



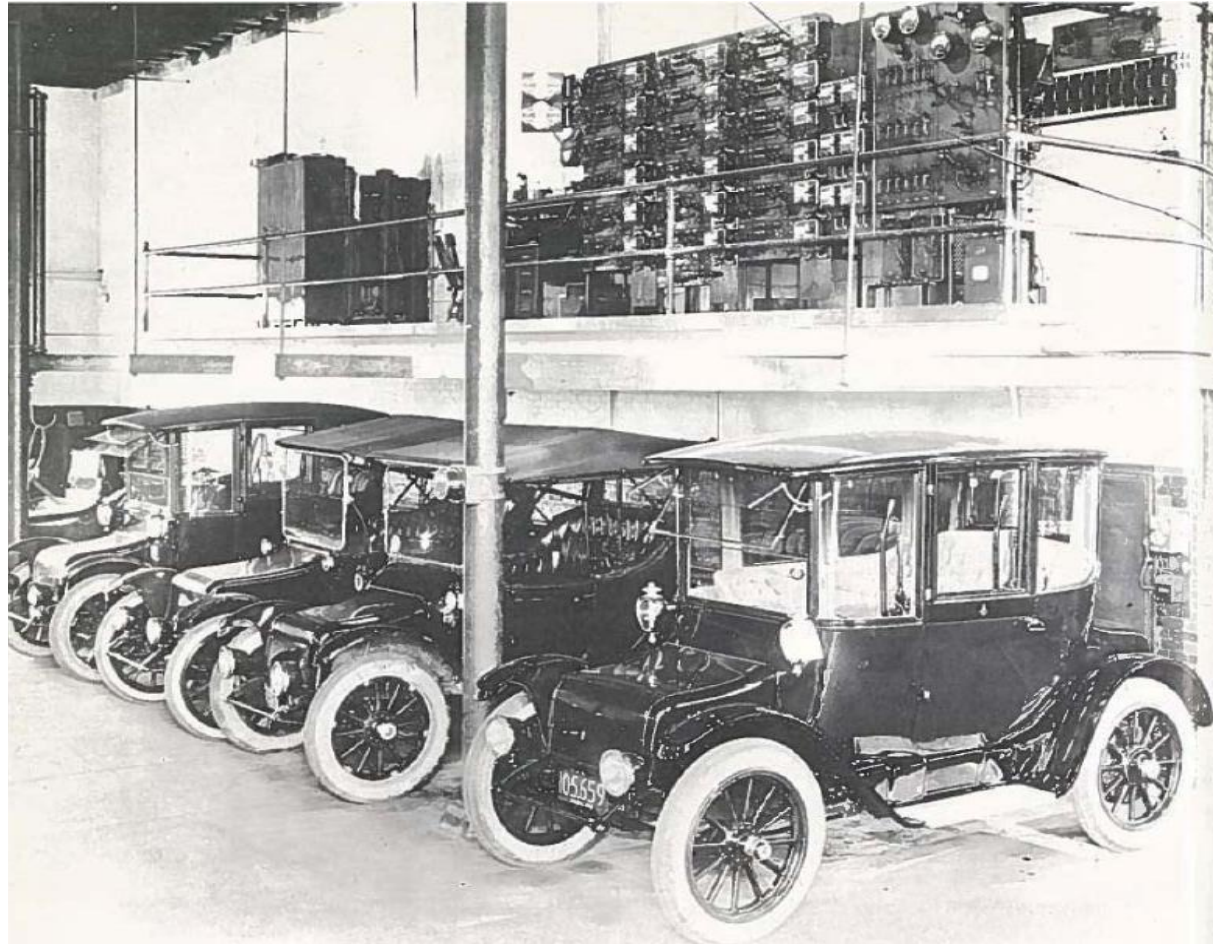
On-Board Vs. Off Board Charging

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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



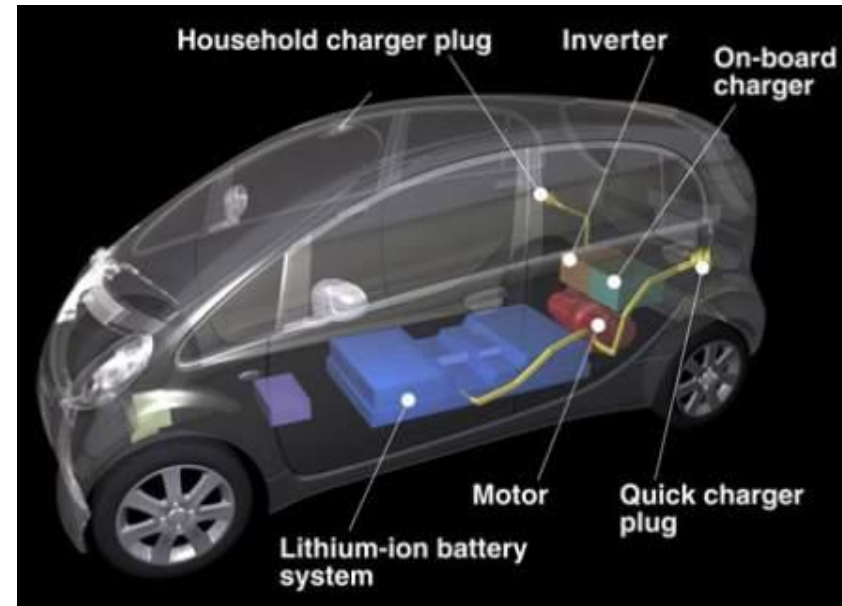
DC Charging:

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

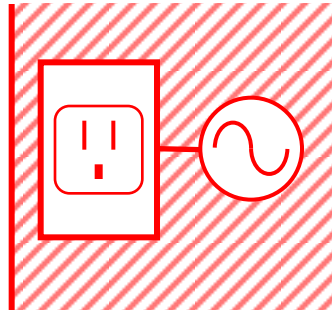
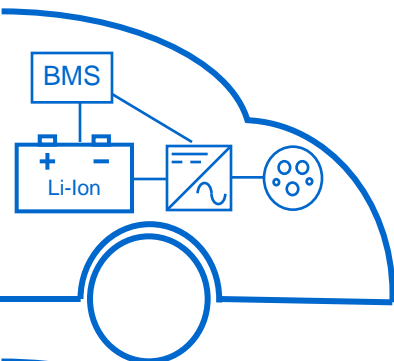
How an EV Works

- 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

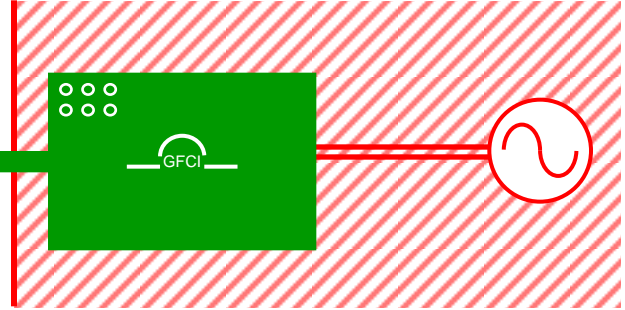
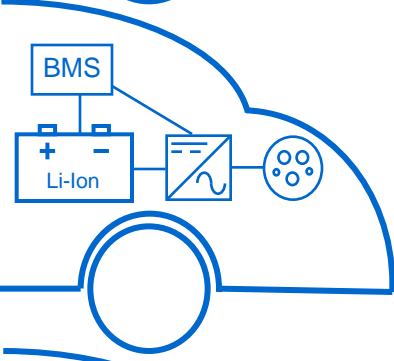
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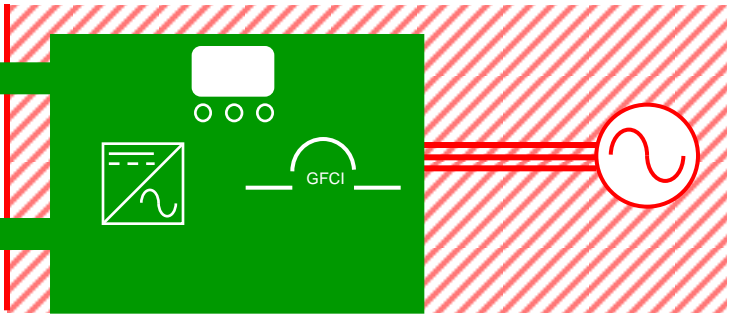
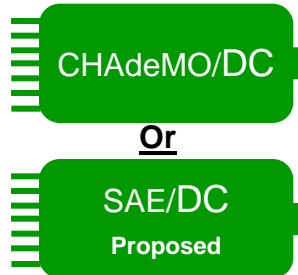
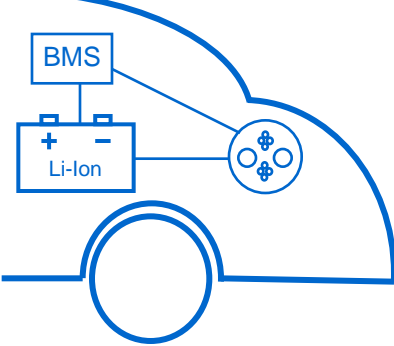
Vehicle, EVSE Type, and EVSE Components



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

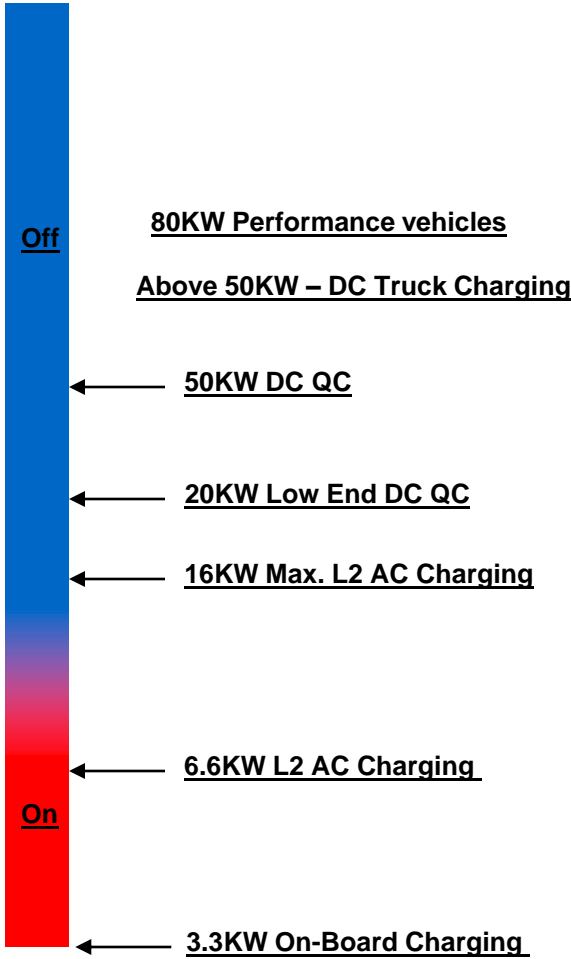
On Board Vs. Off Board Basics



- **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



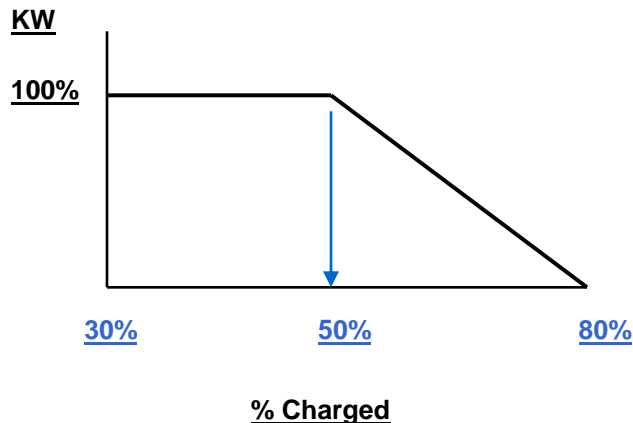
- **On-Board**
 - Generally lower KW transfer
 - Less concern about battery heating
 - Operated by pilot signal J1172
 - BMS is managed by on board rectifier
 - Adds weight to vehicle



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



Based on DC Charge Estimates

↑

↓

Based on AC Charge Estimates

Manufacturer	Mitsubishi	Nissan
vehicle	I MiEV	Leaf
battery capacity	16kWh	24kWh

Charger Size	Time	Time
50KW	23m	35m
40KW	26m	39m
30KW	27m	40m
25KW	30m	45m
20KW	36m	54m
15KW	46m	1.2 hrs
10KW	1.1 hrs	1.7 hrs
6.6KW	1.7hrs	2.5hrs
3.3KW	3.4hrs	5.1hrs
1.5KW	7.5hrs	11.2hrs

All times are estimates

3. Starting Energy Level of Battery

Connecting to the Grid

Level 1
16amp
Receptacle



12 - 18
Hours

This image shows a Level 1 EVSE with a blue top section and a grey body. It features a standard 16-amp NEMA 5-15P receptacle for charging. The unit is shown against a dark background.

Level 1 & 2
AC
16 & 30amp



4 - 12
Hours

This image shows a Level 1 and 2 AC EVSE with a blue top section and a grey body. It has a 16-amp receptacle and a 30-amp outlet. A black charging cable with a white connector is shown plugged into the 16-amp outlet. The unit is shown against a dark background.

Level 2 AC
30-75amp



4 - 8 Hours

This image shows a Level 2 AC EVSE with a blue top section and a grey body. It has a 30-amp outlet and a 75-amp outlet. A black charging cable with a white connector is shown plugged into the 30-amp outlet. The unit is shown against a dark background.

DC Charging
20-50KW
Field
Upgradable



20 - 60
Minutes

This image shows a DC charging station with a blue top section and a grey body. It has a digital display and a charging cable. The unit is shown against a dark background.

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



EATON

Powering Business Worldwide