SUCCESS CASE 21.2024

PQsmart

POWER QUALITY WITH SMART METERS

THE CHALLENGE

During the **smart-meter rollout**, Netz Niederösterreich (Netz-NÖ) evaluated the possibilities for sensible operational management and planning. In that context, several use cases for utilising voltage measurements were identified.

As a distribution grid operator, Netz-NÖ is obliged to **maintain power quality**, in accordance with European standard EN 50160, for each individual grid customer. EN 50160 defines the essential characteristics of the supply voltage in terms of voltage level, form of the signal, symmetry and frequency under conventional operating conditions in public low (LV) and medium voltage (MV) grids. With regard to this, the 10-minute average **voltage values from the installed smart meters** provide valuable information for grid operation and planning, leading to optimisation of the LV grids. However, the voltage values are not relevant for the actual purpose of the smart meters (i.e., customer billing). Thus, they are treated with lower priority during data transmission and may even be discarded. The following benefits can be obtained from the use of the smart meter voltage values:

1. **Detection of component errors and failures** by analysing the metadata.
2. Provision of **topological information** on the monitored grid.
3. **Mapping of the components** to the respective transformer stations.
4. **Determination of the current switch positions and states** in the LV grid.

THE SOLUTION

The **PQsmart project** was launched at an early stage of the smart meter rollout. To consider the rollout status of the smart meters and the underlying technical measures, the development of the project was pursued using an agile approach. The programming of visual analysis systems was a crucial aspect of the project. Such systems had to fulfil the following range of requirements:

- Visualisation of violation of voltage limits described in EN 50160.
- Early detection of faults (before their occurrence) by means of statistical limit violations.
- Detection of defective components (e.g. joints).
- Optimization of LV switch states.

Furthermore, the PQsmart tool was integrated into Netz-NÖ's daily work processes to optimise the time resources of the field service technicians. A detailed **fault diagnosis** can already be conducted remotely to initiate the required actions.

By enriching smart meter data with several metadata, e.g. from smart meter communication to the data concentrators, grid components (e.g., transformer stations), the electricity grid lines, cable distribution cabinets, photovoltaic generation and voltages of the higher-level substations, Netz-NÖ can analyse the **topology of** their **LV grids**. As a result, smart meters can be located via their voltage signature and reallocated geographically if there is a metadata problem. A statistical comparison of the smart meter voltage signatures can be used to form clusters. In addition, the communication information of the data concentrators can be used to determine transformer areas, enabling a **load flow calculation** in the LV grid.

MAIN SUCCESSES

Within two years, the project was turned into a system that is an integral part of Netz-NÖ's grid operations management for maintenance and optimisation. During this period:

- 220 billion data points were collected and processed.
- 3,100 voltage violations were found and rectified.
- 600 transformer stages were adjusted.
- 200 local grid optimisations were carried out.
- 186 defective smart meters were recognised and replaced.

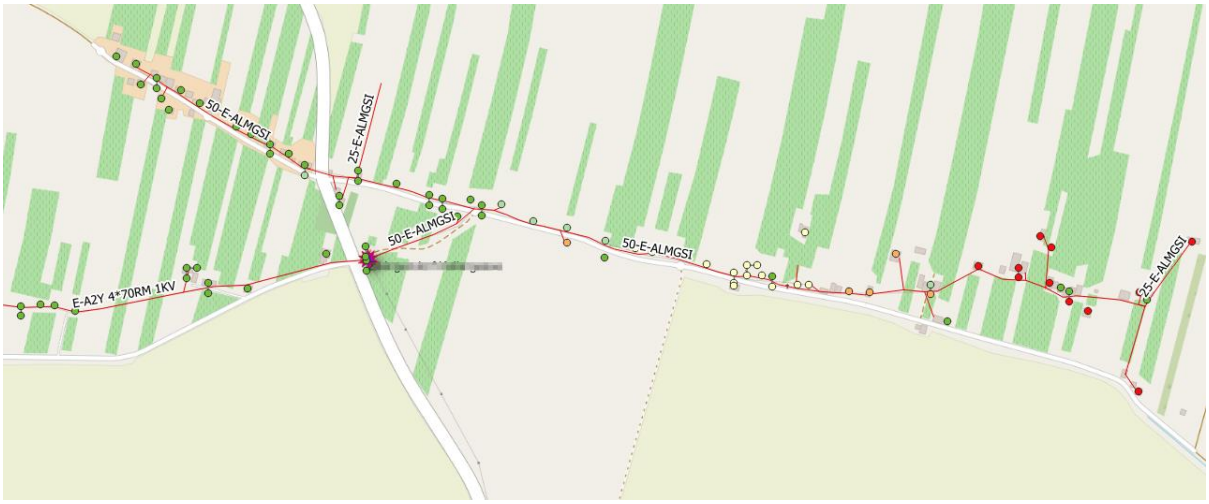
In addition, the smart meter data provided the foundation for calculating the load flow in the LV grid to a level of detail up to the customer grid connection point.

Limit violation. *In the example, 3 voltage phases are visualised with the yellow one out of the permitted range due to a contact error.*

KEY FACTORS FOR SUCCESS

The following key factors required for a successful utilisation of smart meter data could be identified:

- Use of the **entire data spectrum** of smart meters for in-depth analyses.
- Employees with a deep and **comprehensive technical understanding of electrical engineering, data processing, data analytics** and processes.
- IT systems that **enable large amounts of data** to be stored and analysed.
- Tools for simple visual **analyses and monitoring** to identify new problems and the actions to be derived from them.
- **Automatic detection** of anomalies and integration into existing work processes for validation and rectification.
- **Integration of field staff** for improved **acceptance** of the system.
- Development in an **agile approach** free of system boundaries for optimum success.



Map of smart meters at a feeder. *The colours symbolise the asymmetry from green to red, where red represents a limit value. Red clusters are analysed in sequence.*

NEXT STEPS

The planned next steps primarily include the **classification of possible faults** identified through machine learning. By using a data model in combination with forecasting models, potential bottlenecks in the distribution grid can be identified and rectified at an early stage before they actually occur. In addition, suitable methods will be defined to determine the **topology of the LV grid for load flow calculations**. Both objectives are supported by consulting universities and research institutions.