

Key Things to Know about Electric Vehicle Battery Performance

Electric vehicles (EVs) have evolved significantly since rising in popularity in the last decade. This fact sheet addresses common questions and progress surrounding EV battery performance. Each point is followed with references from studies and articles for those who want to dive deeper.



EV BATTERY RANGES HAVE GROWN SIGNIFICANTLY OVER TIME AND WILL CONTINUE TO WITH NEW INNOVATIONS

EV battery ranges have steadily increased due to advancements in battery technology, improved energy densities, and more efficient power management systems. As manufacturers continue to invest in the research and development of new battery improvements and technologies, the battery range on a single charge will continue to grow.

- When modern EV batteries were introduced in 2011, their median range was 68 miles. Fast forward to model year 2023, and that median range has more than tripled to 270 miles.¹
- Solid-state batteries use a solid electrolyte instead of the liquid electrolyte found in traditional lithium-ion batteries. They promise significant advantages over traditional batteries, including faster charging times, increased energy capacity, better performance in extreme conditions, and reduced fire risk. Numerous automakers, such as Hyundai, Toyota, Kia, and Honda, are making significant strides in advancing the technology, as demonstrated by the thousands of patents they've filed in recent years.² The leading manufacturer in solid-state battery patents, Toyota, is expected to offer EVs using the technology by 2027–28. The EVs are expected to offer more than 600 miles of range on a full charge and a fast charge time of ten minutes or less.³

¹ “FOTW #1323, January 1, 2024: Top Range for Model Year 2023 EVs Was 516 Miles on a Single Charge,” US Department of Energy, Office of Energy Efficiency & Renewable Energy, January 1, 2024, <https://www.energy.gov/eere/vehicles/articles/fotw-1323-january-1-2024-top-range-model-year-2023-evs-was-516-miles-single>.

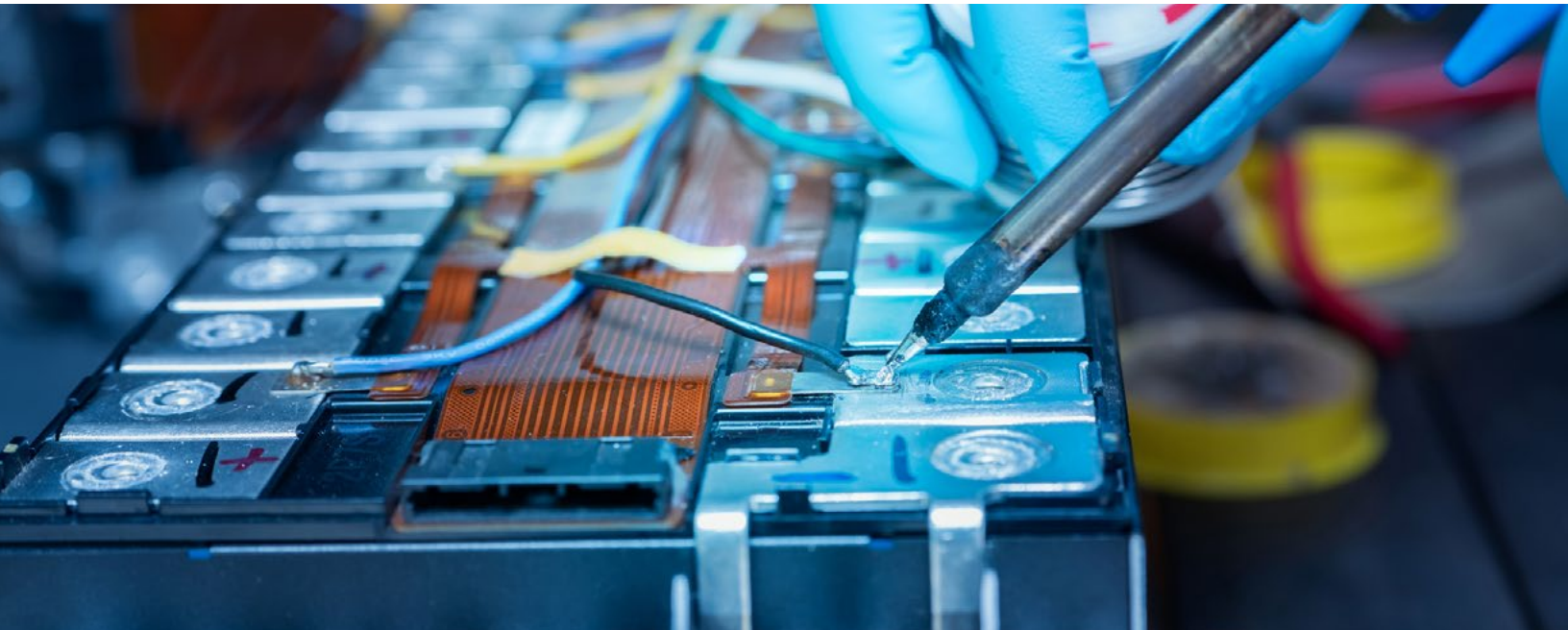
² Elizabeth Cooke, “Signal: Toyota dominates solid-state battery patents,” JustAuto, November 8, 2023, <https://www.just-auto.com/news/signal-toyota-dominates-solid-state-battery-patents/?cf-view&cf-closed>.

³ “Toyota’s advanced battery technology roadmap,” Toyota Europe Newsroom, September 14, 2023, <https://newsroom.toyota.eu/toyotas-advanced-battery-technology-roadmap/>.

MODERN EV BATTERIES HAVE LONG OPERATIONAL LIVES, AND NEW CHEMISTRIES WITH EVEN LONGER LIVES ARE ON THE HORIZON

While EV batteries undergo a gradual degradation process with time and use, they rarely need to be replaced before the vehicle's end-of-life. With new battery chemistries with even longer ranges on the horizon, this sustained durability underscores the economic viability of EVs and their contribution to reducing their overall environmental impact by minimizing the need for frequent replacements.

- Federal law mandates that manufacturers offer at least eight years or 100,000 miles of EV battery warranty coverage. Many manufacturers go beyond the federal mandates and offer extended warranties. Evidence identified by the International Council on Clean Transportation (ICCT) suggests that each EV only uses its original battery since battery degradation is not a typical problem.⁴
- The study, *How Long Do Electric Car Batteries Last?*, from Recurrent Auto found that across all years and models since 2011, only 2.5 percent of vehicles have had batteries replaced outside of big recalls. Battery replacement rates for cars older than 2015 are 13 percent but under 1 percent for cars from 2016 and newer.⁵
- Battery manufacturers, including Tesla and CATL,⁶ have announced new EV batteries with ~1 million mile ranges. With this range, these batteries can even outlive the vehicles they power!
- According to the ICCT report, *Effects of Battery Manufacturing on Electric Vehicle Life-cycle Greenhouse Gas Emissions*, after electric car batteries are done powering vehicles, they still have much of their capacity left (75 to 80 percent!). This means they can still be used for other purposes, like storing energy for the power grid, further reducing their lifetime emissions.⁷



⁴ Dale Hall and Nic Lutsey, Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions (The International Council on Clean Transportation, February 2018), 8, https://theicct.org/sites/default/files/publications/EV-life-cycle-GHG_ICCT-Briefing_09022018_vF.pdf.

⁵ Liz Najman, "How Long Do EV Batteries Last?" Recurrent, May 20, 2024, <https://www.recurrentauto.com/research/how-long-do-ev-batteries-last>.

⁶ Peter Johnson, "CATL Launches New EV Battery with close to a 1 Million Mile, 15-Year Lifespan," Electrek, April 3, 2024, <https://electrek.co/2024/04/03/catl-launches-new-ev-battery-last-1-million-miles-15-yrs/>.

⁷ Hall and Lutsey, "Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions," 7.

EV BATTERIES ARE DESIGNED TO FUNCTION IN A WIDE RANGE OF TEMPERATURES AND CLIMATES

While EV battery performance can be negatively affected by extreme cold and hot temperatures, various technologies can mitigate these effects and ensure they operate smoothly regardless of environmental conditions.

- Many EV models can “precondition” their batteries, meaning that they can be programmed to draw power from the grid while charging to heat or cool the cabin and battery to a temperature for optimal range and performance before departure. This function can also preheat or cool the battery to the optimal charging speed temperature while going to a charger.⁸
- Manufacturers and researchers are continuously exploring new ways to manage battery temperature and improve performance in extreme conditions. Recent promising discoveries include new temperature-resistant battery electrolytes and cell structures, circuits that efficiently utilize the heat created by electricity transfer, innovative thermal energy storage systems, and battery thermal management systems with advanced heating pipes and cooling liquids.⁹

EV BATTERIES UNDERGO RIGOROUS TESTING AND INCLUDE ADVANCED FEATURES TO ENSURE SAFETY

Batteries undergo stringent testing before being approved for use in an EV and incorporate advanced technologies to ensure their safety. Many EVs also include features that monitor battery health in real time during operation, allowing drivers to fix their batteries or get to safety before issues arise.

- In addition to meeting the same safety standards as conventional gas-powered vehicles,¹⁰ manufacturers put their batteries through an extensive list of tests. These tests include mechanical vibrations, thermal shock and cycling, mechanical integrity, overcharge/discharge protection, fire resistance, thermal protection, water resistance, and external/internal short circuit protection.¹¹
- Some safety features and technologies that enhance battery safety include advanced stable battery chemistries, thermal management and monitoring systems, specialized battery enclosures, thermal runaway barriers, and the ability to automatically shut down the electrical system when a collision or short circuit is detected.¹²

⁸ Andrew Gaberson, “Winter & Cold Weather EV Range 10,000+ Cars,” Recurrent, January 2, 2024, <https://www.recurrentauto.com/research/winter-ev-range-loss>.

⁹ Jorge Hurtado, “Can EV batteries keep up with the cold? The latest breakthroughs and advances,” Prescouter, March 2024, <https://www.prescouter.com/2024/03/can-ev-batteries-keep-up-with-the-cold/>.

¹⁰ “Electric Vehicle Myths,” United States Environmental Protection Agency, last updated July 16, 2024, <https://www.epa.gov/greenvehicles/electric-vehicle-myths#Myth7>.

¹¹ “How EV Batteries Are Tested,” Integrated Micro-Electronics Inc., October 18, 2023, <https://www.global-imi.com/blog/how-ev-batteries-are-tested>.

¹² Nick Zamanov, “Electric Cars and Vehicle Safety: Discussing the safety features and considerations specific to electric vehicles, including battery safety, crash testing, and advanced driver-assistance systems,” Cyber Switching, September 3, 2023, <https://cyberswitching.com/electric-cars-safety-in-features-batteries-and-crash-testing-and-drivers-assistant-systems>.



Facilitated by the Great Plains Institute, Drive Electric Minnesota is a partnership of electric vehicle (EV) champions, including automakers and auto dealers, utilities, charging companies, environmental groups, and state and local government. The coalition paves the way for the deployment of EVs and charging infrastructure through public-private partnerships, financial incentives, education, technical support, and public policy. Visit us at www.DriveElectricMN.org. Contact us at driveelectricmn@gpisd.net.