

Charging BEVs Facts

L. David Roper, ROPERLD@VT.EDU, 25 April 2024

BEV = [Battery Electric Vehicle](#) (Not a PHEV = [Plug In Hybrid Electric Vehicle](#))

kW = kilowatt ([electric power](#)), kWh = [kilowatt-hour](#) (electric energy), V = volt (electric power / [electric current](#) [AC / DC])

[BEV battery types](#): [NMC](#) (1865, 2170, 4680), [LFP](#)

BEV Battery Types

Some lower-cost (lower-range) Tesla and Ford BEVs have LFP batteries; whereas, the higher-cost (longer-range) BEVs have NMC batteries. The LFP batteries should be charged to 100% SOC; whereas, NMC batteries usually should be charged no higher than 80%, except up to 100% during nights before long trips.

Fueling Differences Between BEVs and ICEVs

Fueling a BEV is a completely different situation than fueling an ICEV ([Internal Combustion Engine Vehicle](#)). An ICEV driver has to find a dirty, smelly gasoline station to refuel; a BEV driver can refuel anywhere there is an electric outlet. The refueling speed of a BEV depends roughly on the power (kW) of the electric outlet used. Charging a BEV at home garages or driveways and at work or multifamily parking lots or garages is a much superior way to refuel than at a polluting gasoline station.

Charging BEV Batteries

It is best for the environment to charge overnight when power plants are less busy.

BEV batteries charge faster at low SOC ([State Of Charge](#)). Typically, it takes about as long to charge from 0% to 80% as it does from 80% to 100%; this is a good reason to not charge to 100% unless needed. This is a big difference between BEV and ICEV refueling. This difference is well worth not having to smell gasoline and spew out global-warming carbon dioxide and respiratory pollutants. Here are the three charging-speed categories:

1. Refueling a BEV at 120-V-AC (@ 15-A or 1.8-kW power) is quite slow, but may be sufficient when charging overnight for local driving. Typically, using 120-V charging, a BEV should be charged every night by plugging into a standard 120-V outlet, charging up to 80% SOC (State Of Charge). (Only charge beyond 80% during a night before a long trip the next day; NMC lithium-ion batteries lose less capacity over time if not regularly charged to 100%.) A portable [charging station](#) (\$100-\$200) has to be used to connect a BEV to a 120-V outlet; e.g., for Teslas: <https://shop.tesla.com/product/mobile-connector>.
2. If a standard electric outlet at 120-V is too slow, a 240-V-AC outlet, such as used for an electric range or a clothes dryer, can provide 7.2-kW power (30-A) up to 14.4-kW (60-A). A portable (\$100-\$200) or [mounted](#) (\$300-\$600) charging station has to be used to connect a BEV to a 240-V outlet. Being able to charge at home or at work is a **game changer** compared to ICEV refueling; it means that the number of necessary public charging stations per BEV is much smaller than the number of necessary gasoline station per ICEV. In addition, many hotels, parks, restaurants, etc. provide 240-V charging stations for clients to use; also, there are many public 240-V charging stations for the general public.

- Charge at 480-V-DC (50-kW up to 350-kW) fast charging stations on long trips as needed. DC fast charging for a Tesla involves simply attaching a Supercharger cable to the BEV and walking away, as the Tesla automatically credits the kWhs used to the car's credit card. For most other BEVs, an electronic card has to be used to pay for the kWhs used at CCS ([Combined Charging System](#)) chargers. Again, only charge higher than 80% SOC when it is necessary to get to the next location or overnight when a long trip is scheduled for the next day.

4. Charging speed versus charging power.

In 2025 all new BEVs will have the NACS ([North American Charging Standard](#)) "Tesla" plug; they will be able to charge at Tesla Superchargers (150-kW or 250-kW) using a Tesla app on a smartphone. Older non-Tesla BEVs will have to use the less reliable CCS (Combined Charging System) fast chargers or a NACS to CCS adapter to use the NACS cables at Tesla Superchargers. The changing of fast charging of BEVs from CCS to NACS is a **big deal**; eventually all BEVs will be able to charge at all fast charging stations, especially the extensive and most reliable Tesla Superchargers.

Eventually, all older BEVs with CCS plugs will be able to have a NACS to CCS adapter



to use NACS fast chargers, including Tesla Superchargers.

This adapter, or one similar to it, will enable companies other than Tesla to sell BEVs made in 2024! In 2025 all new BEVs will have NACS charging ports, enabling them to use Tesla Superchargers! [Here is a web page about the Ford adapter.](#)

Some Tesla Supercharger stalls will have a CCS adapter connected to the NACS cable; called a "[Magic Dock](#)".

Eventually, all current CCS fast charging stations will also have cables for NACS charging, such as for Teslas and other BEVs newer than 2024. Currently, Tesla BEVs have available a CCS to NACS adapter, so that Teslas can charge at CCS



fast chargers.

Using this adapter at EVgo CCS charging stations can allow [Plug and Charge](#) to work for Tesla BEVs, similar to the easy procedure at Tesla Superchargers.

Refueling during long trips is quite different for BEVs than for ICEVs

- Fuel BEVs to greater than 80% overnight only before a long trip, to reduce NMC battery capacity loss.
- Use a trip planner for BEVs, such as [abetterrouteplanner.com](#), as well as the Tesla trip planner in the vehicle and the Tesla app, to plan charging stops; the best BEVs have a similar trip planner on a large display. The Tesla trip planner shows how many stalls are at a Supercharger, their charging power (150-kW or 250-kW), how many charging stalls are available for charging and how many BEVs are on the way to be charged there.
- Refuel BEVs at a stop only long enough to get to the next refueling stop plus a reserve for emergencies or detours; I use 15-20% reserve. Tesla's in-car trip planner sometimes goes as low as 10% reserve. Remember that charging is faster for low SOC. Often it takes only 5-10 minutes at a 250-kW Supercharger to get the charge needed.
- Use the Internet, such as [plugshare.com](#), to find hotels that have 240-V charging stations for overnight charging or nearby fast charging. Call ahead to the hotel to see if they have working 240-V charging stations; if so, they may reserve one for you.

5. Eventually, all BEVs will have [Plug and Charge](#) similar to what Tesla has: just plug in and walk away to do whatever you need to do, and use the Tesla app to view the charging progress.

Precondition a Tesla Battery before Charging in Cold Weather

Tesla batteries automatically precondition on the way to a Supercharging for charging, which is especially important in cold weather. If you are charging **not** at a Supercharger, you should select the nearest Supercharger so the Tesla will precondition before you arrive at the charging station you plan to use. [Tesla Winter Driving Tips](#).

If a BEV is parked at a charging station in cold weather, leave it plugged in so that the battery is kept warm.

Buying a BEV

I recently did a study to decide which BEV to buy; here were my desired features:

- Length would fit in my garage.
- Range greater than 300-miles.
- [Internet software updates](#).
- [Mobile repair service](#) in my garage, when possible.
- [Extensive fast charging network](#) availability with [Plug and Charge](#) for long trips.
- [Lane Centering](#) on Interstates and city streets.
- Comfortable and attractive interior.
- [High efficiency](#), greater than 120-MPGe.
- Beautiful aerodynamic styling (part of high efficiency).
- Large LCD screen to contain vehicle controls.
- Simplified controls that minimizes buttons and switches on the dash.
- \$50,000 price range

In every item Tesla's Model 3 and Model Y excelled. I decided that the Model Y was not a good fit for my garage. I bought a 2023 Tesla Model 3 Long Range AWD in Pearl White, to reflect sunlight and not heat the Earth.

Another item I would like to be able to have is a 10-amps or higher current 120-volt electric outlet on the BEV ([V2L](#)) to use to charge our [house backup battery](#) during a grid outage. The [Hyundai Ioniq 5](#) & 6, the [Kia V6](#) & V9, the [Ford F150 Lightning](#), the [Chevrolet Silverado Ev](#) and the [Rivian](#) have this capability, but lack other important features. The Tesla Cybertruck has a V2L the feature, called [Powershare](#), but TC does not fit in my garage or pocketbook. I hope that Tesla soon will provide a V2L adapter, similar to the Ioniq one, and a software download to allow Powershare on all Tesla BEVs.

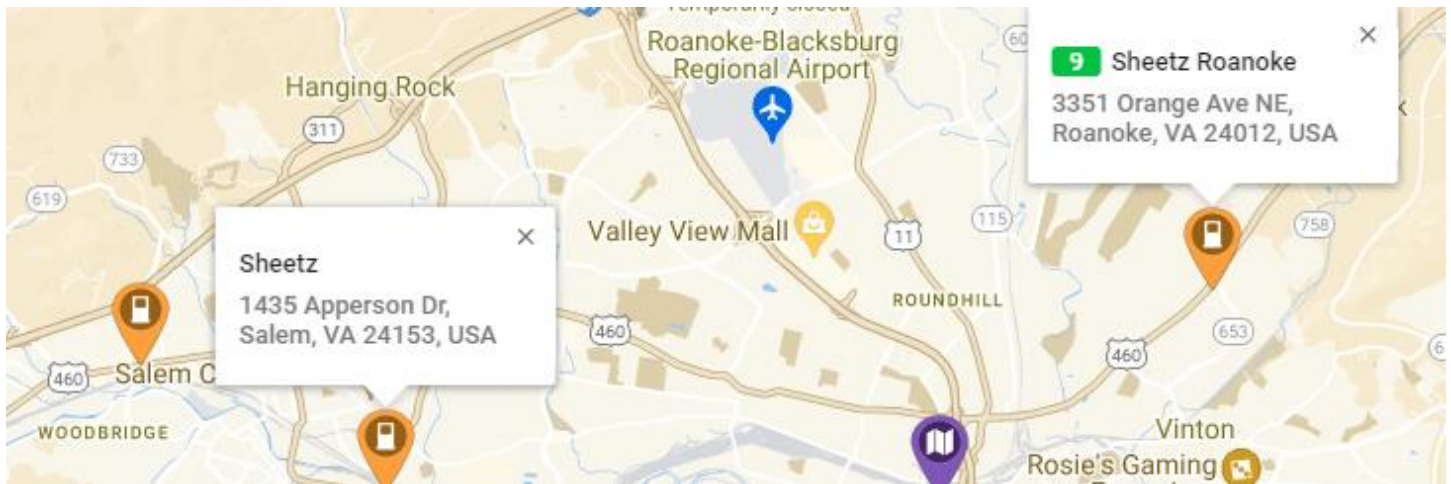
By 2026 when all BEVs have access to Tesla Superchargers and have adopted many of the features listed above, there will be many more choices for excellent BEVs.

Charging Teslas in Blacksburg, Virginia

Tesla drivers in Blacksburg who do not have access to a level-2 charging station (7 to 10-kW power) for charging overnight will soon have access to an 8-stall Tesla Supercharger at a new Sheetz store in Blacksburg; the 8 stalls have been installed, but the concrete has not been poured yet. (**The Grand Opening is scheduled for 29 February 2024, 9-11 AM.**)

In the meantime, here is a better solution than slow chargers (7 to 10 kW) for Tesla drivers visiting with their Teslas in Blacksburg: I suggest that you charge to a **high SOC** at the 250-kW Supercharger at a Sheetz store in Salem (<https://www.plugshare.com/location/407568>) or the 250-kW Supercharger at a Sheetz store in Roanoke (<https://www.plugshare.com/location/543312>) before coming to Blacksburg and charge there again when you are leaving Blacksburg. That way you will have a high SOC when you arrive in Blacksburg and a slightly higher SOC as you start driving home.

Here is a map showing the two 250-kW Superchargers in Salem and Roanoke:



The older Supercharger on the left is only 150-kW.

Route Planners for BEVs

- <https://abetterrouteplanner.com/>
- <https://www.plugshare.com/trip-planner.html>
- <https://www.tesla.com/trips>

Fast-Charging Protocols and Adapters

- <https://www.forbes.com/sites/stacynoblet/2023/06/23/nacs-versus-ccs-its-more-than-a-connector/?sh=6e922200bddd>
- <https://cars.usnews.com/cars-trucks/advice/nacs-vs-ccs>
- <https://www.makeuseof.com/ccs-versus-tesla-nacs/>
- <https://insideevs.com/reviews/672485/ccs1-tesla-nacs-charging-connector-transition-info/>
- [**CCS-Compatible Tesla Superchargers To Be Eligible For Public Funds**](#)
- <https://www.tesla.com/support/non-tesla-supercharging>



- <https://electrek.co/2024/02/22/ford-leaks-j3400-to-ccs-adapter-for-tesla-superchargers/>
- <https://www.consumerreports.org/cars/ev-chargers/how-well-do-tesla-superchargers-work-for-non-tesla-evs-a4713673565/> (Magic Dock)
- [**CCS1 to Tesla Charger Adapter for Models 3 Y S X Manufactured 2021 and After \[Safety Certified\], Charging**](#)



[**speeds up to 250 kW, Charge Tesla at Public DC Fast Charging Stations**](#)

- <https://www.caranddriver.com/news/a35044132/plug-and-charge-ev-charging-mustang-mach-e/>
- <https://www.evgo.com/autocharge/>

Myths about Electric Vehicles

- <https://www.carbonbrief.org/factcheck-21-misleading-myths-about-electric-vehicles/>
- <https://www.epa.gov/greenvehicles/electric-vehicle-myths>
- <https://www.kbb.com/car-advice/electric-car-myths/>
- <https://www.theguardian.com/business/series/ev-mythbusters>
- https://www.washingtonpost.com/outlook/five-myths/electric-vehicles-five-myths/2021/09/23/e554b6cc-1bf2-11ec-a99a-5fea2b2da34b_story.html
- <https://www.nationalgrid.com/stories/journey-to-net-zero/electric-vehicles-myths-misconceptions>
- <https://www.theverge.com/2021/7/21/22585682/electric-vehicles-greenhouse-gas-emissions-lifecycle-assessment>
- <https://www.autoblog.com/2023/05/18/the-biggest-myths-about-electric-cars-debunked/>
- [**How Clean is Your Electric Vehicle? \(Union of Concerned Scientists\)**](#)

Reusing and Recycling BEV Batteries

- <https://www.ucsusa.org/resources/ev-battery-recycling#read-online-content>
- <https://www.autoweek.com/news/green-cars/a35803612/battery-recycling/>
- <https://www.advancedenergy.org/news/electric-vehicle-battery-reuse-and-recycling>
- <https://www.ucsusa.org/resources/ev-battery-recycling>
- <https://www.redwoodmaterials.com/>
- <https://www.globaltechenvironmental.com/services/hybrid-ev-battery-recycling/>
- <https://www.autoweek.com/news/technology/a43937159/b2u-company-reusing-ev-battery-packs-to-store-solar-energy/>
- [Lithium-Metal Batteries Can be ‘Revived’](#)

Myths about Solar Energy, etc.

- <https://www.energy.gov/eere/solar/articles/busted-common-solar-myths-and-misconceptions>
- <https://www.energysage.com/blog/top-solar-myths/>
- <https://www.forbes.com/home-improvement/solar/solar-myths/>
- <https://freedomspower.com/blog/debunking-11-common-solar-myths>
- <https://www.weforum.org/agenda/2021/03/renewable-energy-myths-debunked/>
- <https://todayshomeowner.com/solar/guides/solar-energy-myths-debunked/>
- <https://www.energy.gov/eere/solar/articles/benefits-powering-your-ev-solar-energy>
- <https://www.weforum.org/agenda/2022/01/could-solar-energy-power-an-electric-vehicle-future/>
- <https://interestingengineering.com/transportation/all-you-need-to-know-about-solar-powered-cars>
- <https://www.energysage.com/electric-vehicles/solar-panel-cars/>
- <https://electrek.co/2024/02/15/us-solar-panel-recycling-2/>
- [Solar Estimator for Virginia](#)

General References

- [Different types of EV chargers](#)
- [Plug and Charge](#)
- <https://www.caranddriver.com/news/a35044132/plug-and-charge-ev-charging-mustang-mach-e/>
- [Charge after every trip, if possible](#)
- <https://electrek.co/2024/03/18/why-you-might-be-charging-your-ev-wrong-and-what-to-do-instead/s>
- [There should be a few \\$25,000 BEVs available for purchase by 2026.](#)
- [Why you can't buy a Tesla in these states](#)
- [Tesla Mobile Service](#)
- [The hybrid-car dilemma](#)
- [Is a plug-in hybrid vehicle right for you?](#)
- [The future of electric technology](#)