EV 101

We develop EV charging solutions to reduce range anxiety.

PLUG ZEN

Putting the EV in Everybody

Objectives

After this training session, and individual should be able to:

- Describe the differences between ICE Vehicles & EV's
- Understand the relative costs of charging units
- Understand EV ranges and relative cost per mile
- Explain the different types of charging
- Recognize various charging manufacturers
- Determine the ideal placement of charging stations
- Understand their role in Mobility

Internal Combustion Engine

An automobile that burns fossil fuels (unleaded gasoline/ethanol, diesel, propane, natural gas). Below are the primary benefits and drawbacks of internal combustion engine vehicles.

Pros

- More infrastructure (over 100 years)
- Refuels faster
- Lower purchasing price

Cons

- CO_2 emissions (20 lbs per gallon of gas)
- Higher fueling and repair costs (>$3,000 annually)
- Shorter life cycle

Electric Vehicle

An automobile that is either partially (Plug-in hybrid-PHEV) or completely (Battery-BEV) operated by a battery that has to be plugged in to a charging station to recharge. Below are the primary benefits and drawbacks electric vehicles.

Pros

- No CO_2 emissions*
  C02 is emitted in the energy that it uses
- Lower fueling & repair costs (>$3,000 annually)
- Longer vehicle life cycle

Cons

- Higher 1st Cost price (battery costs)
- Slower refueling
- Lack of infrastructure

Relative Cost per mile

The EPA estimates that the average person drives approximately 40 miles per day, using an equation of 40 miles x 365 days (14,600 miles). Here are the relative costs per mile for ICE and Electric vehicles

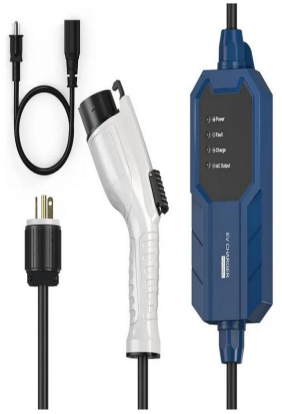
ICE: Average mileage 20 mpg. Dividing 14,600 by 20 miles per gallon gives you 730 gallons of fuel, multiply that by the average gas price of $4.30 (will vary daily) gives you an annual fuel cost of $3,139

EV: A 100 kWH battery drives 330 miles per charge, dividing 330 miles by 100 kwH gives you 3.3 miles per kwH, dividing 14,600 miles by 3.3 miles gives you 4,425 kwH, multiply the total number of kwH by the average kwH in the U.S. ($.14) equals $619, which would be the total annual costs if you recharged your vehicle at home. Public charging Is subject to higher re-charging costs,

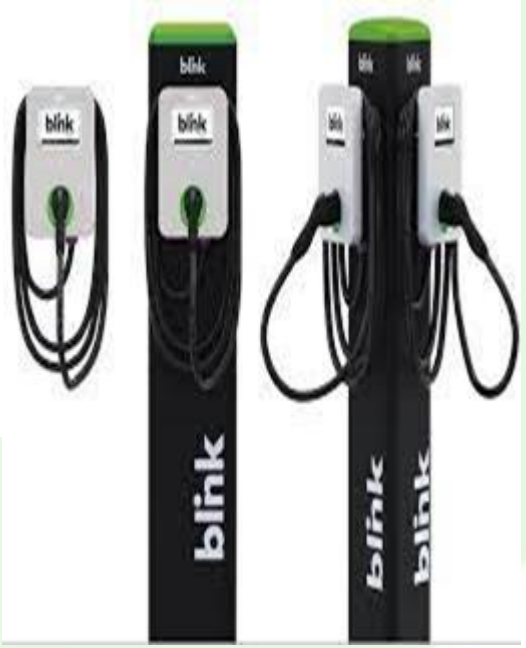
Types of EV Charging

Here are the different types of EV Chargers used to recharge the batteries in electric vehicles.

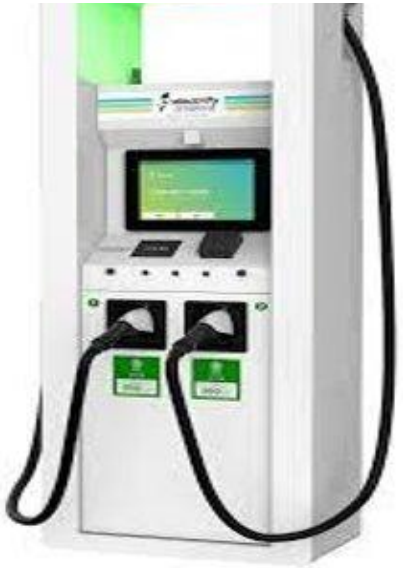
Level 1



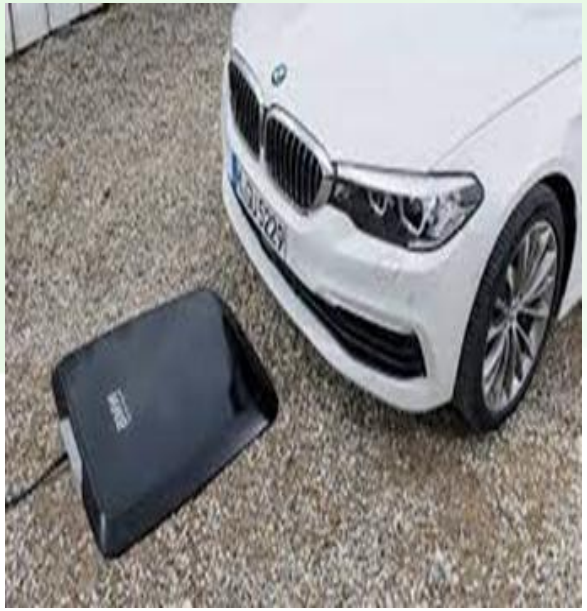
Level 2



DC Fast Charging

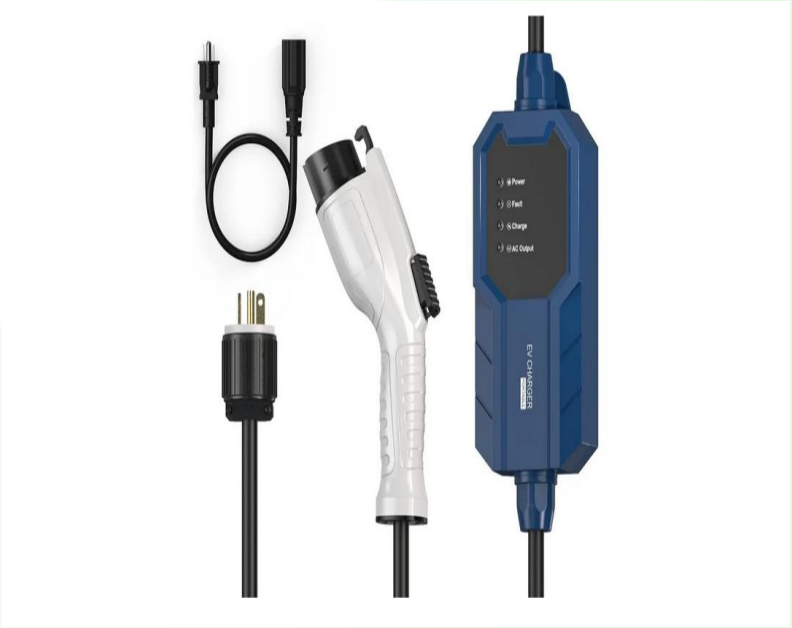


Wireless



Level 1

Here are the positive and negative characteristics of a level 1 Charger, which has the slowest rate of charge



Characteristics

- 120 Volts
- Residential
- Commercial
- Uses standard household plu
- Charging time (upto 16 hours)

*** Depending on how drained the battery is**

Pros

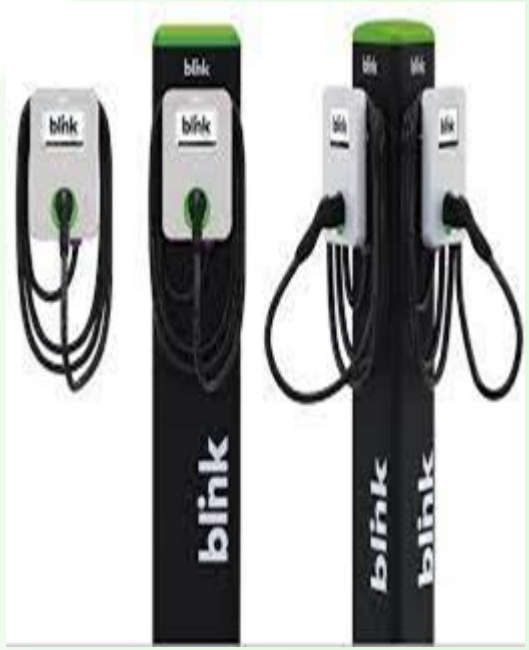
- Lower installation costs
- Lower demand on grid
- Higher flexibility

Cons

- Slowest charging rate

Level 2

Here are the characteristics, benefits, and drawbacks of a level 2 Charger, which charges 2x as fast as a level one charger.



Characteristics

- 240 Volts
- Uses SAE J1772 Plug
- Residential
- Commercial
- Charging time (upto 10 hours)

*** Depending on how drained the battery is**

Pros

- Lower installation costs
- Lower demand on grid
- Higher flexibility

Cons

- Charges slower

DC Fast Charging (Level 3)

Here are the character, benefits and drawbacks of a DC Fast Charger, which charges more than 2x as fast as a level 2 charger .

Characteristics

- 480 Volts

  ***amperage varies, higher amperage equals higher KwH from 50kwH to 330 kwH**

- Uses SAE J1772 CCS (combo) plug)
- Commercial
- Charging time (upto 4 hours)

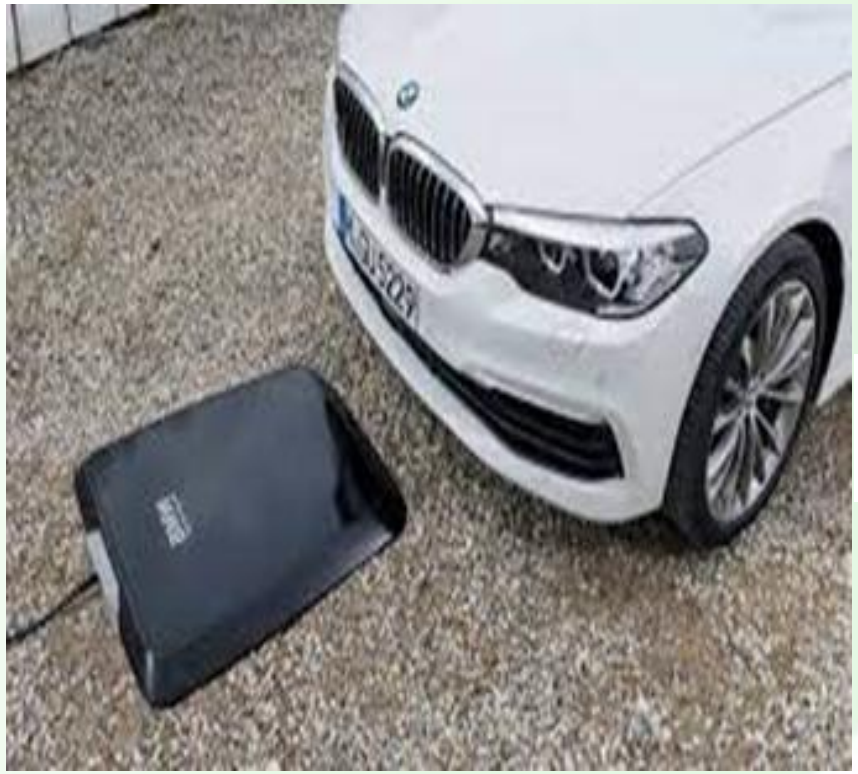
*** Depending on how drained the battery is, ands the amperage of the DC Fast Charger**

Pros
- Charges vehicle faster

Cons
- Costs more to install
- Higher power demand
- Deteriorates battery fast

Wireless

Here are the positive and negative characteristics of a wireless Charger which charges as fast as level 2.



Characteristics

- 240 Volts
- Uses wireless pad
- Residential
- Commercial

Pros

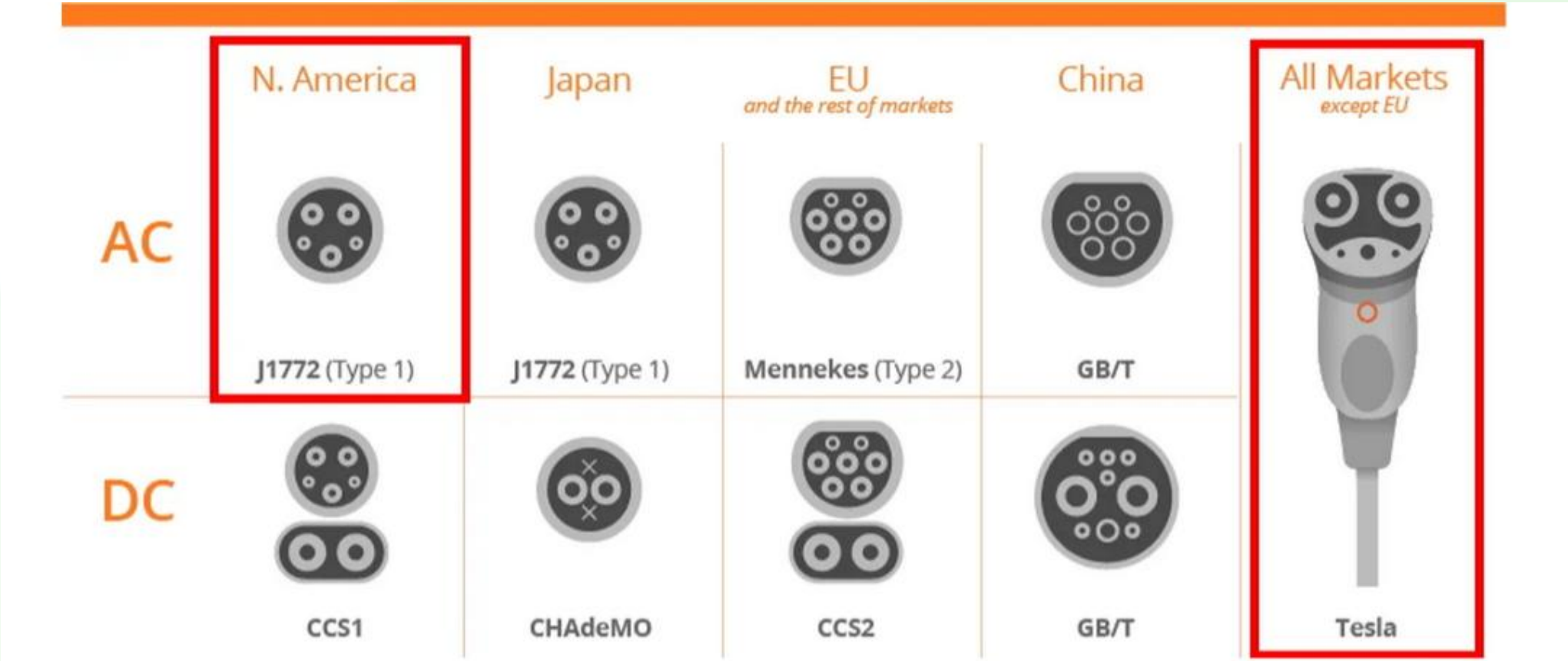
- Contactless charging

Cons

- Power loss
  * **There is a 2 foot gap in the charging and receiving plate that causes power loss**
- Still in development
  (12 to 24 months away)

Connectors

Here are the different types charge connectors and the regions where they are used.



***Tesla vehicles can recharge on Type 1 with an adaptor**

****Nissan and Mitsubishi use optional CHadeMo in the U.S., but can use Type 1**

Placement Factors

These are the top two factors in deciding where to place and EV Charger.

Location:

- Type of Facility
  - Residential, Retail, etc.
- Purpose of charging
  - Business attraction or other
  - Revenue generating or other
- How long will the vehicle be parked
  - Minutes, hours, overnight

Vehicle Usage

- Type of vehicle
- Daily driving distance

Industry Trends

- **Hybrid Vehicles**
  (ICE/EV)
- **Alternative Fuel**
  Hydrogen/ Fuel Cell generates electricity
- **Bi-directional Charging**
  (V2G) Sends power back into the grid
- **Battery Development**

Improvements in materials and chemistry improve capacity which lowers costs

Common Terms

- **EVSE**- Electric vehicle supply equipment
- **BMS**- Battery management system-built into vehicle
- **SAE J1772**- common connector for EV charging stations
- **CCS**- J1772 connector with 2 additional pins for DC Fast charging
- **DCFC**- DC fast charging- Charges a battery at 480 VDC
- **Level 2**- Charges a battery at 240 VAC
- Level 1-Charges Battery at 120 VAC
- **Wireless charging**- inductive charging though air (similar to wireless phone charging)
- **Bi-directional charging**- the ability of the vehicle to charge and send power back to the grid (vehicle to grid)
- **ICE**- Internal Combustion Engine
- **BEV**- Battery Electric vehicle
- **PHEV**- Plug in Hybrid Electric Vehicle- runs on electric until battery is drained
- **EREV**- Extended Range Electric Vehicle- runs on ev motors part time and recharges the battery in ICE mold
- **Autonomous Vehicle**- a vehicle that doesn't require a human to manually steer it
- **Lithium Ion**- the most common EV battery material (also used in most small electronic batteries)
- **Hydrogen fuel cell**- Uses hydrogen to generate electricity
- **kwH**- Kilowatts per hour- battery capacity or battery recharging rate (Amps x VAC= kwH)
- **Thermal runaway**- overheating of a lithium battery that results in fire or explosion

FAQs

How far will an EV go on a single charge? Depends on the size of the battery, and weight of the vehicle, automakers and the EPA publish estimated vehicle ranges for all EVs

How long does it take to recharge a vehicle? Depends on the level of charge and how drained the battery is. Typically level 2 charging of a completely drained battery can take upto 8 hours, while charging on a DCFC can take upto an hour

How can I avoid running out of power and being stranded? develop a habit of always "topping" off your battery while doing other activities (work, home, shopping,, sporting events, etc.). For daily driving the best practice would be to keep your battery charged at 50%

Why do EV's cost more? The battery packs in EV's are made of costly materials

How safe are EVS? Advancement over the years have made EVs safer than earlier versions. However, there are always risks with both ICE vehicles and EV's, but EV's are not less safer than ICE vehicles

How is an EV better than a ICE vehicle? No harmful CO2 emissions (better for environment), lower re-fueling and maintenance costs, longer life cycle, higher resale value

EVSE Roles

The industry term for EV charging stations is EVSE which stands for Electric Vehicle Supply Equipment. There are 4 types of EV Charging companies

- Hardware manufacturer
  - Develop & mass produce ev charging stations
- Software/network provider
  - Designs software
  - Maintains networks
- Installer
- Facilitator
  - Consults and develops turn-key installation strategies
  - Distributes & sales EV charging stations
  - Coordinates and manages installation

Reference Links

https://driveelectric.gov/

https://afdc.energy.gov/

https://www.energy.gov/eere/vehicles/batteries-charging-and-electric-vehicles

https://doee.dc.gov/service/electric-vehicles-resources

https://www.epa.gov/greenvehicles/explaining-electric-plug-hybrid-electric-vehicles