CHAdeMO: the enabler of EV bi-directional charging (V2X)

Risø, 21 November 2018
Tomoko BLECH
Agenda

- CHAdeMO basics
- CHAdeMO V2X
  - History
  - Standardisation & certification
  - Product & system developments
- CHAdeMO principles for evolution
- Summary
CHAdEOMO and CHAdEOMO Association
Association members

Who are our members?

413 entities

41 countries

And many, many more..
CHAdeMO members in Europe

EU members: 123
Countries: 26

 Governments

<table>
<thead>
<tr>
<th>Year</th>
<th>Regular</th>
<th>Supporting</th>
<th>Special</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015/05</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2016/05</td>
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<td>2017/05</td>
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<tr>
<td>2018/05</td>
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<tr>
<td>2018/10</td>
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</tbody>
</table>
CHAdEMO global/European installation

TOTAL

22 600

Note: as of Sept 2018
Source: ChargeMap, EAFO, Zap-Map, NOBIL, Girève, GoingElectric, ChargeHub
CHAdeMO plug-in share in the world

Global plug-in sales by fast charging inlet (2008-2018/6)

- Unknown
- N/A
- AC fast
- CCS
- GB/T
- Tesla

TOTAL: 24%
BEV: 31%
PHEV: 11%

Source: EV-volumes.com
Note: includes light commercial vehicles
CHAdEMO in the EU EV market

### EU plug-in share by fast charging inlet

(Cumulative, 2008-2018/H1)

- **BEV**
  - N/A
  - ACC
  - CHAdeMO
- **PHEV**
  - N/A
  - ACC
  - CCS
  - CHAdeMO
- **Total**
  - N/A
  - ACC
  - CCS
  - CHAdeMO

#### Top 5 BEV
- Nissan Leaf
- Renault Zoe
- Volkswagen e-Golf
- BMW i3
- Tesla Model S

#### Top 5 PHEV
- Mitsubishi Outlander PHEV
- Volkswagen Passat GTE
- Volvo XC60 PHEV
- BMW 225xe Active Tourer
- Volkswagen Golf GTE

Source: EAFO, passenger cars only; EU+EFTA+Turkey

Source: EV-volumes.com; includes LCVs
CHAdemo V2X

Typically up to 10kW
CHAdEMO and V2X: the beginning (1/2)

Restoration of infrastructures post East Japan Earthquake (2011)

<table>
<thead>
<tr>
<th>Date</th>
<th>Water</th>
<th>Gas</th>
<th>Electricity</th>
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<tbody>
<tr>
<td>11 Mar.</td>
<td>100%</td>
<td>0%</td>
<td>0%</td>
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<tr>
<td>18 Mar.</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>25 Mar.</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>1 Apr.</td>
<td>50%</td>
<td>50%</td>
<td>0%</td>
</tr>
<tr>
<td>8 Apr.</td>
<td>100%</td>
<td>50%</td>
<td>100%</td>
</tr>
<tr>
<td>15 Apr.</td>
<td>100%</td>
<td>50%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: N. Nojima, JSCE

ICE cars needed petrol, which took time to arrive at the affected areas
CHAdeMO and V2X: the beginning (2/2)

**Heating**
- Kettle (700-1000W)
- Electric blankets (50W-90W)

**Information access**
- Phone charging (15W/phone)
- Portable PC (50W-150W)

**Recovery support**
- LED floodlight (70W)
- LED electric signs (200W)
Standardised V2X: specs and certification in place

**CHAdemO Standard**

<table>
<thead>
<tr>
<th>Year</th>
<th>V2H Specifications</th>
<th>Certification (Bi-directional &amp;DC side)</th>
<th>Grid-connection (AC side - JP)</th>
<th>International Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>Initial Guideline 1.0</td>
<td>CHAdemO Guideline 2.0-2.1</td>
<td>CHAdemO Guideline 2.0-2.1</td>
<td>IEC61851-23, 24</td>
</tr>
<tr>
<td>2013</td>
<td>CHAdemO Guideline 2.0-2.1</td>
<td>CHAdemO Certification</td>
<td>Industrial Standards</td>
<td>CHAdemO Certification</td>
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<tr>
<td>2014</td>
<td>CHAdemO Certification</td>
<td>3rd-party certification in place</td>
<td>Certification in place</td>
<td></td>
</tr>
<tr>
<td>2015</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2016</td>
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<tr>
<td>2017</td>
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<tr>
<td>2018</td>
<td></td>
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</tbody>
</table>

**Relevant standard examples:**
- IEC 62909 / IEC 61850 / ISO/IEC 15118
- IEC61851-23, 24 Ed2 TC69
  - Bi-directional charging: MT5
  - Grid connection: JWG11
Certification in Japan

Home/Grid Communication Certification
- Defined by relevant industrial organisations
  (ECHONET / ECHONET Light / BACnet)

Source: JET [http://www.jet.or.jp/](http://www.jet.or.jp/);
https://echonet.jp/about/certification_system/

Grid Connection V2H-EVPS Certification
- JET (Japan Electrical Safety and Environment Technology Laboratory)

CHAdemo V2H Certification
- EVSE-EV communication
- EV-interactive sequence control for interoperability
V2X products in the market

- **V2V** (Vehicle)
- **V2L** (Load)
- **V2H** (Home-off Grid)
- **V2G/B/H** (Grid)
Seen at eMove360

eNovates /the New Motion: wall-mountable V2G (10kW)

Magnum Cap: MC V2G (10kW)

Wallbox: DC V2X charger (7.4kW)

Photo courtesy of Narcis Vidal, Enel X
Grid-integrated EVs: demo to commercial applications
V2X Market trend: multi-source systems

Multi-source system for homes

Large-scale multi-source system

Source: Nichicon

Source: TU Delft and Last Mile Solutions, PRE Power Developers
Development in progress: fast-charge on V2X system

V2X mode:
- Charge / discharge
- Safety and convenience of equipment usage

Fast-charger mode
- Parallelization DC/DC converters
- Communication between each converter
- Ensure fast-charge
CHAdemo principles for evolution

- Adaptation (as flexible as possible)
- Backward compatibility
- Core values
Adaptation (as flexible as possible)

**DC charge at home/office**
(6-10kW)

- Enhanced V2X Functionality

**Battery as energy device**
- Peak cut
- PV connection
- VPP participation
- Resilience
- Leisure

**Varied charge needs**
(22kW, 50kW, inductive, smart charge..)

- Full charge
- Top-up
- During stay
- Low Power (low cost)
- Charge guided by AI

**High Power Charging**
(50kW+)

- Varied charge needs

**Battery capacity**

<table>
<thead>
<tr>
<th>Capacity</th>
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<tbody>
<tr>
<td>40kWh</td>
</tr>
<tr>
<td>30kWh</td>
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<tr>
<td>24kWh</td>
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<tr>
<td>16kWh</td>
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<tr>
<td>10.5kWh</td>
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<tr>
<td>9kWh</td>
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</tbody>
</table>
Backward compatibility

- CHAdeMO 0.9: 62.5kW (125A x 500V)
- 1.0: 200kW (400A)
- 1.1: Fully backward compatible
- 1.2: 400kW (1kV)
- CHAdeMO 2.0
Core values: safety, CAN, interoperability

New techno
High power/voltage, V2X, PnC, Smart Charging..

Compliant variants

CHAdeMO Core
Safety / Communication protocol / Certification...

Regional variants

CHAdeMO (THE ORIGINAL)
Next-gen ultra-fast protocol: harmonisation with GB/T

New protocol

Target 900kW (600A x 1.5kV)

- Co-development with CEC (China Electricity Council)
- For vehicles including trucks, buses and passenger vehicles

- New connector shape
- **Full backward compatibility** with current CHAdeMO and current GB/T
- Aimed for 2020
- V2X included in scope
All possible with CHAdeMO

- OFFICE/HOME CHARGING
  - VPP DR via V2X
- DESTINATION CHARGING
  - Billing Authentication PnC
- PATHWAY CHARGING
  - High Power
  - Pantograph Wireless Dynamic
- Vehicles of all size
  - Already developed
  - Development on-going
Summary

- CHAdeMO is the first and the only international protocol to enable V2X with production EVs / PCS

- Having engaged in a variety of demo and commercial projects, CHAdeMO leads the innovation in the V2X domain

- CHAdeMO protocol evolves and optimises functionality adapting to the various market needs around charging / discharging