EV Batteries Today

EV Ranges

Most personal vehicle trips in the U.S. are under 31 miles so EVs with a 100-mile range would satisfy 87% of daily driving needs. EV ranges today vary from 115 to 516 miles—more than adequate for most daily driving needs.

- In 2022, the average range for personal EVs in the U.S. was 300 miles.
- In 2023, over 30 models of personal EVs were available in the U.S. with ranges of at least 300 miles.¹
- Plug-in hybrid EVs in the U.S. offer electric driving ranges of 15 to over 60 miles per charge more than adequate to meet most daily travel needs.²

Medium- and heavy-duty EVs (MHDVs) offer ranges from 230 to 350 miles. Several manufacturers offer MHDVs for U.S. and North American markets, and more are on the way.³

- Volvo anticipates that these EVs could completely replace urban diesel trucking fleets for various uses and industries.
- The Tesla Semi is an electric truck with a 500-mile range.
- Nikola Tre Bev produces an electric truck with a 350-mile range.



Electric MHD truck. Photo: WSU staff.

EV Charging Speeds

The greatest issue facing the EV industry today is how long it takes to charge the battery to 85% (the recommended threshold). The average time it takes to charge an EV from empty with the three types of charging available in the U.S. today are:

- **Level 1**: 2 to 5 miles per hour of charge (40 to 50 hours to full), typical of at-home chargers on 110-amp circuits.
- Level 2: 10 to 20 miles per hour of charge (4 to 10 hours to full), common at workplace charging stations, public stations, and some at-home chargers on 240-amp circuits.
- **Direct current fast charging (DCFC)**: 180 to 240 miles per hour of charge (20 minutes to 1 hour to full), offered at select public charging stations.

Promising innovations will reduce EV charging times.^{4 5} Companies working to improve charging speeds, such as Group14 Technologies, are innovating a new type of anode and cathode that will allow batteries to accept lithium ions faster from the charger.

EV Charging Networks

In the U.S., current charging standards are the Combined Charging System (CCS) and the North American Charging Standard (NACS). CCS is used by almost every EV in the U.S. except for Tesla, which uses the NACS system.

Tesla licenses the use of its NACS network to some EV manufacturers in the U.S. so their vehicles can use the NACS network. Tesla also offers a NACS-to-CCS adapter so Tesla vehicle owners can use the CCS network.

In late 2023, the U.S. Dept. of Transportation announced: "... Implementation of J3400 TM, a new standard for charging EVs published by the Society of Automotive Engineers (SAE), any supplier or manufacturer will now be able to use and deploy the Tesla-developed NACS connector" as soon as 2025.

NACS vs CCS

NACS currently has a lower failure rate than CCS and is available at a wider range of fast-charger stations. NACS also has an integrated payment system so the charging experience is quick and seamless compared to CCS.

Even though NACS currently offers more DCFC options, CCS has more stations throughout the U.S. In 2024, only CCS offered bidirectional charging but Tesla claims that NACS will be able to handle bidirectional charging by 2025. CCS also offers greater charging rate capabilities at 350 kW compared to NACS' maximum charging speed of 250 kW.⁷⁸

Charging in Washington

Washington has over 7,000 public EV charging ports. The WA Dept. of Commerce has pledged \$84 million to install 5,000 more Level 2 ports and 420 DCFC ports throughout the state at multi-family housing buildings, workplaces, school districts, public agencies, and other public locations.⁹ 10 11

In August 2024, the Joint Office of Energy and Transportation announced that Washington communities received over \$29 million to install additional chargers.

Battery Weight

EV battery weight is a crucial component of EV performance. The battery is the single heaviest part of an EV, affecting its acceleration and braking, handling and cornering, and energy storage and power delivery. The average EV battery weighs about 1,000 pounds (compared to a 90-pound average weight for the battery in a gas-powered vehicle). The Nissan Leaf battery weighs 660 pounds, and the Tesla Model Y battery weighs 1,700 pounds.

Heavier batteries can produce higher energy density and offer longer ranges, but there comes a point of diminishing returns when the frame around the battery must be reinforced to support the heavier battery. With this extra structural weight, the vehicle requires more energy to accelerate and slow down, and creates more stress on the suspension.

Balancing EV battery weight and range are crucial. The typical lithium-ion (Li-ion) battery offers 90 to 190 Wh/kg, ¹² depending on battery components. Amprius Technologies plans to build a 500 Wh/kg Li-ion battery with reduced weight and increased capacity. ¹³ ¹⁴ ¹⁵ ¹⁶

Charging Costs

Every EV on the market costs less to recharge than it costs to refuel an internal combustion engine (ICE) vehicle. If charged at home, an EV can save up to \$600 a year compared to fossil fueling costs. Charging costs may be even lower when charging overnight.

Maintenance Costs

EVs also cost less to maintain per mile than ICE vehicles. Batteries degrade very slowly and all EV batteries are covered by mandatory federal warranties of 10 years or 100,000 miles.

The Natural Resources Defense Council found the following cost savings from EVs:17 18

- Over the lifetime of the vehicle (seven years on average for a new car), savings were close to \$11,000 compared to comparable ICE vehicles.
- On average, EVs are half as expensive to maintain as their ICE counterparts.

EV Incentives

Incentives, rebates, and credits can help bring down EV prices:19

- Federal tax incentives are available for eligible new, used, and leased EVs.
- WA Dept. of Commerce offers instant rebates to low-income households to purchase or lease eligible new and used EVs (from \$2,500 to \$9,000).²⁰ ²¹
- Tax breaks are available for installing EV charging infrastructure including the Alternative Fuel Infrastructure tax credit²² and Puget Sound Energy rebate for installing at-home charging.²³

²³ Electric Vehicle Incentives. Puget Sound Energy Up & Go Electric. Undated.



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¹ The Long-Range EV Boom Has Arrived. *Bloomberg*. March 6, 2024.

² 2024 U.S. Electric Car EPA Ranges Ranked Lowest To Highest. *Inside EVs.* Feb. 12, 2024.

³ The obsession with EV range is all wrong. The Washington Post. July 7, 2023.

⁴ What Will It Take to Charge Electric Vehicles Faster? Smithsonian Magazine. May 24, 2023.

⁵ Electric Vehicle Charger Levels and Speeds. U.S. Dept. of Transportation. Updated June 29, 2023.

⁶ On the Heels of New Industry Standard for EV Charging, Biden-Harris Administration Takes Key Step Toward Updating Federal Standards to Promote Innovation. U.S. Dept. of Transportation. Dec. 19, 2023.

⁷ NACS vs. CCS: What's the Difference? U.S. News & World Report. Sept. 28, 2023.

⁸ NACS vs CCS - Which one is better? Lectron. April 11, 2024.

⁹ Surge of new EV charging stations coming to Washington state. KUOW website. Feb. 1, 2024.

¹⁰ Find Charging Stations in Washington. ChargeHub. Undated.

¹¹ Electrification Statistics: EV Charging Stations in Washington State. Qmerit. Undated.

¹² Watt-hour per kilogram (Wh/kg) - a unit of specific energy used to measure the density of energy in batteries and capacitors.

¹³ New EV Battery Developments Add Range, Reduce Weight. Engineering.com. June 27, 2023.

¹⁴ What Affects Car Battery Weight? UFine Blog. April 22, 2024.

¹⁵ Auto industry must halve EV battery weight over next decade, Stellantis CEO says. Reuters. April 3, 2024.

¹⁶ A Complete Guide on Electric Car Battery Weight. EVGas Blog. July 6, 2023.

¹⁷ Plug-In Hybrid Electric Vehicles, Dept. of Energy EERE website, undated.

¹⁸ Electric vs. Gas Cars: Is It Cheaper to Drive an EV? NRDC. March 21, 2024.

¹⁹ Search for Incentives. Electric for All. Undated.

²⁰ Washington EV Instant Rebate Program. WA Dept. of Commerce. Undated.

²¹ Ready, set, drive electric: State instant rebate program. WA Dept. of Commerce. April 23, 2024.

²² Credits for new clean vehicles purchased in 2023 or after. Internal Revenue Service. Undated.