Electric vehicles charging systems

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The charging system of Electric Vehicles (EV), given the battery energy storage system on board the vehicle, can be considered one of the important DER (Distributed Energy Resources) systems, providing flexibility to the distribution and transmission system operator, in the form of a stationary Battery Energy Storage System (BESS) when the EV is connected to the charger. The state of charge of the EV battery and the available energy depend upon the past use of the EV and the energy stored in the battery during the charging process at the time of use of the system as a DER. In the charging process, the EV battery becomes a load on the electrical grid, a fully controllable load if the customer agrees, allowing the system operator to control the charging rate as required.

When fully charged, the EV battery becomes a fully controllable BESS, if the customer agrees. When multiple EV chargers are considered, EV charging can also be controlled and coordinated to meet distribution grid requirements and constraints. In addition, when fast charging stations incorporate large stationary batteries on their premises to support simultaneous fast battery charging for several or even many EVs, demand charges can be reduced and the stationary battery acts as a BESS even in the absence of a connection to an EV.

The EV battery and its charging system, with or without the addition of a stationary battery, can therefore be used in almost the same manner and with almost the same potential benefits as any BESS type DER. Some of the benefits include demand response management (load shifting and load smoothing), distribution grid resilience enhancement (building back-up power supply, local grid support, enhanced hosting capacity and increased grid stability, contribution for islanding operation and black start in microgrids), renewable energy system balancing (namely solar PV), and ancillary services to the transmission system, particularly when aggregated, for purposes such as ramping and frequency support in terms of different ancillary services types.

This new WG C6.40 intends to deal with the EV charging systems as a key distribution grid enabling technology. The EV battery and charging system technologies are presented from the distribution grid perspective, and the control systems required to enable the multiple benefits these systems can provide are described.
Results from previous Working Group C6.20 (see TB 632, *integration of electric vehicles in electric power systems*, May 2015) will be taken into account.

The scope of this Working Group includes different evolving EV charging station configurations, their benefits and impacts on the distribution grid, and their potential to enable enhanced solutions for intelligent electricity distribution systems. The following topics will be addressed:

1. Overview of different forecasts worldwide on EV deployment, current and future prospects – impact of EV charging (discharging) on the distribution grid and EV hosting capacity issues. Charging requirements, charger locations, and charging patterns for slow and fast charging for EV individual transportation (cars and smooth electric mobility solutions like electric scooter / bikes) and electric buses and trucks, considering spatial and temporal distributions for the different types of EV charging solutions and mobility types.
2. Review of EV charging technologies – Technology readiness and expected developments, charger types (slow and fast charging, Grid-to-Vehicle (G2V), charger technology, enabling bi-directional capabilities (Vehicle-to-Grid (V2G) and Vehicle-to-Building (V2B)); different semi-fast and fast chargers with integrated storage (battery storage, other technologies), installation in residential, commercial and utility settings; coupling chargers with renewable energy resources, standardization (existing and planned); typical connection voltage to the grid.
3. Review of approaches worldwide to managing EV charging – Single EV charging, multiple charger control and coordination, demand management and response to meet grid constraints; managing fast charging and the impact on the planning and operation of distribution systems; role of advanced metering and need for additional sensing devices.
4. Review of worldwide progress enabling EV charger ancillary services to distribution system operator (DSO) and transmission system operator (TSO) – Demand response management (load shifting and load smoothing); distribution grid resilience

enhancement (building back-up power supply, local grid support, grid hosting capacity, and grid stability); ancillary services to the transmission system (aggregation) for ramping and frequency support services; EV support to islanding operation of distribution grids with large-scale deployment of RES (microgrids) and support to black start strategies in microgrids and electric energy communities.

5. Review of regulatory issues and multiple EV charger management – Business and ownership models, intermediaries, aggregators, and coordinators; technological, socio-economic, financial, and regulatory challenges in the deployment of G2V, V2G, V2B, and fast charging.
6. Overview of worldwide business cases for EV charger deployment – Experiences and case studies, regional differences, ownership in slow, semi-fast, and fast charging systems – for different mobility types.
7. Building on all the above reviews and overviews, discussion and derivation of guidelines and recommendations for technology deployment, business case and

it is very important to list the expected benefits resulting from this development work:

1. Commercial, business, social, and economic benefits for industry and/or the community can be identified as a direct result of this work,
2. Existing or future high interest in the work from a wide range of stakeholders,
3. Contributions to new or revised industry standards,
4. State-of-the-art or innovative solutions, or identification of new technical directions,
5. Development of a guide or survey related to existing techniques; or an update on past work or previous Technical Brochures,
6. Contributions to improved safety utilization,
7. Contributions to environmental requirements and the UN sustainable development goals.