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Electromobility Stress Test

Network analysis to enable the expansion and reliable integration of electromobility

At a glance

With an increasing development of electromobility, electric vehicles (EVs) will have a large impact on the distribution networks. The existing low voltage (LV) and medium voltage (MV) networks must be developed to cope with future requirements resulting from new load patterns and the integration of large numbers of charging poles, as well as fast-charging stations for electromobility. Siemens Power Technologies International (Siemens PTI) can provide the full range of necessary knowledge and tools to:

- increase the 'hosting capacity' of existing networks for electric vehicles (EVs)
- determine optimal and cost-efficient solutions for upcoming challenges and identify necessary technologies
- improve network performance by considering the integration of charging control into intelligent management systems

The challenge

The emerging trend to substitute combustion engine cars with EVs for private and commercial transportation will have significant impact on the existing LV and MV networks.

The modern charging technologies enable EVs to be charged with electrical power ranging from several kW to more than 300 kW (Figure 1).

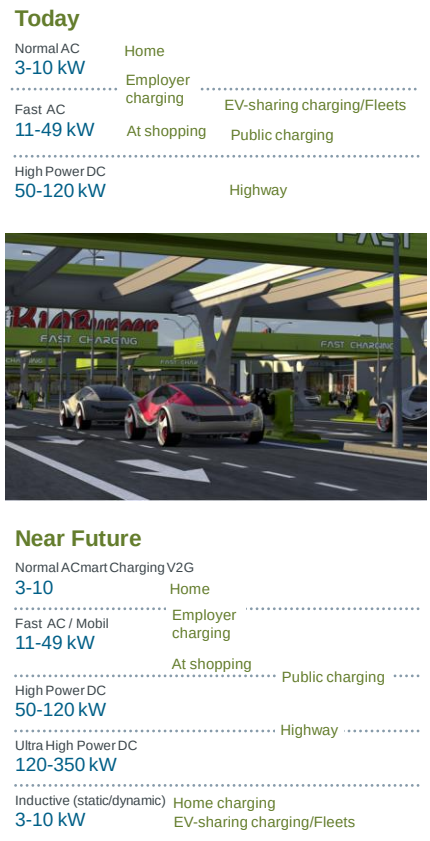

Figure 1: Charging power

The charging load of EVs is dependent on many factors such as charging simultaneity and the power demand of charging technology which can be much larger than the average household load and does not follow the known consumption patterns. Since the existing networks are not designed for a substantial penetration of EVs, there is a tremendous potential for overloading network components.

With the help of Information and Communications Technology (ICT) the charging procedure of EVs can be controlled, which gives players like distribution network operators ample opportunities for optimized charging, as well as utilization of EVs for ancillary grid services. In the long-term, for example, these new types of loads might even be operated as energy storage for renewable energy in distribution networks (“vehicle to grid”).

As the transition is expected to occur over the next decade, the changes will affect the networks and its operators. Nevertheless, the networks must be designed accordingly so that a large-scale integration of EVs can be accommodated.

Networks have to be analyzed and adapted, but additional measures must also be considered to allow for a cost efficient integration of EVs with consideration of future developments and tasks.

Our solution

When connecting large numbers of EVs to the existing grid, various tasks must be taken into consideration for network planning and operation strategies. In respective studies, different measures are investigated to develop

and verify the optimal solution for the upcoming challenges. In this process, the necessary technologies have to be identified and selected.

Interaction between network and EV
The initial step for assessing the impact of EVs and battery charging stations on the electrical network is the analysis of the current network. Key performance indicators can be defined to answer questions like:

- How many EVs can be integrated into the existing structures of the electrical network?
- Where are the most suitable locations and connection points for individual charging poles and fast charging stations on the LV / MV network?
- Depending on the different levels of EV integration, how is the network performance affected in terms of voltage stability, loading of equipment, reliability or harmonics?

Systematical network assessment can be performed using load-flow and short-circuit analyses, calculation of harmonics, as well as reliability analyses.

In addition to the network analysis, future scenarios for electromobility must be developed, taking into account business cases, usage patterns, charging technology and derived charging profiles.

Enhancing network performance
There are several possible solutions to improve network performance and to increase the 'hosting capacity' of existing networks for EV. Some of these include:

- identification of the optimal location for chargers or fast-charging stations
- assessment of investment costs for derived variants
- evaluation of charging strategies and optimization of network operation using communication and intelligent controls

A technical and cost-efficient combination of the measures above has to be selected based on the individual network structure, customer targets and framework requirements.

Integration into Smart Grid control
To improve the network performance and to minimize network extension costs, charging stations can be integrated into overall network controls (Figure 2). One possibility is to increase the maximum number of EVs by selecting appropriate charging control strategies, such as:

- uncontrolled low power charging
- first come, first serve
- according to availability of DER or to energy price
- market participation by using the storage capability

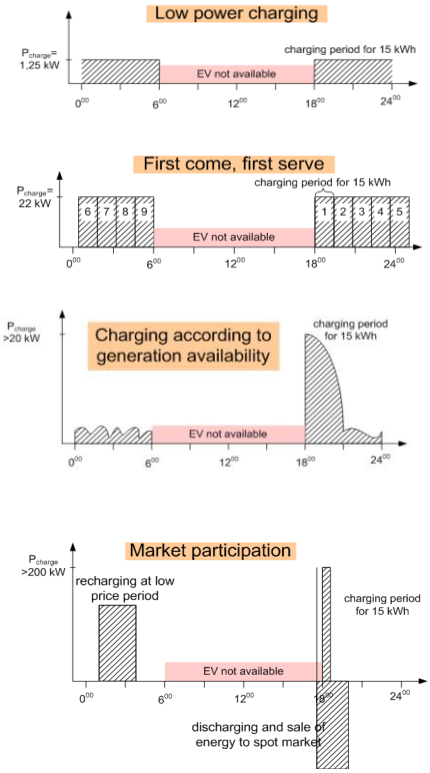

Figure 2: Examples of charging strategies

Possibilities such as using EVs to participate in ancillary grid services and advanced distribution management systems can be evaluated. Control applications might include:

- reactive power or voltage control
- load shifting of charging sequences
- operation as energy storage for vehicle-to-grid functionality and primary control
- balancing of renewable energy sources and integration into Demand Side Management systems.

In these cases, the requirements for an optimal integration of chargers into smart grid control applications for ICT and metering have to be determined.

Power quality issues
When interconnecting large numbers of charging stations into LV and MV networks, possible interactions of chargers with the network and surrounding customers must be investigated. It is critical to investigate harmonic currents from the charging converters, as they might influence sensitive loads located nearby. The charging station will be designed for the optimal voltage level according to the charging power and the number of connected EVs.

How you can benefit

With our consulting services, we can provide expert advice to help our clients by:

- analyzing the influences of EVs on electrical networks, including steady-state, as well as dynamic simulations
- developing an optimal, flexible and transparent roadmap ensuring economic efficiency
- ensuring system availability and increasing system resilience with optimized network concepts

With our industry leading expertise and software, we offer a broad spectrum of studies that are based on thorough understanding of processes and align with the need for enhanced planning capabilities, allowing us to provide concrete improvements to our customer's performance

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