct. 1 until 2025 Sept. 30.

The DISPELEC project aimed to develop a prototype to valorise the energy flexibility potential of industrial electrolyzer installations. Included electrolyzer technologies are alkaline water electrolyses (AWE) technology and proton exchange membrane (PEM) technology.

Two distinct electrolyzer installations were modelled:

- A grid connected industrial electrolyzer
- An island mode electrolyzer, connected with renewable energy sources, and capable to produce either hydrogen, either ammonium (Haber-Bosch process)

The prototype model for the grid connected industrial electrolyzer was validated based on real process data of an industrial electrolysis installation. Validation includes the comparison of linear with more accurate non-linear models. The linear model leads to flexibility revenues deviating less than 5% compared to the non-linear models, which makes it appropriate for many industrial applications.

The parametrised electrolyser model is used to analyse the techno-operational potential of an electrolysis installation providing ancillary services (grid reserves). In general it can be stated that an electrolyser, especially with PEM technology, has such characteristics that it complied with the needed dynamics to deliver ancillary services (FCR, aFRR, mFRR). Also the AWE technology electrolyser are suited to provide these services, yet being typically limited by ramping rates.

Also the opportunity cost of providing ancillary services is qualitatively defined, with the day-ahead market as basis. Ancillary services can be provided without opportunity cost if they are aligned with normal operation – provide downward reserves when the plant is operating below its maximum capacity or provide upward reserves when the plant is operating at full load. If not, an opportunity cost is present and should be defined based on the cost to deviate from the optimal operational schedule of the electrolysis installation.

The prototype model for the island mode electrolyzer was validated against an available study on this application. The model leads to a levelized cost of ammonium production (LCOA) deviating less than 5% compared to the benchmark study. Furthermore, the prototype model allows the optimization of storage and synthesis processes. Iterative use of this prototype can help to determine the minimum CAPEX per installed MWh for a BESS to become an economically interesting addition to the system.

The deliverables of the DISPELEC project are:

1. Proof of a working prototype of a grid connected industrial electrolyzer model capable of calculating the value of flexibility, based on alkaline or PEM technology. Flexibility capabilities include day ahead optimisation and reserve products (FCR, aFRR and mFRR).
2. Proof of a working prototype of an island-mode industrial electrolyzer model consisting of electrolysis modules, renewable energy sources, haber-bosch conversion and storage of hydrogen, ammonium and electricity. The model calculates the levelized cost of hydrogen and ammonium, taking into account flexibility options. The model allows optimization of all components on different parameters like size, power and energy.
3. The results include:
    - Load (MW) to flexibility potential (EUR) curves
    - Overview of flexibility capabilities of electrolyzers with specific technical and operational boundary conditions
    - Benchmark of the model prototypes developed under the DISPELEC project

The flexibility potential of Belgian industrial electrolyzer installations is significant due to their high total power (MW) and due to the possibility to shift power at a high rate. However, the potential will only be made available by the owners when additional revenues from unlocking the flexibility potential are significantly higher than the costs. Furthermore, the potential grows considerably when the load factor of the electrolyzer installation drops below 90%. Flexibility can be further unlocked by dimensioning the subsequent storage and processing facilities correctly. The current economic situation for European industries results in a lower overall load factor and allows for a considerable flexibility potential.

Entras has developed a software package Endustries to valorise flexibility for a broad range of industrial processes and appliances. The models developed under the DISPELEC project will be included in the Endustries software, and will allow the valorisation of the full flex potential of any industrial electrolyzer installation.

For more information on the electrolyzer models and software, please contact us via www.entras.be.