Technology Trends in EV Charging – an Overview

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Emerging Charging Technology and Future Trends

Presentation Objectives

1. Current Charging Technologies
   i. Charging Modes
   ii. Connectors
   iii. Power Levels

2. Charging System Trends
   i. Higher Power Charging
   ii. Inductive Charging
   iii. Vehicle-to-Grid
   iv. Interoperability
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Current Charging Technologies
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EV Charging..

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AC Connectors

Vehicle Connector Types – AC Charging Cable

**SAE J1772 Type 1**
- Release Button and hole for padlock
- Control Pilot
- Proximity Pin
- Earth
- Live 1
- Live 2/N

**EN62196-2 Type 2 Female**
- Control Pilot
- Proximity Pin
- Neutral
- Live 1
- Live 2
- Live 3
- Recess for plug lock

**EN62196-2 Type 2 Male**
- Control Pilot
- Proximity Pin
- Neutral
- Earth
- Live 1
- Live 2
- Live 3

Nissan Leaf socket

Renault Zoe socket

Tesla Model S socket
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**DC Connectors**

**CCS Combo 2**
- Control Pilot and Proximity Pins
- Earth Pins
- DC +/--pins

**CHAdeMO JARI JEVS/G105**
- DC +/--pins

**BMW i3 socket**

**Nissan Leaf socket**
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### Vehicle Charging - Power Levels

<table>
<thead>
<tr>
<th>Charger Type</th>
<th>Charge Time</th>
<th>Power (kW)</th>
<th>Connection Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow</td>
<td>0-100% in 10-12 hours</td>
<td>2.3-3.7 kW</td>
<td>Home, Workplace</td>
</tr>
<tr>
<td>Fast</td>
<td>0-100% in 4-6 hours</td>
<td>7-22 kW</td>
<td>Home, Workplace, Long stay car parks, Publicly accessible locations</td>
</tr>
<tr>
<td>Semi-Rapid</td>
<td>0-100% in 1-2 hours</td>
<td>22-43 kW</td>
<td>Workplace</td>
</tr>
<tr>
<td>Rapid</td>
<td>0-80% in 20-30 mins</td>
<td>43-50 kW, 120 kW, Tesla Supercharger station</td>
<td></td>
</tr>
<tr>
<td>Vehicle-to-Grid</td>
<td>0-100% in 6 hours</td>
<td>7 kW</td>
<td>Pre-commercial</td>
</tr>
</tbody>
</table>
Charging System Trends
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Higher Power Charging

2010 - 2016

- DC high-power charging CCS (≥350 kW @400/800 V)
- DC high-power charging CCS (≥150 kW @400 V)

2017

- DC fast charging CCS (50 kW @400 V)

2018

- DC fast charging CHAdeMO (50 kW @400 V)

2019

- AC fast charging 43 kW
- AC charging 22 kW
- AC charging 11 kW

2020

- Only AC slow (3.6-7.2 kW)

2021, ...

- 500 km
- 500 km
- 500 km
- 500 km
- 500 km

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Higher Power Charging

Source: electrek, “The first ‘High-Power fast-charging station’ (150-350kW) is installed by EVgo and ABB right in Tesla’s backyard”, 27 Feb 2017.
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Porsche – 800 volt DC Charging

CHARGING TIME IN COMPARISON (80% CUSTOMER SOC / 400 KM)

<table>
<thead>
<tr>
<th>kW</th>
<th>400 volts</th>
<th>50 kW</th>
<th>400 volts</th>
<th>100 kW</th>
<th>400 volts</th>
<th>150 kW</th>
<th>400 volts</th>
<th>220 kW</th>
<th>300 volts</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>State of the art</td>
<td>50 kW</td>
<td>400 volts</td>
<td>100 kW</td>
<td>400 volts</td>
<td>150 kW</td>
<td>400 volts</td>
<td>220 kW</td>
<td>300 volts</td>
<td>“Charging = Fueling”</td>
</tr>
<tr>
<td></td>
<td>Infrastructure</td>
<td>Plug/Battery cell</td>
<td>Plug (350 A)</td>
<td>Battery cell</td>
<td>FURTHER POTENTIAL FOR REDUCTION AT 800 V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EXAMPLE OF FAST CHARGING: TRIP FROM BERLIN TO LINDAU (CA. 720 KM)

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Inductive Charging

Three main components:

- Control panel
- Vehicle adapter
- Parking pad

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Inductive Charging

Qualcomm Halo Wireless Electric Vehicle Charging (WEVC) is another wireless/inductive charging system.

The charging pad’s multi-coil design delivers high energy-transfer efficiency and high power – 3.3 kW and 6.6 kW - even if pads are misaligned.

Assessment of electromagnetic field will require new approaches to estimation due to the lack of standardised procedures at low frequencies (<10 MHz).

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Vehicle-to-Grid Systems

itheca demonstration project

Leaf to Home power supply system

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Charge Point Management Systems (CPMS)

- CPMS is a Back Office function provided by a Charge Point Network Operator. It is hosted on a server and controls and monitors a network of charge points.

- The CPMS provides the following functions:
  1) A database of:
     i. all the Charge Points on its network;
     ii. the network’s authorised EV users;
  2) The ability to remotely diagnose and operate charge point functions;
  3) The system collects charging data for operational and billing purposes;
  4) A user help line and website (typically with location map);
  5) Pay As You Go billing options for EV users;
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Open Charge Point Protocol

- **OCPP 1.5**
  - 2013
  - Open Charge Alliance
  - In a SOAP over HTTP based protocol for operating a Charge Point from a Central System, which supports the following functionalities:
    - Locality and remotely started transactions including metering for billing purposes
    - Metersing values not related to transactions
    - Authorizing charging sessions
    - Caching authorization IDs and local authorization list management for faster and offline authorizations
    - Intermediate (non-transactional)
    - It status Reporting, including periodic heartbeat
    - Reservations (Immediate)
    - Firmware management
    - Provisioning a Charge Point
    - Reporting diagnostics information
    - Setting Charge Point availability (operative / inoperative)
    - Remote unlocking of connectors
    - Remote Reset

- **OCPP 1.6**
  - 2015
  - Support for JSON over websockets to reduce data traffic (JSON, Javascript Object Notation, is a lightweight data-interchange format and allow operation over networks not supporting charge point packet routing (e.g. public internet).
  - Smart Charging, load balancing, central smart charging and local smart charging
  - Possibility to ask a Charge Point to send a Charge Point initiated message (with current information), for example the last metering value or status of the Charge Point
  - Extended configuration options for offline operation & authorization

- **OCPP 2.0**
  - 2017
  - (in preparation / draft)
  - New features:
    - Extended Security (i.e. security profiles, certificate handling, encryption, security testing, etc.)
    - Device Management of the Charge Point for improved provisioning, monitoring and maintenance. This also allows a Charge Point Operator to monitor, configure, etc. on a lot of parameters in a Charge Point
    - Improved Smart Charging support, including
      - Vehicle to grid
      - External local smart charging signals (HEMS)
    - Support for EIC(JIQ, 15116) including Plug and Charge
    - Support for displaying tariffs & costs
  - Enhancements:
    - EV driver preferred languages to adjust the language displayed on the terminal to the specific EV driver
    - Extended authentication options (e.g. Bluetooth, plug and Charge, local mechanical key, etc.) in addition to RFID
    - Improved support for displaying messages on a Charge Point
    - Support for starting transactions using payment terminals
    - Standardised automated mechanisms for accurate Charge Point data/file maintenance, including automated daylight saving time adjustment
    - Extended support for group transaction-related messages to help central systems with the processing of transaction related messages
    - Mark offline transactions to inform the Central System which transactions occurred whilst the Charge Point was offline
    - Support locally generated transaction unique IDs
    - Numbered use cases, requirements and sequence diagrams in the specification
    - Proposal for digital signing of metering data
  - Additional transport protocol
    - Improved data reduction

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Open Platform for Charging Point Management System

Why do we need an open platform for charging point management systems?

1) The EV users want to access chargepoints across different network.
2) Easy access method via app or contactless bank card.
3) EV users do not want to sign up every single chargepoint network provider.

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<table>
<thead>
<tr>
<th>CHARGE POINT OPERATOR (CPO)</th>
<th>E-MOBILITY PROVIDER (EMP)</th>
<th>NAVIGATION SERVICE PROVIDER (NSP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sends</td>
<td>Sends</td>
<td>Sends</td>
</tr>
<tr>
<td>1. Charging station geodata</td>
<td>1. Authorization data</td>
<td>/</td>
</tr>
<tr>
<td>2. Billing information</td>
<td></td>
<td>/</td>
</tr>
<tr>
<td>3. Live status data</td>
<td></td>
<td>/</td>
</tr>
<tr>
<td>Receives</td>
<td>Receives</td>
<td>Receives</td>
</tr>
</tbody>
</table>
Thank you for listening
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