EV Charging Explained

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Gasoline, Diesel replaced by electricity in Battery pack. Engine replaced by Motor or Dual Motors.

Battery pack equivalent to gas tank.

Measurement of Battery Capacity is kWh, common 40–50kWh pack.

Vehicle fuel economy or efficiency: MPGe(equivalent), or kWh/100m (mile), mile/kWh. 1 mile/kWh = 33.4MPGe

The size of battery pack decides drive range: e.g., 25kWh/100mile, 4 mile/kWh, 133MPGe. For 40kWh pack, it will travel 160miles. 300 miles requires above 75kWh battery pack.

Charging Time: for a 40kWh battery pack, a charger of 4kW, it takes 10 hours; if a 40kW charger, it needs only 1 hour. Charging a 75kWh pack by a 175kW charger takes 25–30 min.
Battery Charging

- AC Charging (Level 1 or 2)
  - SAE J1772 for AC
  - Type 1 for North America, Type 2 for EU

- DC Charging (Level 3)
  - AC (SAE J1772) + DC Charging:
  - Combo Charging System (CCS1, North Am and CCS2 EU) ; CHAdeMO

CCS1 (SAE J1772 + DC) North America /US
Every EV requires an onboard charger for AC Charging, Typical power of 7.7kW

- AC Charging Standard of North America, J1772 or Type 1
- Europe, IEC Type 2
- China GBT AC
- Tesla Charging
- All the same electrically, difference in shape.

<table>
<thead>
<tr>
<th>N. America</th>
<th>Japan</th>
<th>EU and the rest of markets</th>
<th>China</th>
<th>All Markets except EU</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC</td>
<td>J1772 (Type 1)</td>
<td>J1772 (Type 1)</td>
<td>Mennekes (Type 2)</td>
<td>GB/T</td>
</tr>
<tr>
<td>DC</td>
<td>CCS1</td>
<td>CHAdcMO</td>
<td>CCS2</td>
<td>GB/T</td>
</tr>
</tbody>
</table>
Typical J1772 AC Home Chargers

- Level 1 AC Charger
  - 120V/16A, 1.9kW

- Level 2 AC Charger
  - 240V/16A, 3.8kW
  - 240V/32A, 7.7kW
  - 240V/40A, 9.6kW
  - 240V/50A, 12kW

- Power Utilization Level all depends upon OBC. AC charger is just a switch control device.

- Wall Plug and Outlet:
  - NEMA50, 60(A)
  - AC power supply breaker needs a 10A margin
EV DC Charging

- In US, also called Level 3 Charging
- DC voltage (+) and (−), 350–800 VDC
- DC Current: 50–250 A
- Charging Power, 20–350 kW
- Charging Current and Voltage are controlled by Car BMS (Battery Management System)
- Needs special equipment and three phase power supply. Not for home.
- Charging Time: < 60 min
DC Charging Standards in North America

- CCS1 (Combo Charging System) (Europe CCS2)
- Tesla Super Charging
- CHAdeMO charging system (Japanese Standard)
- Adapters
  - CHAdeMO to Tesla
  - CCS1 to Tesla
Typical CCS1 Charging Site
One to Multiple Dispensers
Dispenser with CCS 1/CHAdeMO Connector
One to Dual Connectors (CCS1 / CHAdeMO)

CCS 1 Connector
CHAdeMO Connector

CCS 1 system getting more and more popular
Three Phase 480VAC 4 Wire power supply. Supports 83kW per 100A.

- Depends on the total aggregate DC power output. Add AC line current together. Size the power breaker accordingly.

- All the AC Power Supply has to meet regular industrial standard: 480V/AC/3PH/60Hz.
CHAdeMO to Tesla Vehicle

CCS1 to Tesla Vehicle. See YouTube video: https://youtu.be/gQA6J2nbXj8