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Network solutions for electromobility

Integration of electromobility into existing networks

At a glance

Electromobility will have a large impact on present distribution networks. The existing low voltage (LV) and medium voltage (MV) networks of today must be developed to cope with the future requirements resulting from 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 a large 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 200 kW (Figure 1). The charging load of EVs is dependent on charging simultaneity and the power demand of charging technology which can be much larger than the average household load. Since the existing networks are not designed for a penetration of EVs, there is a potential for overloading network components. With the help of Information and Communications Technology (ICT) the charging procedure of EVs can be controlled, which gives the network operators ample opportunities in the future to utilize EVs for ancillary grid services. In the long term, for example these new types of loads can be operated as energy storage for renewable energy in distribution networks.

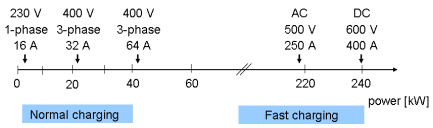

Figure 1: Charging power

As the transition is expected to be realized over the next ten to fifteen years the changes will affect the networks and its operators step by step. Nevertheless the networks have to be designed accordingly so that a large-scale integration of EVs will be possible.

Networks have to be analyzed and adapted, but also cost efficient measures for integration of EVs have to be developed to make them fit for future tasks.

Our solution

When connecting integration of large numbers of EVs in the existing grids, there are various tasks for network planning and operation strategies. Different measures are investigated in network studies 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 currently existing structures of the electrical networks?
- Where are suitable locations and connection points for individual charging poles and fast charging stations to the LV / MV network?
- How is the influence on network performance in aspects to voltage stability and loading of equipment, reliability or harmonics, in dependence of different penetration degrees of EVs integration?

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 have to be developed, taking into account business cases, usage patterns, charging technology and derived charging profiles.

Enhancing network performance
There are different possible solutions to improve network performance and to increase the 'hosting capacity' of existing networks for EV:

- 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

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, e.g.:

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

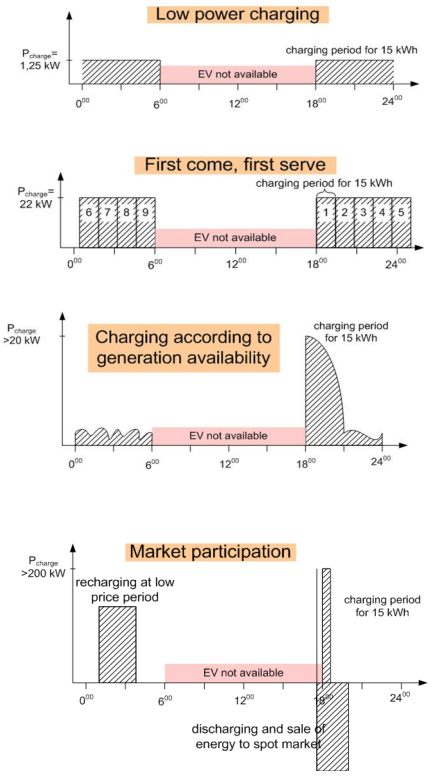

Figure 2: Examples of different charging strategies

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 Vehicle2Grid (V2G) functionality and primary control
- balancing of renewable energy sources and integration into Demand Side Management systems (DSM).

In these cases the requirements for 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 have to be investigated. Especially harmonic currents from the charging converters 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.

Software tools
Dedicated features have been developed in PSS®SINCAL which are especially suitable for analyzing the influences of EVs on electrical networks, including steady-state as well as dynamic simulations.

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Energy Management Division
Freyeslebenstrasse 1
91058 Erlangen, Germany

For more information, please contact
power-technologies.energy@siemens.com