Charging at Home and Away

Fueling an Electric Vehicle

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What’s Unique about Fueling an Electric Vehicle?
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You can fuel up at home!
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You can fuel up at home!

And, how fast you charge matters.
A Quick Word on Power and Energy…

POWER

- Typical units of measure
  - Watt (1W = 1 Joule per second)
  - Kilo-watt (1kW = 1000W)
  - Horsepower (1HP = 746W)

ENERGY

- Typical units of measure
  - Kilo-watt-hour (kWh)
  - Mega-Joule (1 million Joules) (1 kWh = 3.6 MJ)
  - British Thermal Unit (BTU) (1kWh = 3412 BTUs)

Energy Examples

- A 2000 kilo-calorie diet is about 2.32kWh
- A Nissan Leaf uses about 0.3kWh per mile traveled

(1) https://www.eia.gov/energyexplained/use-of-energy/transportation.php

People and goods movement accounted for 28% of US Energy Consumption in 2018 (1)
EVs – Power (kW) and Energy (kWh)

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How Hard is it to Charge?

- Vehicle charging is designed to be intrinsically safe
  - Industry standards have been written to ensure that charging can be done safely
- Can I damage the battery if I’m careless?
  - You can’t overcharge your car (the vehicle’s battery management system won’t let you)
- What about over-discharging the battery? Can I run it too low?
  - Nope – vehicle designers have considered this as well (the battery management system!)
  - Vehicles have range indicators and warnings when you “push it too far”
- Will how I charge (like using DC fast chargers frequently) shorten the life of the battery?
  - No, not with the latest generation of EVs – auto makers design cars to meet warranty requirements independent of charging behavior[1]
  - This is based on proper design of the battery management system and the battery thermal management

[1] Bedtime reading if you want to know more: https://iopscience.iop.org/article/10.1149/2.0981913jes
How Long Will it Take to Charge My Vehicle?
Power X Time = ENERGY = Driving Range

AREA = ENERGY = kWh = RANGE ADDED

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What Power Level Should I Use?

Away and in a hurry

Home

Away and you have time
For the Techies in the Audience

- **DC “FAST” CHARGING**
  - Up to 350+ kW

- **AC Level 2 CHARGING**
  - Up to 19.2 kW

- **Wireless CHARGING**

- **AC Level 1 CHARGING**
  - Up to 2 kW
Back to the Question - How Long will it Take to Charge?

I would ask - How Far Have you Driven?

- You only need to “fill” the portion of the battery that you’ve used since your last charge session
- A typical EV can go ~ 3.3 miles on a kWh (or 0.3 kWh/mile)
- Say you’ve driven 20 miles since your last charge
  - You’ve used about 20 x 0.3 = 6 kWh
  - A typical 7kW AC level 2 charger could top that off in about 1 hour
- Say you’ve driven 100 miles since your last charge
  - You’ve used about 100 x 0.3 = 30 kWh
  - A typical 7kW AC level 2 charger could top that off in about 4.5 hours
  - A 50kW DC fast charger could top that off in about 30 minutes
Methods of Charging

AC  WIRELESS  DC
HOME  AWAY
Some AC Electric Vehicle Supply Equipment Examples

Level 1 AC - Cord Set
120V charging

Level 2 AC
208/240V charging
Home About an AC Charger at My Home?

- Do I Need to Upgrade My Electric Service?
  - Maybe
  - Distance from service to parking
  - Spare capacity
  - Trenching and concrete

**Table 6: Average Residential EVSE Install Costs**

<table>
<thead>
<tr>
<th></th>
<th>Premises Wiring Cost</th>
<th>Direct Installation Cost</th>
<th>Total Installation Cost</th>
<th>EVSE Cost</th>
<th>Total Costs Installation + EVSE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Networked (110)</strong></td>
<td>$946</td>
<td>$438</td>
<td>$1,384</td>
<td>$1,061</td>
<td>$2,445</td>
</tr>
<tr>
<td><strong>Non-networked (113)</strong></td>
<td>$1,016</td>
<td>$237</td>
<td>$1,251</td>
<td>$515</td>
<td>$1,766</td>
</tr>
</tbody>
</table>

Wireless Charging – a Future Home Charging Option

Notes: Limited availability but likely to change in 2021; public wireless charging may be a few years out
There are Three DC Fast Charge Connectors

- SAE Combo
- CHAdeMO
- Tesla

DC Level 2
DC Fast Chargers
In Summary

▪ There are a lot of options for charging an electric vehicle
  – Location and power level
▪ Charging at lower power levels will cost less overall (equipment and electricity)
  – The longer you have to charge, the lower power needed
▪ Roughly three power ranges – slow, medium, fast
▪ There are three types of charging – AC, DC, wireless
▪ There are three types of DC charging interfaces
Together...Shaping the Future of Electricity