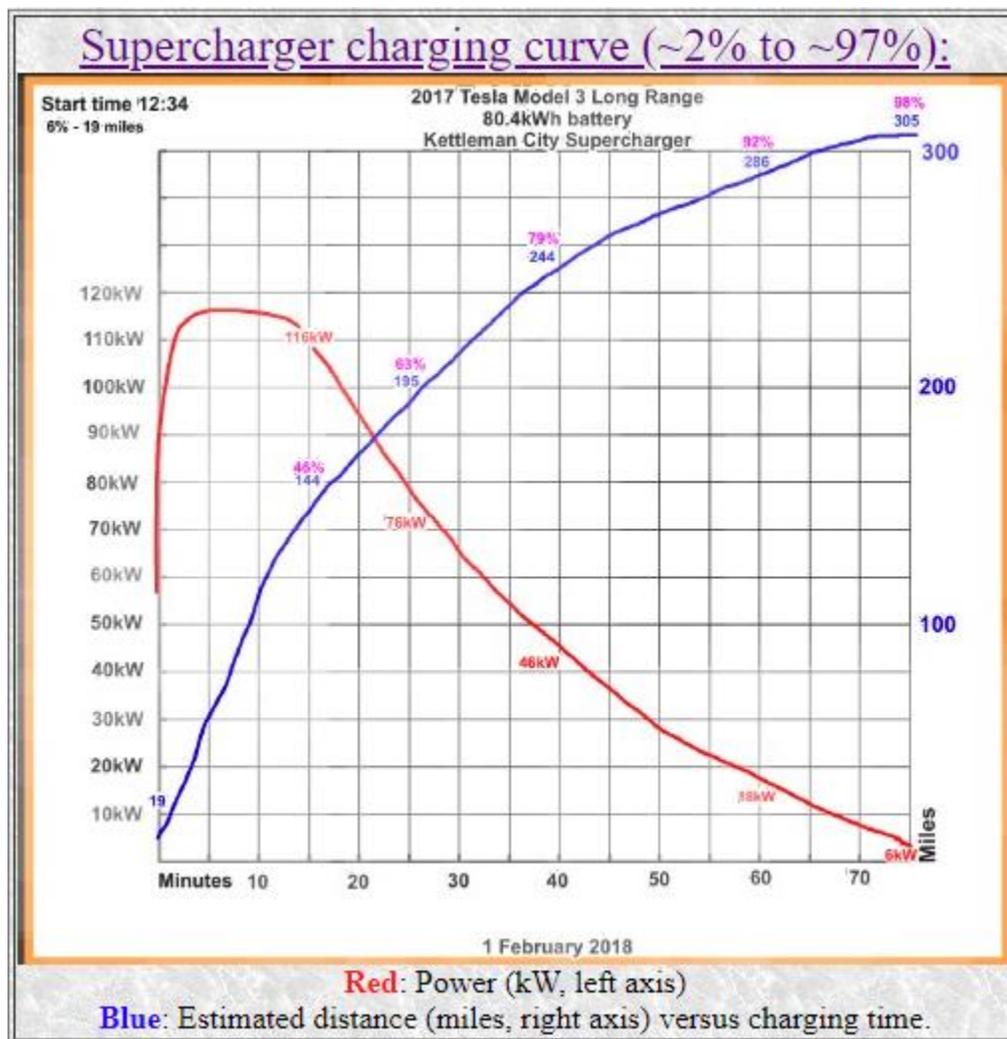


Charging Battery-Electric Vehicles (BEVs)

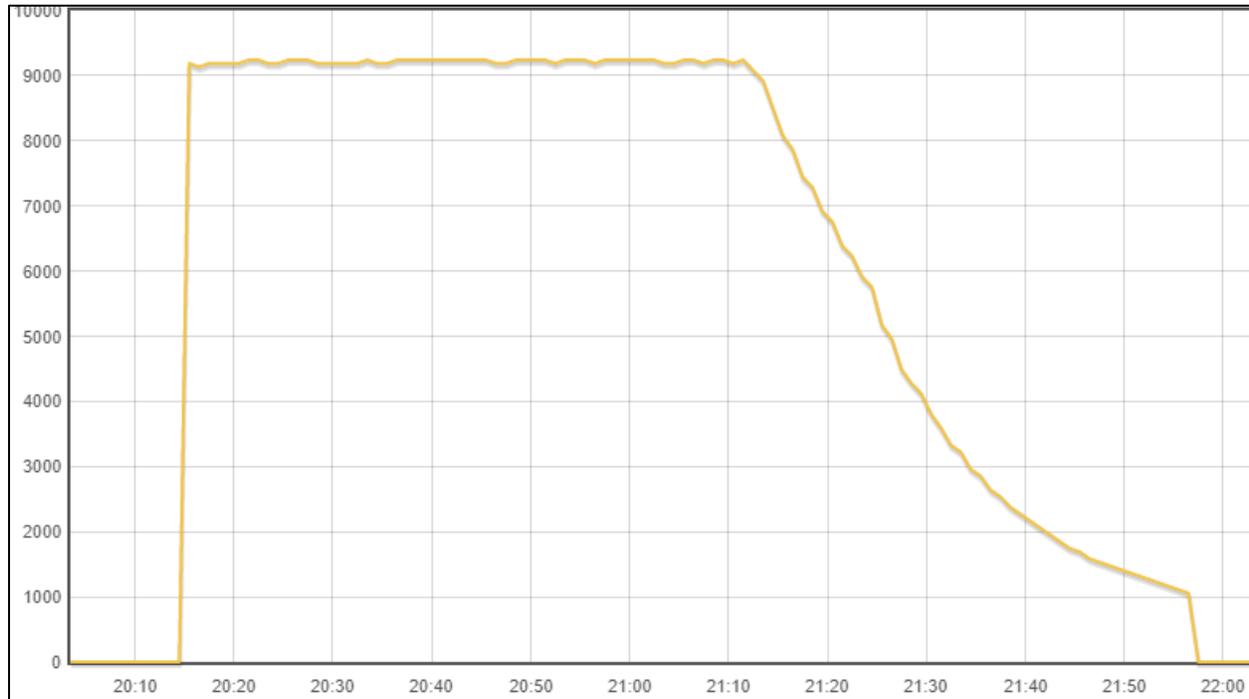
A driver of a battery-electric vehicle (BEV) needs to know how to compare the speed of charging for different ways to charge the BEV battery. The best way to compare the speed of different ways to charge a BEV is to give the charging power in [kilowatts](#) (kW). A BEV battery contains kilowatt-hours (kWh) of energy. Speed of charging is kWh/hour = kW. If a BEV has a 100-kWh battery and is charged at a **constant rate** of 10-kW, it would take 10 hours to charge it from empty to full.

However, a BEV battery cannot be charged at a constant rate from empty to full. A typical charging situation is:



Note that the **power curve** is high only for a short time and then declines. This is to keep the battery from overheating. The blue curve, given in range miles, is proportional to the battery kWh. Lower power BEV charging types will have a longer fraction of the time near its rated power.

Here is an example of a short charging session to 100% using the 9.6-kW charging station in the Roper garage:



Note the nearly constant power of ~9.2-kW for about 55% of the charging time and then the tailing off.

All BEVs and PHEVs come with a portable charging station, called an EVSE (Electric Vehicle Supply Equipment). Most are Level-1, but some are Level-1 and Level-2. There are adapters for Level-2 EVSEs that allow charging at RV parks, water-heater, dryer and welder 240-volts outlets. For Teslas see <https://forums.tesla.com/forum/forums/charging-rv-park>. Teslas come with an RV-park NEMA-14-50 adapter.

Here is a list of the types of charging for BEV batteries:

- Level-1 AC: 115-volts x 12-amps = 1.38-kW
- Level-2 AC:
 - 220-volts x 30 amps = 6.6-kW
 - 240-volts x 30 amps = 7.2-kW
 - 240-volts x 40 amps = 9.6-kW
- [Tesla Destination Charger](#) AC: 8-kW to 16-kW (~3000 in USA at hotels, parks, restaurants, etc.)
- [CHAdeMO](#) DC: 10-kW to 65-kW currently (Asian BEVs)
- [CCS](#) DC: 50-kW to 80-kW currently (US & European BEVs)
- [Tesla Supercharger](#) DC: 120-kW to 145-kW currently (~400 in USA with 6 to 40 stations at shopping centers, hotels, etc.)
- [Tesla Urban Supercharger](#) DC: 72-kW being built
- [Tesla will install one or two Destination Chargers and one or two Level-2 charging stations](#) at most hotels, parks, restaurants that apply.
- [Electrify America](#) is installing CHAdeMO and CSS charging stations across the U.S. Example: [Brugh's Mill Country Store, Fincastle VA](#)
- Many companies are [planning for up to 350-kW charging stations](#).

Only Teslas can use the Tesla Superchargers and Destination Chargers.

All BEVs can use Level-1 and Level-2 charging stations; Teslas come with an [adapter](#) that allows this.

Tesla Model-S and Model-X BEVs, using an [expensive adapter](#), can use CHAdeMO charging stations but not CSS charging stations.

L. David Roper, roperld@vt.edu, <http://www.roperld.com/personal/roperldavid.htm>