

Integration of Electromobility

Concepts for Distribution System Operators and Smart Cities

At a glance

The increasing share of electric vehicles (EVs) will have a large impact on our power distribution grids. Existing grids must be expanded 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 PTI offers a holistic solution concept which considers both technical and economical aspects. We draw from a wide range of experiences and support our clients in the following tasks:

- enabling of electromobility strategy by identifying the client's part of the value chain and role
- development of electromobility concepts and viable business cases
- definition of software and hardware requirements as well as operating models
- definition of processes (e.g. interoperability)
- consideration of relevant regulatory and legal requirements as well as subsidy programs
- increasing the hosting capacity for electric vehicles (EVs) in existing distribution grids

- determination of optimal, cost-efficient solutions and suitable technologies for upcoming challenges
- improving grid performance and stability 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 low-voltage and medium-voltage networks.

Today

Normal AC 3-10 kW	Home	
Fast AC 11-49 kW	Employer charging	EV-sharing charging/Fleets
	At shopping	Public charging
High Power DC 50-120 kW		Highway

Near Future

Normal AC/Smart Charging V2G 3-10 kW	Home	
Fast AC / Mobil 11-49 kW	Employer charging	
	At shopping	Public charging
High Power DC 50-120 kW		Highway
Ultra High Power DC 120-350 kW		
Inductive (static/dynamic) 3-10 kW	Home charging	EV-sharing charging/Fleets

Figure 1: Charging power

The modern charging technologies enable EVs to be charged with electrical power ranging from several kW to more than 350 kW.

The charging load of EVs depends 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 distribution grids are not designed for a substantial penetration of EVs, there is a tremendous potential for overloading system components.

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

As the transition is expected to occur over the next decade, the changes will only slowly affect the grids and their operation. Nevertheless, the systems must be adapted to the changing requirements so that a large-scale integration of EVs can be accommodated in the future.

Holistic electromobility concepts and power system studies which identify suitable, cost-efficient reinforcement measures help to ensure that our power supply systems can cope with the future load development. National and international guidelines, standards and regulations need to be considered.

Our solution

When connecting a large number of EVs to an existing grid, various tasks should be addressed: from the development of business models and operational strategies, to the definition of requirements for software and hardware, and to the impact on grid planning and operation. Different aspects can be combined in our consulting studies to find the best solution.

Business case and business model development

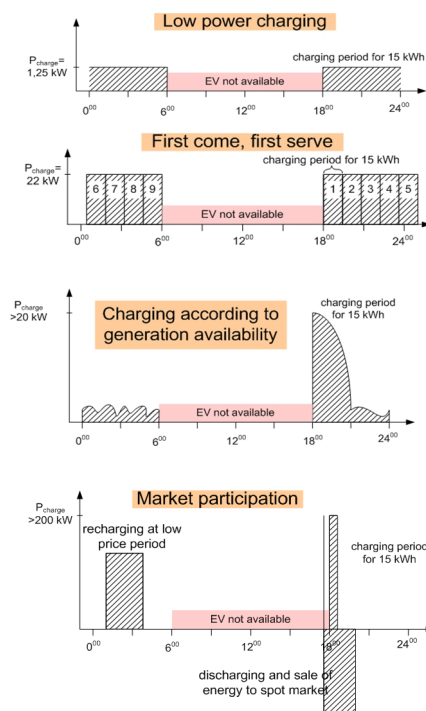
In order to develop an electromobility vision and to set the right objectives, existing concepts, value chains, stakeholder groups and geographical demand models are analyzed. By understanding the individual unique selling proposition of our customer, potential business models can be derived.

Then, economic aspects are evaluated through investment planning and forecasting possible sales / EBIT, including consideration of future expansion scenarios. By this means, viable business cases are developed considering the stakeholder needs. Different scenarios are assessed with varying parameters, such as time, personnel or financials. The result is a practical and executable roadmap to implement the selected and most promising business model.

Demand modeling

Together with our customers we develop specific scenarios for consumption patterns and, in particular, for the expected load demand. Relevant charging technologies and strategies are assessed and depicted in a consistent model.

In order to achieve an improved grid performance at minimal costs, charging stations can be integrated into the overall grid control. For example, by selecting appropriate charging control strategies, the maximum number of EVs can be increased, or required investments for grid extension can be reduced. Based on the existing grid structure, the customer's targets and given framework requirements, a technically and economically efficient solution can be selected.



Grid design

The initial step for assessing the impact of EVs and battery charging stations on the electrical network is the analysis of the current grid. Together with our customers we define the key performance indicators for analyzing how many EVs can be integrated into the existing distribution grid and to identify the most suitable locations and connection points for individual charging poles and fast charging stations.

In addition, a systematical grid assessment can be performed using load-flow and short-circuit analyses, calculation of harmonics, as well as reliability analyses. Future scenarios for electromobility are developed, taking into account different business cases, usage patterns, charging technologies and derived charging profiles. According to the previously defined KPIs, the optimal grid structure can be defined.

Grid connection studies

Connecting one or several new charging stations to the grid requires a number of analyses. If the closest point of connection is not technically viable, a grid structure analysis can help to identify a technically suitable and economical connection point.

In this assessment the laying of the existing lines is considered so that any required investments can be included in the calculation.

If a larger number of charging points are to be connected to the grid, possible effects on the grid and connected consumers must be investigated. Especially harmonic currents can negatively affect sensitive loads. Depending on the number of charging stations, the charging capacities and technologies, the right voltage level and topology for the connection points can be selected.

Additionally, the charging infrastructure of depots needs to be protected against internal and external faults. We assist in developing suitable protection concepts to meet our customer's requirements, considering the installed power and thus the importance of the plant. We can also support in determining the optimal protection relay settings.

How you can benefit

With our consulting services for the integration of electromobility into existing distribution grids we provide our clients with:

- a holistic strategy concept for electromobility and an economically efficient, flexible and transparent implementation roadmap
- a detailed assessment of the impact of EVs on their electrical network
- an optimized grid concept for improved resilience and grid performance

Published by
Siemens AG 2018

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