Plug-in (hybrid) electric vehicles (EVs) are becoming a reality. However, this imposes various challenges to the power grid, as the load of charging a single EV on a yearly basis is comparable to that of a complete residential household. Nevertheless, the integration also offers various opportunities, as the EVs connected to the grid can be exploited to deliver grid services, e.g. by giving energy back to the grid to cope with peak demands stemming from household appliances: the storage capacity of EV batteries can be exploited to deliver so-called vehicle-to-grid (V2G) services.

In a typical household, energy consumption peaks occur in the evening when people arrive at home and turn on their electrical appliances. Charging EVs during that peak in energy demand, would lead to a substantial increase in peak load on the power grid, for which the power grid was not designed: voltage deviations or transformer overloads could occur. We are developing algorithms that provide solutions to deal with this new type of energy consumer. For example, the problem of peak load can be mitigated by shifting the charging process in time, to times at which overall energy demand is low, thereby reducing the level of peak demand to its original level without EVs. An example of how EVs can also assist in solving grid problems, is when one could charge EVs in function of the availability of renewable energy sources, thereby increasing the usage of these sources. The energy stored could then be used for driving purposes, but could also be delivered back to the household or power grid during times of peak demand.

The algorithms, and a supporting ICT architecture that we are developing, will contribute to an optimal integration of electric vehicles and also renewable energy sources in the smart power grid of the future. To assess our algorithms and architectural concepts, we developed a simulation framework comprising both the communication network and the power network.

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