V2G

OPAL-RT Simulators to Simulate Electric Vehicle Charging Schedules

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Electric Vehicles (EV) are becoming more and more accessible—and increasingly reaching a wider consumer audience. As the EV user base increases, we're discovering their uncontrolled charging can cause under-voltages and network congestion within the existing electric infrastructure.

At the same time, the accuracy of newer, evolving charging strategies brings considerable cost savings to EV users, in comparison to current uncontrolled charging scenarios. Network losses and their associated costs are also considerably reduced by the new charging strategies.

Real-time simulation models--leveraging realistic models of the electric network, and integrating the EV's physical components, such as batteries and controllers—are showing great promise in testing innovative charging strategies, and in studying the EVs' effects on the electrical network.

OPAL-RT Technology, with its varied suites of targeted real-time software, is well-placed to be the ideal fit to address the most visionary V2G control approaches, and their effects on the grid.

ePHASORSIM

ePHASORsim enables the dynamic simulation of large scale power systems in Phasor mode, and can additionally simulate thousands of nodes, generators, transformers, transmission lines, loads and controllers.

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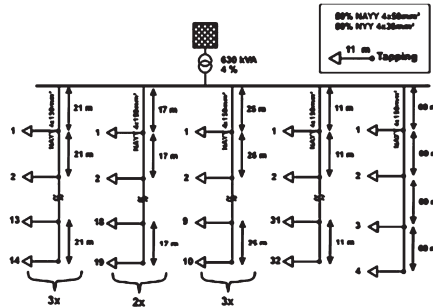
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Figure 9: Topology of the used electric network [42].

The used electric network model, above, represents a typical suburban area in Germany. It is the largest Low Voltage (LV) network generated in [41]. The details for this synthetic electric network model are taken from the dissertation [42] referenced. The topology of the chosen electric network is presented in Figure 9.

This LV-network is equipped with a 630-kVA distribution transformer, and it has 10 main feeders whose cables have a maximum current limit Imax equal to 284 A. The used LV network consists of 294 nodes, where 146 households are located. These households are randomly selected to accommodate an EV. The applied EV penetration rates are 75% (meaning that 110 of 146 of the households are accommodating an EV), and 100% (meaning that 146 of the households are accommodating an EV).
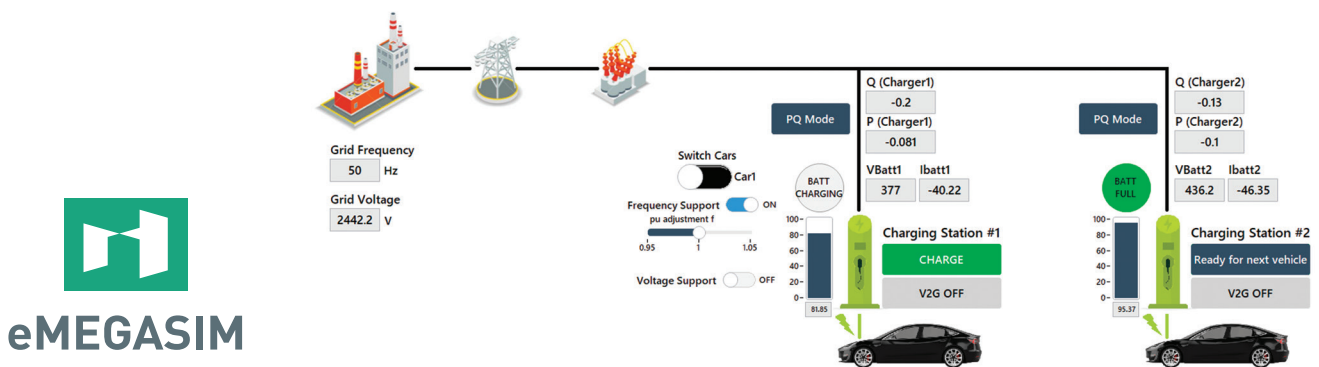
The demo presented at PES 2019 demonstrates an implementation of Vehicle-to-Grid (V2G) services, with data provided by a hypothetical charging station where the vehicles arrive to recharge. The model contains several simulated fast-charging stations connected to a low voltage distribution grid at 22.9 kV via a transformer. The total rating of the charging stations is 200 kW, with two chargers capable of supplying charging power of up to 100 kW per vehicle. Each charging station connects to a simulated vehicle battery that can either charge or discharge to grid (V2G). Various modes of V2G are supported, such as frequency support, voltage support, active power profiles and reactive power profiles. This demo is created in MATLAB/Simulink, and it runs in real-time on an OPAL-RT simulator with a timestep of 50us.

REFERENCES:

[41][42] Application documented in: Optimization Strategies for Electric Vehicle Charging Schedules, by Erkki Juha Matti Rautiainen A Thesis Submitted to the Faculty of Engineering at Cairo University and Kassel University

ABOUT OPAL-RT TECHNOLOGIES

OPAL-RT is the world leader in the development of PC/FPGA Based Real-Time Digital Simulator, Hardware-In-the-Loop (HIL) testing equipment and Rapid Control Prototyping (RCP) systems to design, test and optimize control and protection systems. used in power grids, power electronics, motor drives, automotive industry, trains, aircraft and various industries, as well as R&D centers and universities.

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