Different ways of charging

There are different ways of charging your car, based on different technologies. And these technologies can be used again in combination.

- Home charging (AC)
- Public street charging (Low power AC & High power AC)
- High power (DC) charging
- Battery swap systems
- Inductive / conductive charging
Different ways of charging

Urban area

Focus on AC charging on public street
- High power charge
- Street / normal
- Home + other behind meter / normal

Focus on home charging and high power charging
- High power charge
- Street / normal
- Home + other behind meter / normal

Focus on high power charging (DC)
- High power charge
- Street / normal
- Home + other behind meter / normal

Focus on home charging and at destination
- High power charge
- Street / normal
- Home + other behind meter / normal

Sub urb area

Focus on AC charging = main
- Home & high power = 50/50

Focus on home charging and high power charging
- High power charge
- Street / normal
- Home + other behind meter / normal

Focus on high power charging = main on long term
- AC charging bulb

Focus on home charging and at destination
- Home + destination

Source: TNO Innovation for Life

Dutch situation EV deployment
Cost of different charge infra systems

- Biggest share in cost: battery and energy
- From an energy cost point of view (incl. battery cost): Home charging, street charging and high power charging are almost competitive in 2020 (0.098, 0.109 resp. 0.101 €/km) with a ‘normal’ ICE fuel car (0.078 €/km)
- Battery swap system is the most expensive one, mainly because of high investment cost for infrastructure and the cost of capital (investment financing).

Out of scope:
- Road taxes
- Cost for modifying the energy-grid

Source: TNO innovation for life
Deployment of EV in the Netherlands

Percentage e-auto's, 2012-2050

SOURCE Movaris
The reality

To reach all the goals in a coordinated and structured way 10 April 2010 The Formula E-team was founded. This team was chaired by his royal highness Prince Maurits van Oranje.

The Formule E-team realises break through regarding e-mobility in infrastructure, batteries and EV availability

www.formuleeteam.nl
Agreements interoperable infrastructure

General rules agreed upon:

- Interoperability of infrastructure for cars
- Exchange of user ID (no names) & issuer ID
- Exchange of charge point location & owner
- ‘Opt in’ for users (users need to agree)
- Open to new infrastructure providers with publicly accessible charging points

www.formuleeteam.nl
3. TNO-KEMA study and decision on standard plug in the Netherlands

TNO and KEMA presented the outcomes of their study to the possibility of choosing a standard plug for charging of EV in the Netherlands already. In their research TNO and KEMA considered the following:

Applicable world and European standards (regarding plugs and connectors as well as charging modes);

- The availability of potentially adopted plugs;
- Car manufacturer’s perspectives; and
- The daily safety

Both the ‘Mennekes plug’ and the ‘Scame plug’ could be considered as standard plug in the Netherlands according to TNO and KEMA.

Based on the results from the study the Mennekes plug was unanimously chosen by all parties (Eneco, Nuon, Enexis, Stichting E-laad, Better Place, 365 Energy Group and UNETO-VNI). Also Essent and MisterGreen – who were absent at the meeting – have confirmed that they prefer the adoption of the Mennekes plug.
4. Presentation on interoperability w.r.t. authorization

The progress made in the ‘interoperability workgroup’ in which the providers of public charge spots get together was presented.

Since the infrastructure meeting in January agreements have been made concerning the interoperability with respect to authorization.

Recently a roadmap has been defined on how to realise interoperability with respect to authorization on September 1st 2010. A similar roadmap will be made regarding the adoption of the Mennekes plug in the interoperability workgroup.
`Formule E-team kiest voor Mennekes-stekker`

van David Pedro

In Nederland kunnen elektrische auto's in de toekomst met de Duitse Mennekes-stekker opladen. De standaardisering van de oplaadstekker voor elektrische auto's is onder leiding van het Formule E-team met Prins Maurits aan het roer tct stand gekomen.
Drivers electric transport

Sustainability
- reduction of CO₂-emissions

Cost
- Electric cars are interesting as product because of: cost, technology and other aspects of the car, and other benefits like cheap parking places.

EU-27 all sectors

Average grow: 1.4% per year (between 2000 and 2005)

EU-27 CO₂ emissions from transport

Required reduction in industrialised world to keep global temperature rise < 2°C

(EU ambition for reduction of CO₂ emissions, Presidency Conclusions, Brussels, European Council, 29/30 October 2009)

Source: TNO innovation for life
What happens if there is no load managing system for controlling massive charging EV
Probability of charging at residential level.

Once a day at a fixed time

After every ride, everywhere anytime
Charge sessions during the day (2011)

Distribution starting times charge transactions E-laad, oct – dec 2011

SOURCE Movaris
Power demand during the day (2011)

Total power charge transactions E-laad, oct – dec 2011

SOURCE Movaris
Impact electric transport on the energy grid

Simulation-results

<table>
<thead>
<tr>
<th>Average number of EV's per household</th>
<th>Peekimpact as % trafo capacity Without intelligence</th>
<th>With Intelligence</th>
</tr>
</thead>
<tbody>
<tr>
<td>0,01</td>
<td>57%</td>
<td>56%</td>
</tr>
<tr>
<td>0,02</td>
<td>59%</td>
<td>56%</td>
</tr>
<tr>
<td>0,03</td>
<td>62%</td>
<td>57%</td>
</tr>
<tr>
<td>0,05</td>
<td>66%</td>
<td>58%</td>
</tr>
<tr>
<td>0,10</td>
<td>77%</td>
<td>60%</td>
</tr>
<tr>
<td>0,25</td>
<td>109%</td>
<td>67%</td>
</tr>
<tr>
<td>0,40</td>
<td>142%</td>
<td>74%</td>
</tr>
<tr>
<td>0,50</td>
<td>164%</td>
<td>79%</td>
</tr>
<tr>
<td>0,75</td>
<td>218%</td>
<td>90%</td>
</tr>
<tr>
<td>1,00</td>
<td>273%</td>
<td>102%</td>
</tr>
</tbody>
</table>

Without intelligence peak traffic with 10 EV's in a district of 100 homes goes above 70% of the max capacity of the trafo system.

With intelligence (in this scenario, charging is spread during the evening and night), 25 to 30% can be charged without any problem.

To be taken measurements:

- Expanding grid capacity
- Charge strategies: steering of the charge process
- Influencing behaviour of users

Source: TNO innovation for life

Dutch situation EV deployment
Market model Electric transport
* on request of Formule E-team

For home charging the inhabitant is both CSP as well as CPO. For private environments this can be the same entity. For public charging this are two different entities.

Source: TNO innovation for life

Dutch situation EV deployment

EIA Task 17 25042012
Possible market model for smart charging

Electric Transportation charging market

Production Balancing Retail

TSO / DSO

Metering

Charge spot Operator

Mobility Service Provider

Consumer

Back-end services
E.g.: clearing and settlement

E

ID check

Periodic settlement

Electricity market

TSO / DSO

Metering

Production Balancing Retail

Electricity market

2015-20
The principal of Smart charging

1. Charge request (ToD, SoC)
2. Create charge plan
3. Evaluate charge plan
4. Negotiate charge plan
5. Execute charge plan

CSP
EV
DSO
Bij de Floriade in Venlo staan zestig oplaadpalen voor elektrische auto's. Na de wereldexpo krijgen ze een plekje in de regio.

Florielectric promoot elektrisch rijden • Verkoop van e-cars neemt sterk toe
Drivers’ wishes

ToD
SoC
Contract-id
Battery capacity
(charge me now, ...)

TX-id, Contract-id, phase, max CS-capacity

List({kWh-need, ToD, priority, phase, max. charge, TX-id, session-ID})

Charge plan(15min)

Go/No-Go

Power demand(15min)

CSP

EV

Electricity

Charge Spot Operator

ESCHER

DSO

Local Controller

Charge Spot

CSP

Local Controller

DSO: Transformer

Transformer

ESCHER

Driver’s wishes

Drivers’ wishes

ToD
SoC
Contract-id
Battery capacity
(charge me now, ...)

TX-id, Contract-id, phase, max CS-capacity

List({kWh-need, ToD, priority, phase, max. charge, TX-id, session-ID})

Charge plan(15min)

Go/No-Go

Power demand(15min)
Dutch EV charging point deployment

Charge point interactive Management System


<table>
<thead>
<tr>
<th>Aantal laadpunten</th>
<th>Geplande laadpunten</th>
<th>Ladende auto's</th>
</tr>
</thead>
<tbody>
<tr>
<td>1407</td>
<td>313</td>
<td>63</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ton CO₂ reductie</th>
<th>kWh verbruikt</th>
</tr>
</thead>
<tbody>
<tr>
<td>89 786</td>
<td>107 852</td>
</tr>
</tbody>
</table>

* Brandstofprijs: 59% benzine, 59% diesel
* Verbruik: 32 km/l met 23 kWh wissel: 100 km geschaat
* Gemiddelde CO₂ uitstoot van diesell: 140 g/km
* Gemiddelde CO₂ uitstoot van benzine: 170 g/km
* Meetop gestart op 01-01-2011

http://ev-services.net/e-Laad/Statistics
Dutch EV charging point deployment

Landelijk netwerk van 459 snellaadpalen langs de snelweg

Gepubliceerd op 01-02-2012 om 09:52

VIDEO – Er komt een landelijk dekkend netwerk van minimaal 459 snellaadpalen voor elektrische auto’s op 335 plaatsen langs de snelweg. Onder marktpartijen is grote belangstelling voor het plaatsen van deze oplaadpunten. Dat maakte Rijkwaterstaat bekend. Dit betekent dat bestuurders van elektrische taxi’s straks op meer plekken gemakkelijk langs de snelweg de accu van hun auto kunnen opladen.
Dutch EV charging point deployment

<table>
<thead>
<tr>
<th>Country</th>
<th>AC connector</th>
<th># installed</th>
<th># Commissioned in 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Private</td>
<td>Public</td>
</tr>
<tr>
<td>AT$^9$</td>
<td>Type 2</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>CZ$^{10}$</td>
<td>Type 2</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>DK$^{11}$</td>
<td>Type 2</td>
<td>0$^{12}$</td>
<td>280</td>
</tr>
<tr>
<td>DE$^{13}$</td>
<td>Type 2</td>
<td>385</td>
<td>1750</td>
</tr>
<tr>
<td>ES</td>
<td>Type 2</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>FR$^{14}$</td>
<td>Type 3</td>
<td>3500</td>
<td>4000</td>
</tr>
<tr>
<td>IE$^{15}$</td>
<td>Type 2</td>
<td>358</td>
<td>202</td>
</tr>
<tr>
<td>IT$^{16}$</td>
<td>Type 2</td>
<td>233</td>
<td>120</td>
</tr>
<tr>
<td>NL$^{17}$</td>
<td>Type 2</td>
<td>&gt;1000</td>
<td>&gt;2000</td>
</tr>
<tr>
<td>PT$^{18}$</td>
<td>Type 2</td>
<td>0</td>
<td>525</td>
</tr>
<tr>
<td>UK$^{19}$</td>
<td>Type 2</td>
<td>0</td>
<td>250</td>
</tr>
</tbody>
</table>

Table 1: indicative number of installations per country for the AC connector

Eurelectric, march 2012
## Dutch EV charging point deployment

<table>
<thead>
<tr>
<th>Country</th>
<th>DC connector</th>
<th>#installed</th>
<th># commissioned in 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>CHAdeMO</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>BE</td>
<td>CHAdeMO</td>
<td>12</td>
<td>/</td>
</tr>
<tr>
<td>CZ</td>
<td>CHAdeMO</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>DE</td>
<td>CHAdeMO</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>DK</td>
<td>CHAdeMO</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>ES</td>
<td>CHAdeMO</td>
<td>10</td>
<td>40</td>
</tr>
<tr>
<td>FR</td>
<td>CHAdeMO</td>
<td>30</td>
<td>100</td>
</tr>
<tr>
<td>IE</td>
<td>CHAdeMO</td>
<td>28</td>
<td>60</td>
</tr>
<tr>
<td>IT</td>
<td>CHAdeMO</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>NL</td>
<td>CHAdeMO</td>
<td>27</td>
<td>/</td>
</tr>
<tr>
<td>NO</td>
<td>CHAdeMO</td>
<td>6</td>
<td>44</td>
</tr>
<tr>
<td>PT</td>
<td>CHAdeMO</td>
<td>5-10</td>
<td>/</td>
</tr>
<tr>
<td>SE</td>
<td>CHAdeMO</td>
<td>25</td>
<td>/</td>
</tr>
</tbody>
</table>

*Table 2: Overview of DC infrastructure across Europe*

Note: CHAdeMO stands for Combined Charging System (Chargemaster). No DC charging is considered, preference goes to AC 3-phase 43kW.
Dutch EV charging point deployment

Available websites

http://www.oplaadpunten.nl
http://www.oplaadpalen.nl
Remaining questions and challenges

- Creating an adequate, self-learning capacity forecast
- Automatic communication between EV, CSP and DSO
- Multiple CSP’s: how to divide available capacity?
- What if SLA of CSP cannot be met?
- What if SLA of CSP could have been met but the CSP’s algorithm is not smart enough?
- What to do with multiple DSO’s?
- Clearing house?
- Within which margins are charge plans executed?
- Legislation
- Standardization
- Who is in charge?
- ...
Thank you for your attention