Overview of Vehicle Electrification and the Grid

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Technology- and Testing-Platform for…
- Charging stations
- Charging systems
- Accounting systems
- Communication devices

One-stop-shop for all aspects of system technology in e-mobility
- Power grid
- Power electronics
- Communication
- EMC
- Environmental effects
Technology and Innovation Platform for interoperable E-Mobility, Infrastructure & Grids

- Accounting systems
- Communications networks
- Energy networks

- Personal safety
- Environmental effects

- Charging station
- ICT
- Charging system

- Electric Vehicle
- Controller
- Battery
- Electric drive
- Car-to-X

- Testing and development environment for electrical components
- Testing and development environment for communication
- Protective and safety devices
- EMC testing and simulation

- Model-based system integration
- EM

- Project management, organisation and founding of the Competence Center
Charging Infrastructure Context
Current Charging Concepts

- **3,7 kW AC-Wallbox**
  - 11 kW AC-Wallbox
  - ~2-8 hours
  - 1-2 EV per day

- **11 kW AC-Charging Station**
  - 22 kW AC-Charging Station able to communicate
  - ~1-2 hours
  - 4-10 EV per day

- **22 kW AC-Charging Station able to communicate**
  - ~1 hour
  - 10-15 per day

- **50 kW DC-Charging Station**
  - max. 0,5 hour
  - 12-24 EV per day
## Charging Infrastructure – Standard Plugs

<table>
<thead>
<tr>
<th>AC Plugs</th>
<th>DC Plugs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typ 1 (IEC 62196)</td>
<td>Typ 2 (IEC 62196-2)</td>
</tr>
<tr>
<td><img src="image" alt="Typ 1 (IEC 62196)" /></td>
<td><img src="image" alt="Typ 2 (IEC 62196-2)" /></td>
</tr>
<tr>
<td>Charging capacity: 7,4kW (1-phase, 32A)</td>
<td>Charging capacity: 43kW (3-phase, 63A)</td>
</tr>
</tbody>
</table>

Typ 2 and CCS sind are mandatory for Europe!
Basic Charging Interfaces

DC Power Transfer
(Auto-Connect Charging Device)

Wireless Power Transfer

DC Power Transfer

AC Power Transfer

Electric Vehicles

Charging Infrastructures

Mobility Services

Charging Infrastructure Management Systems

Grid Services

Front-End Communication

Back-End Communication

Quelle: J. Schmutzler, Embedded Web Services Middleware for the Vehicle-to-Grid Communication Interface

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Overview

>80% of all charging processes

in accordance with NPE

<20% of all charging processes

AC 3.7 kW / 11 kW

AC 22 kW

DC up to 150 kW
Current State
Number of (semi-)public Charging Points in Germany

Current State of EVs and Public Charging Points (AC)

Quelle: NPE, Ladeinfrastruktur für Elektrofahrzeuge in Deutschland (2015); KBA/VDA (2016); BDEW (2016)
Current Ratio of EVs and Public Charging Points (AC)

Source: NPE, Ladeinfrastruktur für Elektrofahrzeuge in Deutschland (2015); KBA/VDA (2016); BDEW (2016)
Pro-EV Scenario: Evolution of Charging Points

Current situation

- 5 (17%) Private domain
- 25 (83%) Semi-public domain

Target

- 2014: 131
  - 8 (7%) Private domain
  - 30 (25%) Semi-public domain
  - 93 (78%) Public domain
- 2017: 479
  - 555 (87%) Public domain
  - 11 (9%) Semi-public domain
  - 29 (5%) Private domain
- 2020: 1,134
  - 1,022 (85%) Public domain
  - 70 (6%) Semi-public domain
  - 111 (9%) Private domain

Number of vehicles (thousands)

- 2014: 128
- 2017: 521
- 2020: 1,134

Source: NPE, Charging Infrastructure Roadmap, 2014
Pro-EV Scenario: Charging Strategy 2020

Forecast demand:
- AC: 1,022,000
  - DC: 0
  - 85% private

Location types:
- Domestic parking: Domestic garage or parking space
- Company parking: Employee parking

Ownership of charging station site:
- Private

AC: 103,000
- DC: 7,100
- 10% semi-public

Multi-storey car parks: Customer parking, e.g., shopping centres
Trunk roads: Lay-bys, truck stops, petrol stations

Residential areas: Kerbside
Central locations: Public car parks

AC: 70,000
- DC: 0
- 5% public

Source: NPE, Charging Infrastructure Roadmap, 2014
Pro-EV Scenario: DC Charging Infrastructure

Quelle: NPE, Ladeinfrastruktur für Elektrofahrzeuge in Deutschland, 2015
Place of Charging

Private users’ places of charging in Germany in 2014

- Near home: 96% yes, 4% no
- Public space in the city: 41% yes, 59% no
- At work: 36% yes, 64% no
- Shopping: 24% yes, 76% no
- Leisure facilities: 19% yes, 81% no
- Lay-bys, truck stops on highways/freeways: 19% yes, 81% no

Source: DLR (Institut für Verkehrsforschung)
Private Domain Charging

Available Charging Devices:

**AC Wall Box:**
- Typical capacity 11 kW (22 kW) (limited by grid connection)
- 500€ - 1500€
- Charging time: 2 - 4 h (depending on car)

**DC Home Charging Station:**
- Typical capacity 11 kW (22 kW) (limited by grid connection)
- 10.000€ - 15.000€

**CEE 7/4:**
- Max. capacity 2.4 kW
- Charging time: 10 - 20 h
- 15 €
Bottleneck Grid Infrastructure

Capacity reserve at house connection > 11 kW → 3 phase charging using 16 A (11 kW) possible (approx. 2 hours for 100km range)

Local network station

House junction cable

House connection box

Circuit breakers NH 00 with 63 A – 100 A

Typical household loads + Electric Vehicle

10 medium voltage strings

1 local network station

5 low voltage strings

1 house connection box
Public Domain Charging

Available Charging Devices:

AC Charging Station
- Typical capacity: 22 kW (43 kW)
- 2 Charging spots
- 10,000 €*
- Charging time: approx. 1 h

DC Charging Station:
- Typical capacity 50 kW, approx. 400V DC
- 34,000 €*
- Charging time (SOC=80%): approx. 30 min.

DC High Power Chargers:
- Typical capacity >200 kW, up to 1000V DC
- ??? €
- Cars with high range
- Utility vehicles

Quelle: RWE

Quelle: ebg compleo

*NPE Statusbericht LIS 2015
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Distribution grids reach limits of capacity and voltage due to distributed renewables and new loads

Growing share of distributed renewables

New loads, load management and efficiency measures

Implementation of innovative devices, grid and operation/control concepts
Multi-directional Charging Infrastructure

- Charging with grid renewables
- Charging from local storage
- Charging with local PV

Li-Ion Storage

Local PV

DC Charger

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Requirements

Providing distribution grid ancillary services
- Connection to control systems (e.g. via Smart Metering architecture)
- Enabling flexibilities relying on grid requirements
- Enabling products and services for end customers

Local Optimization
- Optimization of own consumption
- Optimization of energy use, CO2, costs
- Benefit for the overall system not guaranteed
Resulting Challenges in the Power Grid

- **Integration of High Power Charging Infrastructure**
  - New planning rules needed
  - Circuit feedback
  - Introduce E-Mobility to the low-voltage connection conditions

- **Congestion Management**
  - New types of loads in existing structure
  - High peak loads due to un-coordinated charging processes (simultaneity factor)

- **Accounting grid**
  - New types of loads require new load profiles
  - Difficult forecast of behavior and optimized consumption
Thank you for your attention!

Contact

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