# 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 networks of today have to be developed to cope with the future requirements resulting from the integration of large numbers of charging poles and also fast charging stations. Siemens Power Technologies International (Siemens PTI), your provider of network consulting, network planning software and trainings on the Siemens T&D portfolio, can provide the full range of necessary knowledge and tools for the customer 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

Due to increased environmental concerns as well as technological developments such as batteries or information and communication technologies (ICT) at acceptable costs it is expected that in the next years the number of electric vehicles (EV) will increase significantly. The emerging trend to substitute cars with combustion engines by EVs for private and commercial transportation will have a large impact on the existing MV and LV networks.

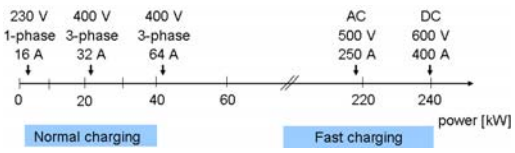


*Figure 1: Charging power*

Currently MV networks are designed to supply on average a household load of around 2 kW, whereas LV network design considers a slightly higher load. If EVs are integrated, this load – depending on the simultaneity and the power demand of the charging technology – may increase to more than 10 kW causing potential overloading of network components. In the long term, these new types of loads might also be operated as energy storage affecting the normal power flow in the network – up to the reversal of the power flow directions.

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 new loads will be possible. If the networks are to be ready to integrate large numbers of new loads, the right steps have to be taken today.

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

## Our solution

When connecting large numbers of EVs to 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.


*Figure 2: Vision of future fast charging stations*

**Siemens PTI – Network Consulting**

Answers for infrastructure.

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*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 electric vehicles 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?
- What is the influence on network performance, e.g. voltage and loading of equipment, reliability or harmonics, in dependence of different degrees of EV integration?

The networks are typically analyzed using load-flow and short-circuit analyses, calculation of harmonics as well as reliability analyses. Also, a probabilistic load-flow approach can be used for special investigations.

In addition to the network analysis future EV scenarios have to be developed, taking into account use 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
- Determination of necessary extensions of the network
- Assessment of investment costs for derived variants
- Evaluation of charging strategies and optimized network operation using communication and intelligent controls

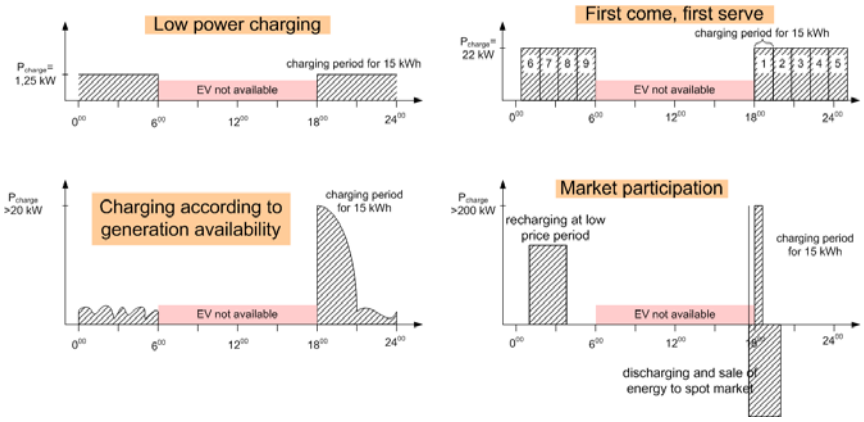


*Figure 3: Examples of different charging strategies*

Optimal 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. 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 renewable generation or to energy price
- Market participation with usage of EV as energy storage capability

Also 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
- Reduction of load peaks or equipment loading
- Operation as energy storage for Vehicle2Grid (V2G) functionality and primary control
- Balancing of renewable energy sources in networks with a high share of distributed generation
- Integration into Demand Side Management systems (DSM) or virtual power plants

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 MV and LV 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. Additionally possible interactions between different chargers can be investigated.

*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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