On-Board Vs. Off Board Charging

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Vehicle Charging is Not New, to Eaton…

Introducing Eaton’s First Off Board (DC) Electric Vehicle Charging Station for Fleets...

An excerpt from the 1907 Cutler-Hammer Product Catalog
EVSE: How We Connect to the Grid

**AC Charging:**

- Level 1: 120V, Single Phase, 2KW and below
- Level 2: 208-240V, Single Phase, Up to 20KW
- Level 3: Undefined, Single or Three Phase

**DC Charging:**

- Level 1: 200–450V, 20KW and below
- Level 2: 200-450V, 20 to 80KW
- Level 3: 200-450V, Above 80KW
How an EV Works

- Powered By Electricity
  - No gas tank, powered by batteries that store the power
- Inverter/Charger
  - AC to DC (Off-board)
  - DC to DC (On-board)
- Traction Battery
  - Gradually run down as the EV drives
  - Required DC voltage to charge
- Electric Motor
  - Drives the gearbox and wheels, not an engine
  - Electricity is fed into the coil to generate a magnetic field making the coil rotate very quickly inside the magnets
  - Spinning coil is fastened to the central shaft that drives the wheels
Vehicle, EVSE Type, and EVSE Components

Level 1 AC
On-board

Level 2 AC
On-board

Level 2 DC
Off-board

AC Charging - Powers the car’s onboard battery charger
DC Charging - Direct charge to the car’s battery
On Board Vs. Off Board Basics

- **Off Board**
  - Generally higher KW transfer
  - Include more sophisticated BMS systems
  - Managing battery heating
  - Communications to building/home/grid energy management systems
  - TOU’s
  - Demand charges
  - Removes weight from vehicle
  - The higher the energy transfer rate, the higher the required EVSE / vehicle conductivity

- **On-Board**
  - Generally lower KW transfer
  - Less concern about battery heating
  - Operated by pilot signal J1172
  - BMS is managed by on board rectifier
  - Adds weight to vehicle

<table>
<thead>
<tr>
<th>Power Level</th>
<th>Description</th>
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<tbody>
<tr>
<td>3.3KW</td>
<td>3.3KW On-Board Charging</td>
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<tr>
<td>6.6KW</td>
<td>6.6KW L2 AC Charging</td>
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<tr>
<td>16KW</td>
<td>16KW Max. L2 AC Charging</td>
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<tr>
<td>20KW</td>
<td>20KW Low End DC QC</td>
</tr>
<tr>
<td>50KW</td>
<td>50KW DC QC</td>
</tr>
<tr>
<td>80KW</td>
<td>80KW Performance vehicles</td>
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</table>

Above 50KW – DC Truck Charging
Estimated Charge Times

Charge Time is a Function on:

1. Battery Capacity
2. Charge Standard: J1772 vs. CHAdeMO/SAE
   - J1772: Charge session at 100%
   - CHAdeMO/SAE: Charge Session: Defined by standard
   - Charge curve helps manage heat dissipation
3. Starting Energy Level of Battery

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Mitsubishi</th>
<th>Nissan</th>
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<tbody>
<tr>
<td>vehicle</td>
<td>MiEV</td>
<td>Leaf</td>
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<tr>
<td>battery capacity</td>
<td>16kWh</td>
<td>24kWh</td>
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</table>

<table>
<thead>
<tr>
<th>Charger Size (KW)</th>
<th>DC Time (m)</th>
<th>AC Time (hrs)</th>
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</thead>
<tbody>
<tr>
<td>50</td>
<td>23</td>
<td>35</td>
</tr>
<tr>
<td>40</td>
<td>26</td>
<td>39</td>
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<td>20</td>
<td>36</td>
<td>54</td>
</tr>
<tr>
<td>15</td>
<td>46</td>
<td>1.2</td>
</tr>
<tr>
<td>10</td>
<td>1.1 hrs</td>
<td>1.7 hrs</td>
</tr>
<tr>
<td>6.6</td>
<td>1.7 hrs</td>
<td>2.5 hrs</td>
</tr>
<tr>
<td>3.3</td>
<td>3.4 hrs</td>
<td>5.1 hrs</td>
</tr>
<tr>
<td>1.5</td>
<td>7.5 hrs</td>
<td>11.2 hrs</td>
</tr>
</tbody>
</table>

All times are estimates.
Connecting to the Grid

**Level 1**
- 16amp Receptacle
- 12 - 18 Hours

**Level 1 & 2**
- AC
- 16 & 30amp
- 4 - 12 Hours

**Level 2 AC**
- 30-75amp
- 4 - 8 Hours

**DC Charging**
- 20-50KW
- Field Upgradable
- 20 - 60 Minutes

Eaton **Pow-R-Station™** EVSE Family
Eaton in Grid Connected Transportation

- Eaton Truck Hybrid Activities
  - Class 8 Hybrid – Idle Reduction Platform
  - Vocational Hybrid Program – FedEx, UPS, Coke

- Truck Stop Electrification
  - National Deployment Program
  - IdleAire, 133 sites, 33 states, >7,500 spaces

- Port Electrification
  - Up to 10MW / 11.6 kV power supply systems

- Marina & RV Electrification
  - Provides utilities to 250,000+ boat slips, RV sites, & parking spots per year
  - Supports vehicles from single-phase 20A to three-phase 600A / 480V