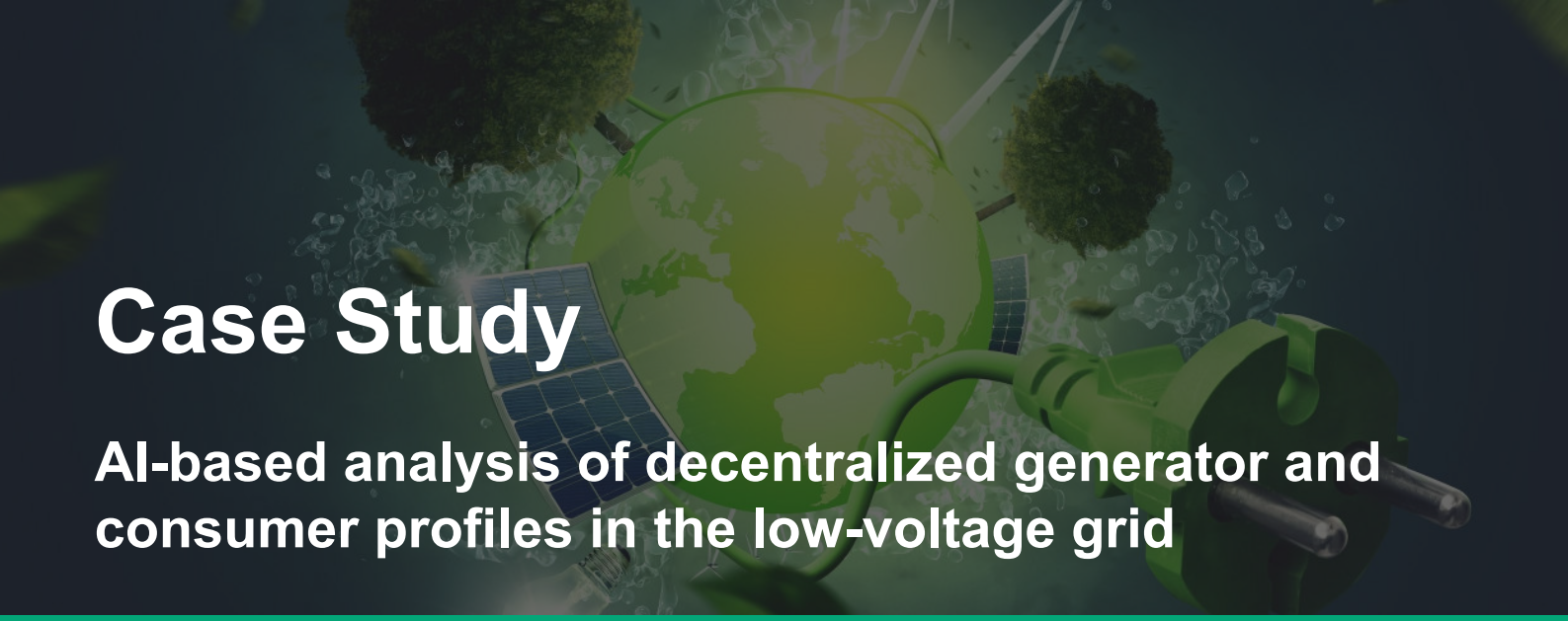

Case Study

AI-based analysis of decentralized generator and consumer profiles in the low-voltage grid

Reasonance. Driving digital transformation.

Challenge

Decentralized energy generators and new types of consumers, such as solar systems or electric vehicles, pose new challenges for distribution system operators and energy companies. In order to guarantee grid stability, ensure optimal operation and properly plan grid expansion, events from the low-voltage grid are to be measured, analyzed and explained with the help of Artificial Intelligence (AI). Equipping transformer stations with data measurement systems forms the basis for an AI-based analysis, which is intended to provide insights into the types and behavior of consumers and generators in the grid. This allows distribution system operators to gain valuable information and a better understanding of the low-voltage grid.

Approach

To identify the generator (e.g. photovoltaic generation) and consumer profiles in the low-voltage grid (e.g. electric vehicles, heat pumps, storage heaters), Netze BW provided measurement data collected at transformer level using the installed sensor equipment. Through exploratory data analysis of the raw data, Reasonance was able to derive suitable hypotheses for the detection of generator and consumer profiles in the grid and to assess their potentials and risks. In addition to the measured data, such as power, current, etc. various external influencing factors, such as weather (temperature and solar irradiation), holidays, and seasonal effects were modeled and taken into account for the analysis of the generator and consumer profiles in the grid. Typical consumer load patterns and further information on consumer usage behavior were also used to derive additional insights and suitable parameter values for the development of the detection methods. Reasonance used physical models for modeling solar-induced photovoltaic energy generation, as well as state-of-the-art machine learning methods for detecting large consumers, such as charging events of electric vehicles, in the multivariate sensor data. In addition, simulation methods were developed to account for future effects and impacts in the grid, e.g. due to the expected growth in the number of electric vehicles and charging stations, as well as installed photovoltaic systems. The developed analysis and detection methods are integrated into an automated data pipeline, which generates labeled data and statistics on the power consumption and generation in the respective grid from the raw input data. This includes, amongst others, the detection of anomalies and potential problems in transformer operation and sensor equipment, as well as a cluster analysis of different transformer networks based on individual energy consumption patterns.

Result

Based on the developed detection and analysis methods, Netze BW can now automatically evaluate the consumer and generator profiles in the low-voltage grid and use the findings for grid optimization, especially with a focus on photovoltaic generation, as well as current and future energy demand from electric vehicles. The provided analysis pipeline can be executed with both historical and new transformer data and thus also provides important insights into the operation of low-voltage grids in future projects.

Contact

Reasonance GmbH
Konstantin Tsenkov
tsenkov@reasonance.de
+49 721 98991310

Netze BW GmbH
Daniel Kemper
d.kemper@netze-bw.de
+49 711 289 82394

reasonance

Netze BW
Ein Unternehmen der EnBW