



Advanced battery technologies

Solid-state batteries

Solid-state batteries offer several advantages over traditional Li-ion batteries, including higher energy density, improved safety, and longer lifespan. As battery size and weight go down, more space could be available for other vehicle features or additional battery capacity.

- Toyota says their solid-state battery will be commercially available by 2027.
- Samsung Advanced Institute of Technology is developing a solid-state battery with a range of 500 miles that can last about 1,000 charges, potentially powering the EV over 500,000 miles.

With the potential to deliver 500 to 700 miles of charge in 10 to 20 minutes, and with durability for 1,000 recharges, these batteries could significantly enhance the practicality and appeal of EVs.

Li-sulfur and Li-metal batteries

Li-sulfur batteries, with sulfur cathodes, are more efficient than Li-ion batteries with cobalt and nickel anodes and cathodes. Li-sulfur batteries that promise longer ranges with similar weights could be commercially available by 2028.^{1 2 3}

Li-metal batteries offer even higher energy density compared to traditional Li-ion, which translates to longer range and faster charging times. GM is working with SolidEnergy Systems to manufacture a Li-metal battery that promises 500 to 600 miles of range and an 80% charge in less than 15 minutes. This battery could be available by 2028. GM will build these batteries at its Woburn, Massachusetts, plant. Upcoming models that use this technology include the Chevy Bolt and Cadillac Lyriq.

Volkswagen is also investing in Li-metal batteries. Partnering with QuantumScape, VW says their ceramic-electrolyte cells can achieve up to 500 miles on a single charge, and are safer, lighter, and quicker to charge. SK Innovation is developing a new 500-mile range battery that can charge from 0% to 80% in ten minutes. They are building a facility in Georgia to supply batteries for up to 300,000 vehicles a year.⁴

¹ [7 New Battery Technologies to Watch](#). BuiltIn. May 6, 2024.

² [Next Gen EV Batteries Will Deliver 500-Mile Range](#). GreenCars. Nov. 18, 2021.

³ [New Toyota electric vehicle batteries to offer 900-plus miles of range](#). FleetNews. June 13, 2023.

⁴ [Next Gen EV Batteries Will Deliver 500-Mile Range](#). GreenCars. Nov. 18, 2021.

Faster charging

The U.S. will need to install 182,000 DCFC ports and over a million Level 2 ports by 2030 to serve the estimated 30 million EVs on the roads.

StoreDot is developing an “extreme fast charging” battery with silicon anodes instead of graphite, potentially reducing 80% charge time from 30 minutes to 10 minutes.

The Japan Advanced Institute of Science and Technology is also developing an extreme fast-charging battery, reducing 80% charge time to under 10 minutes using a binder material to promote “high conductivity, low impedance, and good stability” in the use and charging of the battery.

Researchers at Pohang University of Science and Technology are developing a battery anode made of manganese ferrite, which can hold up to 1.5 times the lithium ions previously thought possible, decreasing average charge time to under six minutes. The current estimates for charging from 0% to 80% charge is 6 to 20 minutes.^{5 6 7}

Reduced battery weight

Li-ion

Li-ion batteries are near their evolutionary peak. But with slight changes to certain aspects of their design and materials, they can be lighter, rangier, and cheaper than they are now. The new generation of Li-ion batteries being developed promises decreased weight, costs, and charge times.^{8 9}

Solid-state

Solid-state batteries weigh significantly less, offer longer ranges, and decrease charge time compared to Li-ion batteries. The lithium anode can increase batteries’ energy density so less material is required for similar ranges.

Li-ion batteries have an energy density of 200 to 325 Wh/kg. Many potential solid-state battery manufacturers are confident they can increase this density from 30% to 50%, dramatically reducing weights of EVs and increasing their range. A solid-state battery could reduce the weight of an EV battery from the average of 800 pounds to 550 to 600 pounds.¹⁰

⁵ [The future of EV charging: revolutionary developments are closer than you think](#). Avnet; October 24, 2023.

⁶ [Researchers from Korea’s IBS suggest quantum charging could cut EV charge time to 3 minutes at home](#). Green Car Congress. March 21, 2022.

⁷ [EV battery material breakthrough could cut charging times to 6 minutes](#). Freethink. Sept. 8, 2023.

⁸ [Can solid-state batteries help EVs shed weight?](#) *Automotive World*. Aug. 1, 2023.

⁹ [What’s Happening in EV Battery Technology](#). Driivz. Nov. 2, 2023

¹⁰ [The Future of Lithium-ion Battery Technology: Chemistries, Comparisons, and the Close Prospects](#). Polarium. May 2024.

Soldium is working on a solid-state battery with a bipolar electrode-to-pack technology that can reach 900 miles on a single charge while “contributing to a dramatically reduced battery weight, volume, and cost.”

Amprius Technologies announced another way to decrease EV battery weight and increase range: They are developing an anode with silicon nanowires that they claim will give their batteries an “unprecedented energy density of 500 Wh/kg.” Amprius intends to deliver battery cells that are about half the weight and volume of current Li-ion batteries.¹¹

Reduced battery costs

Moving away from cobalt and manganese, and toward less expensive and more abundant materials, could drop battery costs by 50% by the end of 2024. These improved battery costs could make EVs less expensive than comparable ICE vehicles by 2027.

- **Li-iron phosphate** batteries, which are dominant in China and making their way to Europe and the U.S., are less expensive than traditional Li-ion batteries due to the relative abundance of iron and phosphate compared with nickel and cobalt in Li-ion batteries.
- **Sodium-ion** battery technology is being developed at the Pacific Northwest National Lab to provide a cheaper alternative to expensive lithium with similar energy densities. Commercially scalable sodium-ion batteries will be much cheaper than current EV batteries because sodium is a much more abundant resource than lithium.¹²
- **Li-silicon** battery anode and cathode developed by companies like Group14 in Washington could rapidly decrease charge time for a more efficient charge and energy release.
- **Li-sulfur** batteries could be cheaper than Li-ion batteries because sulfur is a more available resource than the cobalt or nickel used in Li-ion batteries.

¹¹ [SiMaxx™ Enables Superior Energy Density for High-Performance Applications](#). Amprius. Undated.

¹² [Longer Lasting Sodium-Ion Batteries on the Horizon](#). Pacific Northwest National Laboratory. July 13, 2022.



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