POWERFACTORY

Smart Meter Data in PowerFactory

1 Motivation

Obtaining accurate data for low voltage power consumers has always been a challenge; this can result in imprecise simulation results since the precision can only be as good as that of the input data. In recent years, however, smart meters (advanced metering infrastructure (AMI)) have seen a huge increase in market share in many different countries across the globe. Smart meters can measure and record the energy consumption, energy generation, voltage and frequency at a metering point and provide this data to the utility companies and thus bridge the information gap, leading to a more accurate simulation model and thus more accurate simulation results.

In this paper we will explore how smart meter data can be used in *PowerFactory* and how this can benefit you.

2 Input Data

In *PowerFactory*, a so-called characteristic can be assigned to any parameter. Time characteristics determine the value of the parameter depending on the current study time. Furthermore, *PowerFactory* offers the use of profile characteristics, which are composite characteristics allowing to select time characteristics corresponding to individual days or group of days and seasons.

Measurements, e.g. of active and reactive power, can be used to create a time characteristic, which can be assigned to the respective load or generator in the network model. There are four options for defining the data source of values used in a time characteristic: table (data has to be entered manually in *PowerFactory*), result file (the characteristic is created from data in an existing *PowerFactory* result file), external file and database.

The latter two methods are the most relevant for smart meter data. If the user selects *file* as the data source, he or she can link to an external Comma Separated Values file (*.csv) or a user-defined text file. *PowerFactory* will then import this data. The *database* option enables the data to be taken from a database outside the *PowerFactory* database as shown in Figure 1. Oracle, PostgreSQL, SQL Server and databases with existing ODBC drivers are supported.

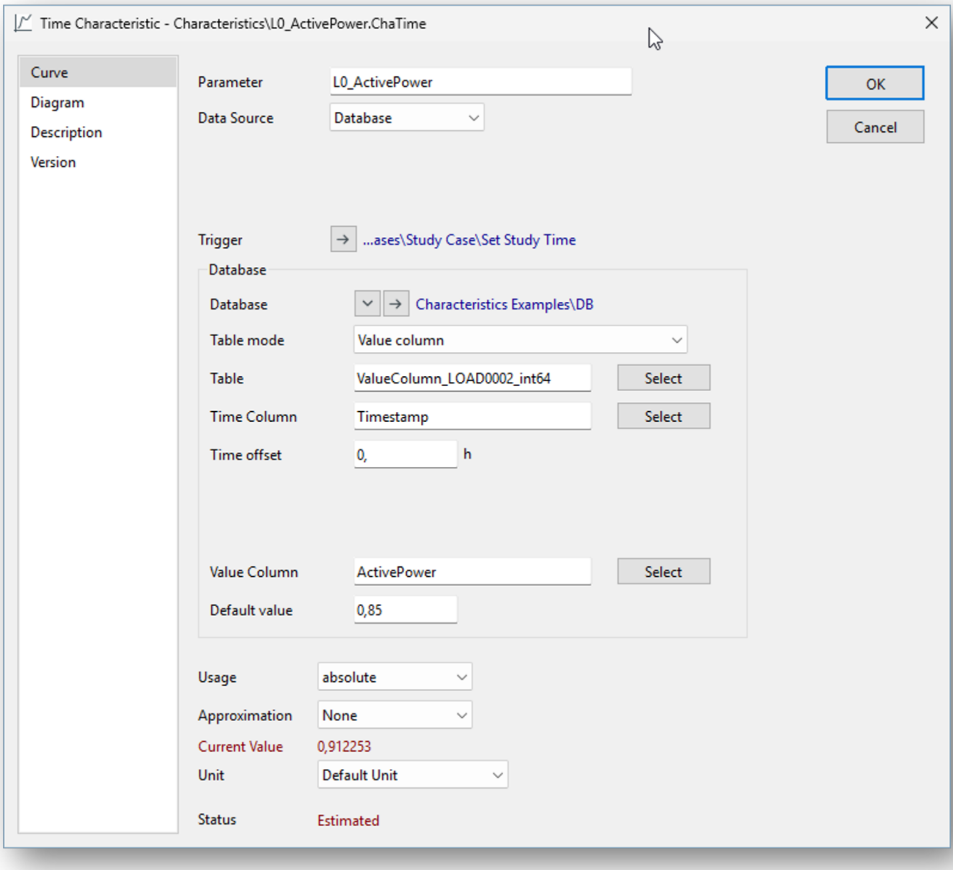

Figure 1: Time Characteristic with a database data source

3 Use Cases

Smart meter measurements can serve as input data for various different calculation functions in *PowerFactory*. In this section we will provide a brief overview of these functions and how they benefit from smart meter measurements.

3.1 Load Flow Analysis

Load Flow calculations are used to calculate the steady state conditions of networks i.e. loading of elements and voltage levels and are therefore an important tool for network owners and operators. Smart meter data can be used for the analysis of past scenarios and for real time analysis. It is also possible to scale measurements with a growth factor in order to perform load flow calculations in potential future scenarios.

3.2 Time Series Calculations

Load Flow calculations only consider one specific point in time. The Quasi-Dynamic Simulation in *PowerFactory* on the other hand, is a series of load flow calculations carried out for a specified time period and with a specified step size and can be used to assess the network state over a period of time. The performance and handling of the Quasi-Dynamic Simulation is much better than running scenarios one by one. Additionally, it is possible to display time curves and statistical values such as maximum and minimum loadings.

The generation dispatch and load consumption in real networks fluctuate. Measurements from smart meters installed at the locations of loads and generators can be used to create time characteristics for active and reactive power serving as input parameters for the Quasi-Dynamic Simulation. Quasi-Dynamic Simulations with smart meter data enable the accurate calculation of the historic state of a power grid. This allows the user to identify critical states and weak points in the network, which might indicate the requirement for grid expansions. Figure 2 shows how plots can be used to visualise the results of a Quasi-Dynamic Simulation. Possible future scenarios of the network can also be assessed by assigning scaling factors to the historic measurements of loads and generation units, to represent growth, or by adding additional units with estimated time curves.

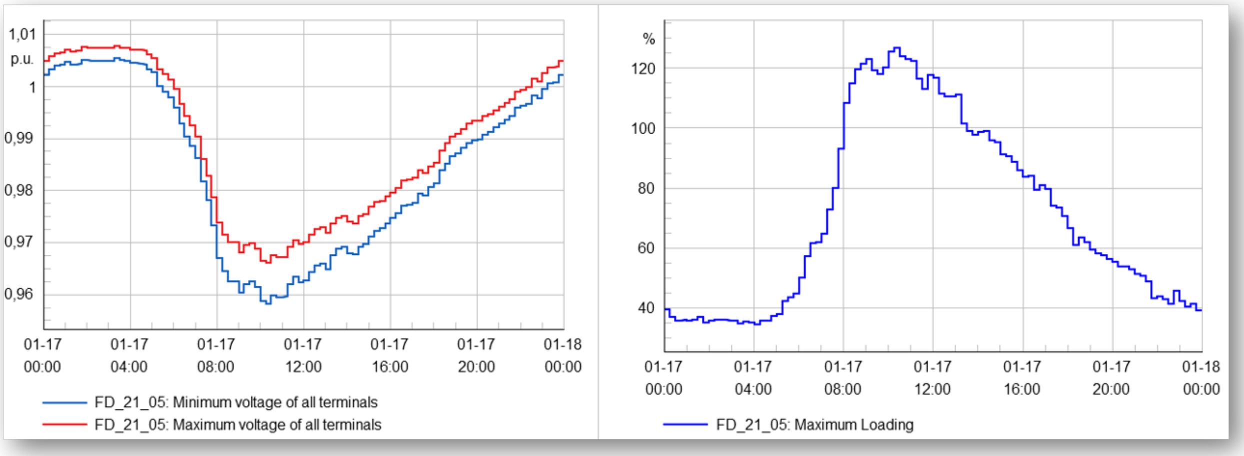

Figure 2: Results of a Quasi-Dynamic Simulation - minimum/maximum voltage and maximum loading of a feeder

3.3 Artificial Intelligence

Running Quasi-Dynamic Simulations over a long period of time for large power grids can take some time. As an alternative *PowerFactory's* Artificial Intelligence can be used to approximate Quasi-Dynamic Simulations using an artificial neural network, leading to very fast results.

3.4 Probabilistic Analysis

The *PowerFactory* Probabilistic Analysis uses probabilistic input data for network analysis instead of analysing individual operation scenarios or time sweeps. It is suitable for use when input data needs to represent a distribution of possible values, or if one wants to simulate the grid at some time in the future with forecast errors. The Probabilistic Analysis requires probabilistic input data e.g. distribution functions of load and generation. Such data is not usually readily available. If the user has smart meter measurements, *PowerFactory* can automatically generate distribution functions based on these measurements. This also works if smart meter measurements are only available for some of the loads in the network. In this case, it is possible to use a distribution function based on a measurement from another load.

The Probabilistic Analysis produces stochastic data using the Monte Carlo or Quasi-Monte Carlo method i.e. each result quantity will no longer be a fixed number but a distribution from which statistic quantities (e.g. mean values, standard deviations, min. values, max. values) can be derived. For example, Figure 3 shows the results of a Probabilistic Analysis using a histogram to visualise the loading of a line. With this diagram it is possible to determine the probability that this line will be overloaded.

3.5 Tie Open Point Optimisation

Tie open points are the connection points of two neighbouring feeders. The position of the tie open point has an impact on the losses and restoration process in the event of an outage. The Tie Open Point Optimisation function in *PowerFactory* can optimise the position of the tie open points with the objective to minimise losses and/or to optimise the reliability while considering constraints such as voltage constraints. The optimal tie open point strongly depends on the infeed of generation units and the consumption of loads in the network and thus may change over time. In *PowerFactory* it is possible to perform a Tie Open Point Optimisation using a time-sweep to take account of this fact. With the help of smart meter data, representing the fluctuating infeed of generation units and consumption of loads, the user can determine the optimal open point for the selected period.

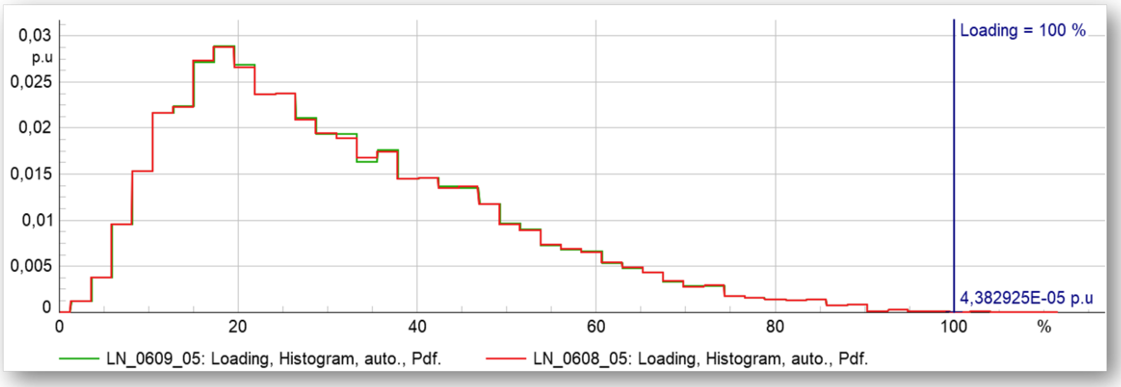

Figure 3: Results of a Probabilistic Analysis - loading histogram of a line

3.6 Quasi-Dynamic Models

PowerFactory allows the creation of user defined load flow and quasi-dynamic models (QDSL models) such to obtain customisable steady state behaviour of various power system equipment. Good examples of such a model would be the charging strategy/behaviour of battery systems and electric vehicles, taking into account their current state of charge (SOC). An example of such a model is shown in Figure 4. Realistic load and generation characteristics are needed to evaluate these models. Smart meters can provide these characteristics.

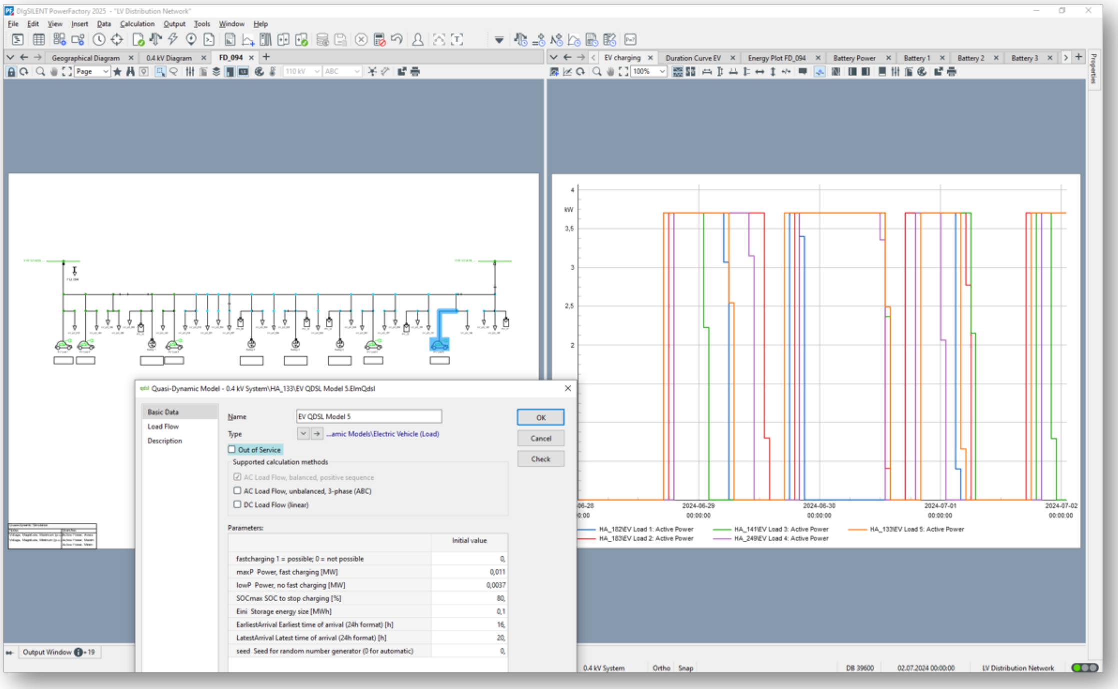

Figure 4: QDSL Model of a an electric vehicle

4 Executive Summary

Smart meter data can greatly improve the accuracy of the simulation model and thus lead to more accurate simulation results. *PowerFactory* offers different options for importing smart meter data, e.g. directly from a database. Various calculation functions such as the Quasi-Dynamic Simulation and the Probabilistic Analysis can be used for power system analysis with measurements from smart meters.

5 Licence Configuration

The functions described in this paper require the following advanced *PowerFactory* modules:

- ✓ Quasi-Dynamic Simulation
- ✓ Artificial Intelligence
- ✓ Probabilistic Analysis
- ✓ Distribution Network Tools for Tie Open Point Optimisation

For more information, visit
www.digsilent.de

DIgSILENT GmbH
Heinrich-Hertz-Straße 9
72810 Gomaringen (Germany)
T: +49 7072 9168-0
mail@digsilent.de

DIgSILENT GmbH is certified to the ISO 9001:2015 standard. More information is available at www.tuv-sud.com/ms-cert.