EV Hub Concept: Optimization of Charging Infrastructure at Specific eMobility Sites

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The increasing share of electric vehicles (EVs) will have a large impact on mobility service fleets and workplace charging. Companies need to evaluate the future charging demand and derive viable charging concepts. These concepts need to consider the optimal number of charging points (CPs) and energy supply, as well as taxation and accounting aspects needed to install appropriate charging infrastructures.

Driving the electrification of mobility

In a constant trend to increasing adoption of electromobility, total cost of ownership of electric vehicles is gaining competitiveness. In combination with the smaller carbon footprint as compared to combustion engines, these are drivers for fleet operators to consider the electrification of their fleet. In order to do so fleet operators need viable charging infrastructure concepts and a charge management system to optimize operation, energy consumption and demand.

At the same time, enterprises and retailers need to start supporting work place charging for their employees. The provided services should be compliant with regulatory guidelines - mandatory or voluntary - such as tax benefits for emission reduction. In order to enable workplace charging and ensure smooth operation, it is essential to integrate EV charging into energy and building management systems and connect it to existing charging management and customer management systems.

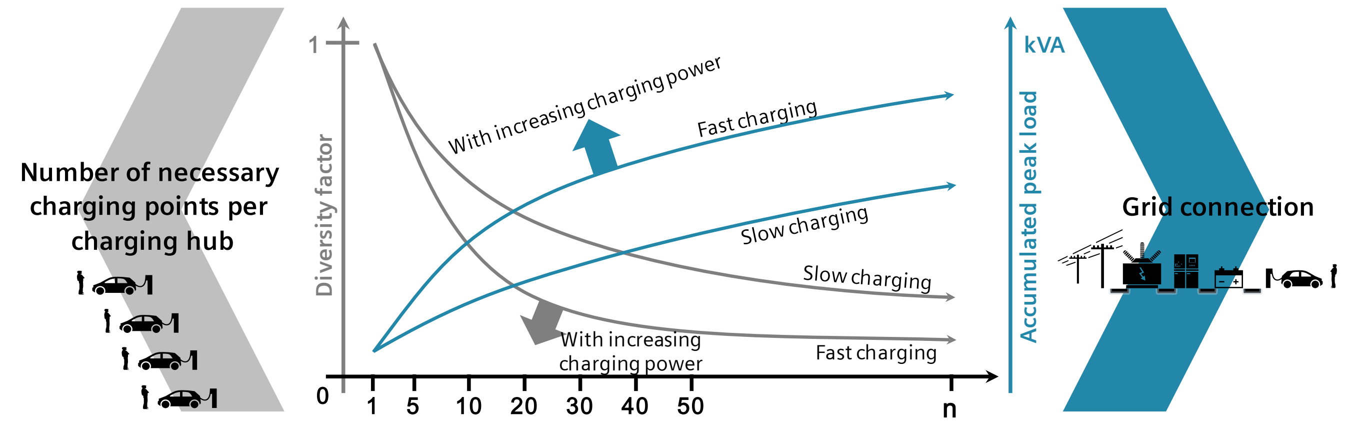

Figure 1: Development of optimal charging hub concept

As expert power system consultant in the field of electromobility, Siemens PTI offers a holistic charging hub concept for fleets and workplaces which considers technical as well as economic aspects. We determine the most suitable, cost-efficient solutions and technologies, including definition of the grid connection.

One of the key challenges during the evaluation of the necessary EV infrastructure is the identification of the optimal techno-economic ratio between EVs and CPs. For instance, for public CPs in metropolitan areas this ratio ranges from less than 5 EVs/CP to more than 30 EVs/CP. In parallel, the EV supply equipment varies broadly across CPs, differing in three main characteristics:

- Level: Power output range of the CP
- Type: Socket und connector used for charging
- Mode: EV-CP communication protocol

The differences become evident when looking at the power level. For example, the available charging output power ranges from level 1 with ≤ 3.7 kW and level 2 with ≤ 22 kW; both AC (via conventional plugs and wall boxes in small household), up to 350 and more kW in the most advanced rapid charging points (Level 3 DC charging). To evaluate the optimal power level and number of CPs per charging station or hub, several aspects must be considered and rated as different objectives. For example, redundancy of CPs and economic efficiency are working in opposite directions and require a case-specific trade-off.

Therefore, the decision strategy to identify the optimal number of CPs should reflect specific implications and priorities, e.g.:

- Drivers mobility services shall not be restricted in their driving demand due to delays caused by an empty battery, long charging times during operating hours or waiting time for free CPs.
- Number of CPs shall be limited to an economic reasonable EVs per CPs ratio (increase number of EV/CP).
- (n-1) redundancy of CPs has to be ensured to avoid the non-fulfillment of 1) and 2) in case that one CP fails, is permanently occupied or has to be maintained.

In accordance with these customer specific objectives, Siemens PTI analyzes multiple scenarios and variants to identify the appropriate level and number of CPs per charging station: Figure 2 shows exemplary results. The red bars represent the uncharged cars parking at the charging station in 5 minutes time steps. As soon as the EVs arrive at the charging station, they are connected to a free CP and their energy demand is charged. Once the EV is fully charged (green bars) the CP is used to charge the next uncharged EV. As during the day only short parking/charging times are favored, fast chargers with 50 kW and more may be installed to decrease the charging time and guarantee the optimal utilization of the fleet. In parallel, the number fast chargers should be selected at an economic optimum, because a 1-to-1 ratio between EV and fast charges is not necessary in most of the cases. If over-night charging is possible, the EVs may be charged via AC wall boxes with 3.7 kW for instance to reduce the peak load and costs.

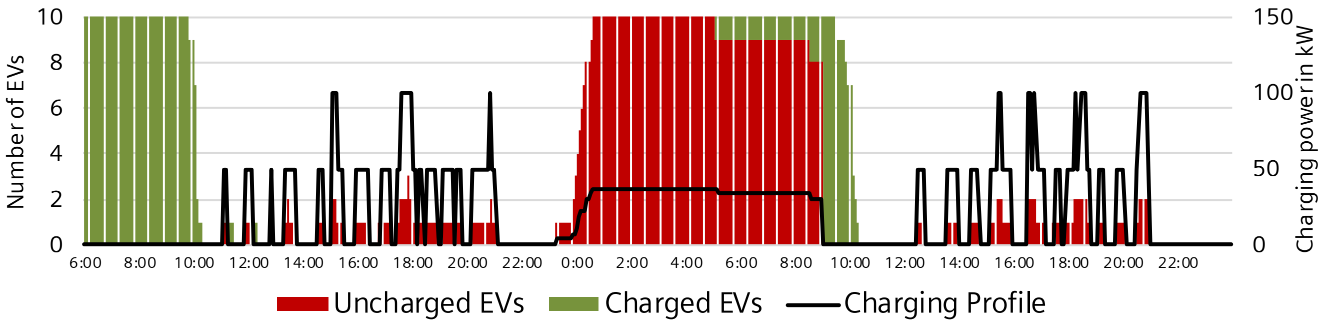

Figure 2: Simulation of charging profile of 10 EVs

Network integration

In another step the grid connection of the charging sites is analyzed. For this investigation a grid model is developed which contains the anticipated loads of possible CS locations and technologies to the distribution grid or independent charging hubs. The eligible ring main units (RMUs) in the grid are identified and the additional peak load coming from the demand analysis is connected to the selected RMU. On this basis different measures can be identified to avoid overloading or critical conditions, if necessary. In addition, the results provide a techno-economic evaluation of the different charging options, such as load management or the installation of a local energy storage.

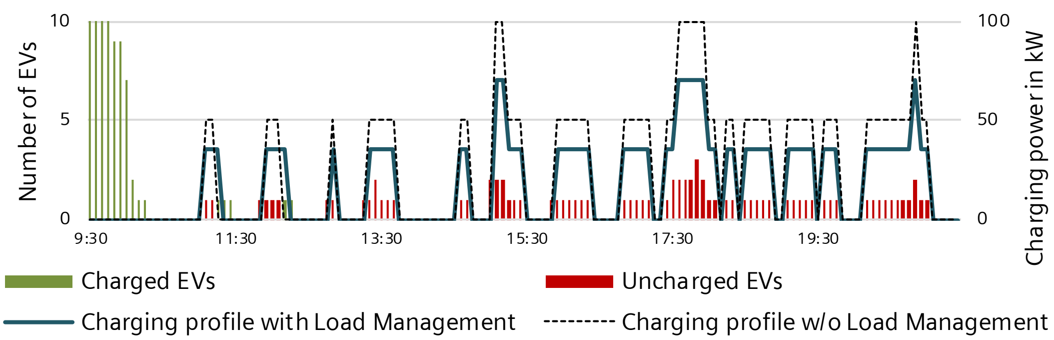

Figure 3: 30% peak load reduction with load management.

If you are interested in identifying your individual optimal charging hub concept, feel free to contact us.

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