

# Charging at Home and Away

## *Fueling an Electric Vehicle*

**John Halliwell**

Senior Technical Executive

**Lincoln Electric System**

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# What's Unique about Fueling an Electric Vehicle?



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You can fuel up at home!

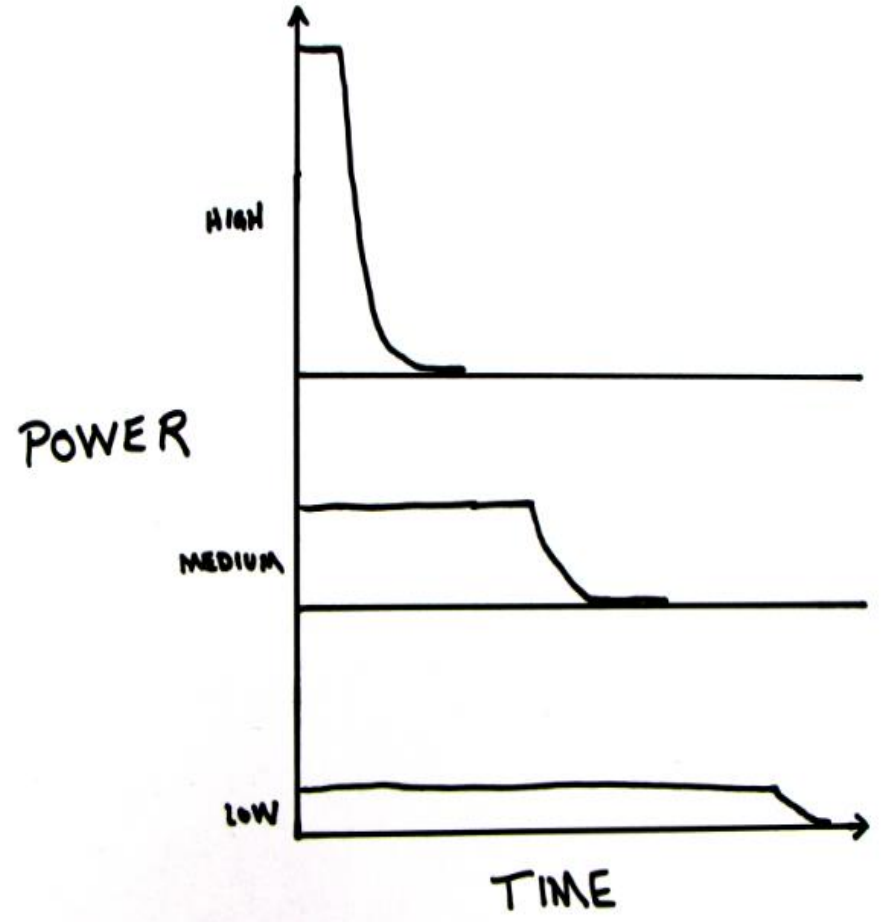


# What's Unique about Fueling an Electric Vehicle?

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 ( $1\text{W} = 1 \text{ Joule per second}$ )
  - Kilo-watt ( $1\text{kW} = 1000\text{W}$ )
  - Horsepower ( $1\text{HP} = 746\text{W}$ )

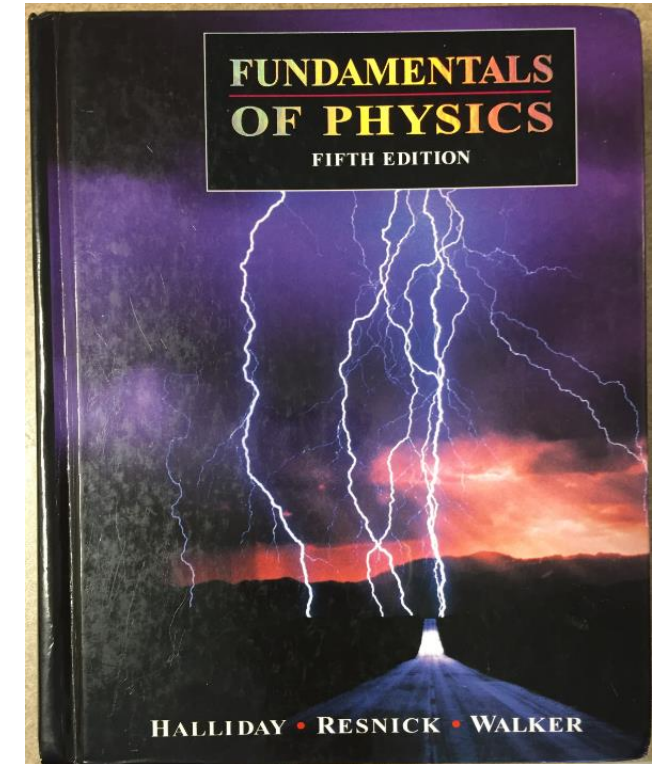
## ENERGY

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

## 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 <sup>(1)</sup>**

# EVs – Power (kW) and Energy (kWh)

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  - Kilo-watt (1kW = 1000W)
  - Horsepower (1HP = 746W)

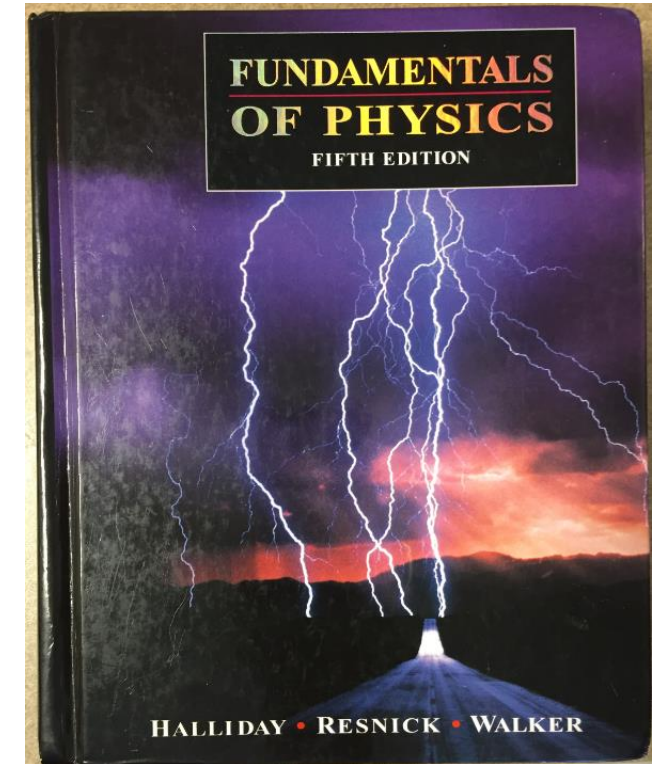
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# How Hard is it to Charge?



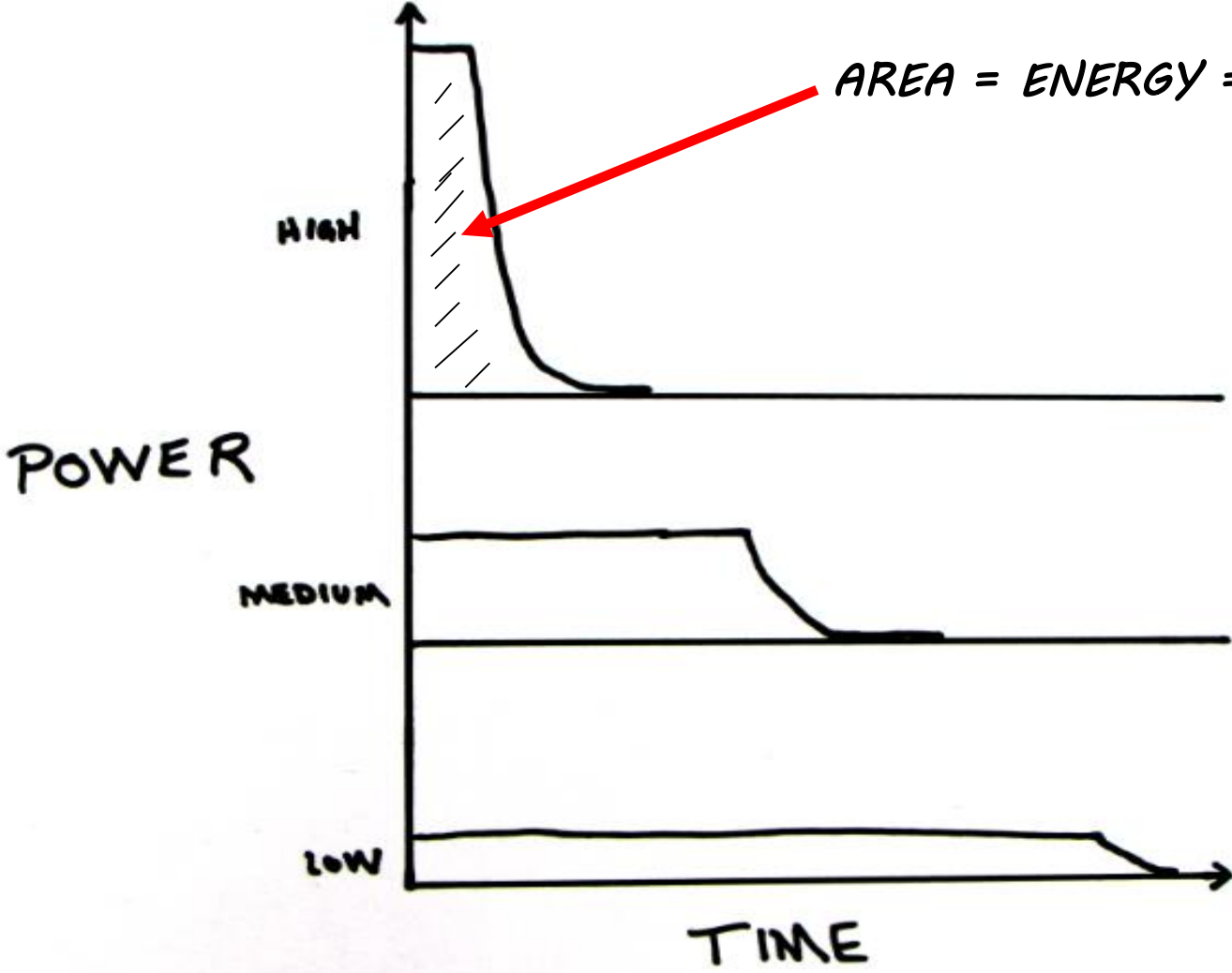
- Vehicle charging is designed to be intrinsically safe
  - Industry standards have been written to ensure that charging can be done safely
- Can I damage the battery if I'm careless?
  - You can't overcharge your car (the vehicle's battery management system won't let you)
- What about over-discharging 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<sup>[1]</sup>
  - 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?

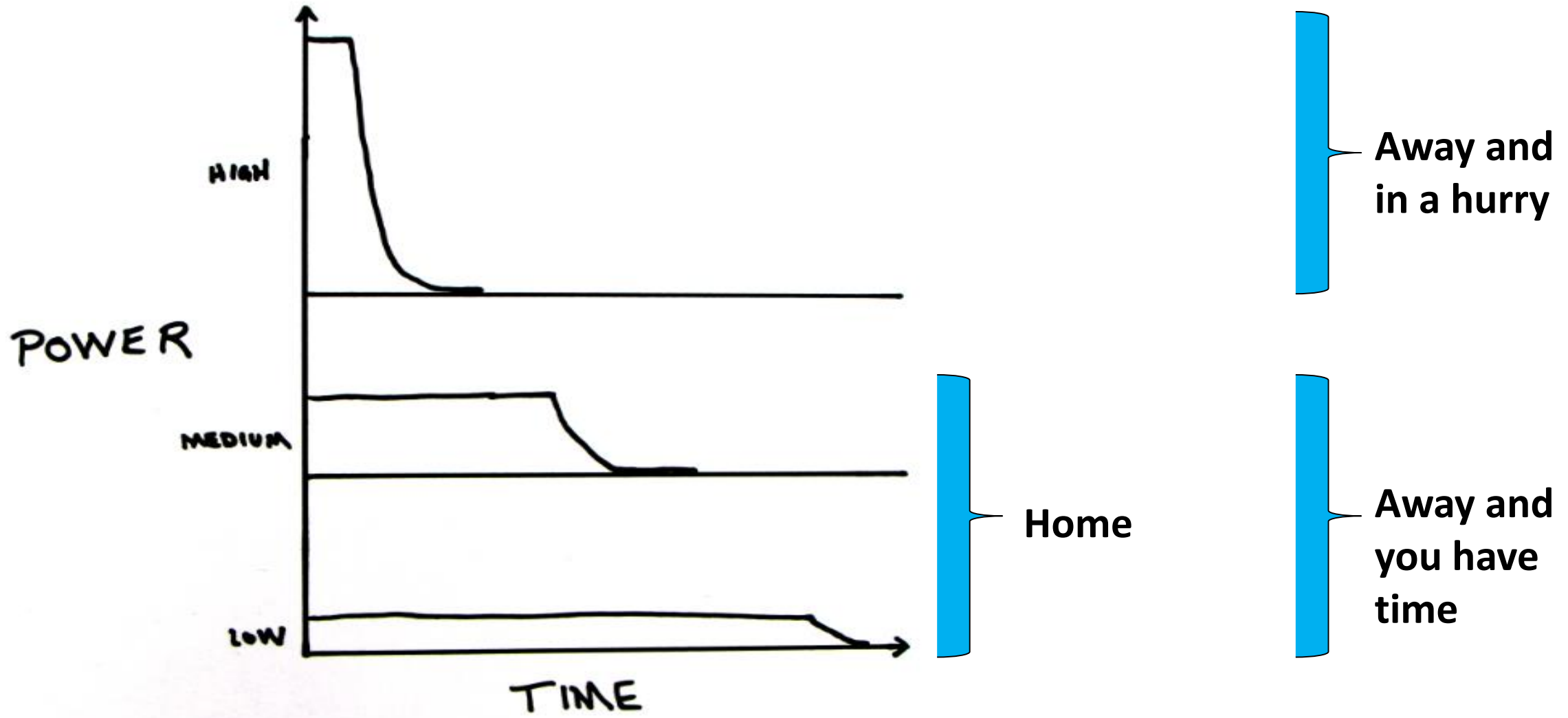


# Power X Time = ENERGY = Driving Range

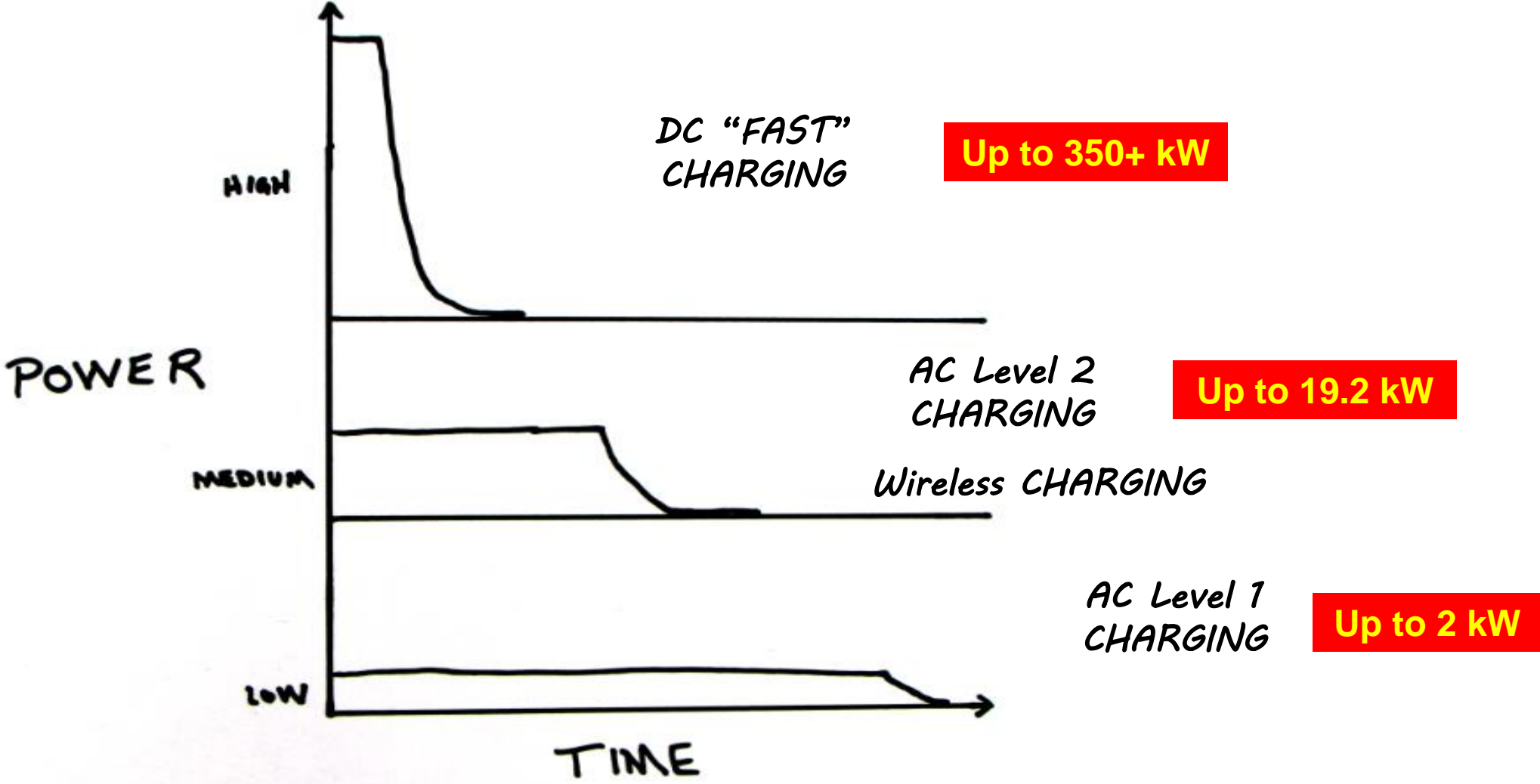


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# What Power Level Should I Use?



# For the Techies in the Audience



# 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  $\sim 3.3$  miles on a kWh (or 0.3 kWh/mile)
- Say you’ve driven 20 miles since your last charge
  - You’ve used about  $20 \times 0.3 = 6$  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  $100 \times 0.3 = 30$  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**

HOME

**WIRELESS**

**DC**

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

	Premises Wiring Cost	Direct Installation Cost	Total Installation Cost	EVSE Cost	Total Costs Installation + EVSE
<b>Networked (110)</b>	\$946	\$438	\$1,384	\$1,061	\$2,445
<b>Non-networked (113)</b>	\$1,016	\$237	\$1,251	\$515	\$1,766

Avista Corp - Report – “Electric Vehicle Supply Equipment Pilot Final Report”, October 18, 2019

# 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**



**DC Level 2**



**CHAdeMO**



**Tesla**



# 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