How Long Do Electric Car Batteries Last?

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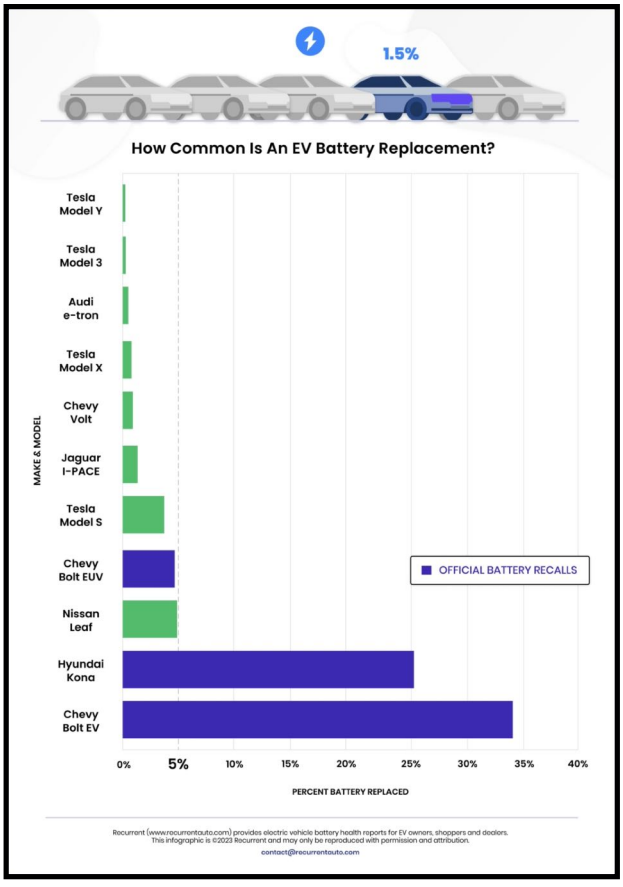
Battery life is a big question as people shop for a used Tesla or other electric car brand. A battery is a lithium ion black box that can make up 50-70% of an electric car's value. The reality is that if the battery dies, so does the car. Study takeaways by Recurrent's team of battery scientists:

- **Battery replacements are quite rare.** In our community of 15,000 cars, only 1.5% have been replaced (outside of big recalls like Chevy Bolt).
- **Degradation is not linear.** Battery degradation curves illustrate how well EV batteries hold up over time. There's some drop in the beginning, then it levels out for a long period.
- **Most replacements occur under warranty.** A new Rivian has battery coverage for 175,000 miles or 10 years. The federal minimum warranty is 8 years or 100,000 miles.
- **This is why Recurrent Reports are essential**. Recurrent can give you insights into an EV battery without costly or invasive tests.

How long is that EV battery going to last? The one simple answer is that we don't know for sure. Electric cars have not been around long enough for us to tell. The best we can do is observe the apparent degradation of cars on the road. Even that observation can prove a challenge, though, since most EVs have been on the road well under six years, with **almost 30% sold in 2022**. We still have very little sense of how they degrade over their lifetime. So far, EV batteries have much longer lifespans than anyone imagined, since very few of them have been replaced, even after warranty periods end.

Car makers say an electric vehicle should last as long as 20 years

Why do we have to worry about battery degradation in EVs? Most electric cars rely on a high voltage lithium ion battery, the same sort of battery found in household devices. Lithium ion batteries start to degrade as soon as they are made, an unavoidable part of battery science that you probably noticed with your cell phone and your laptop. Even if you never use lithium ion batteries, they slowly lose power and efficiency over time. The good news is that your EV battery is far more complex and sophisticated than other lithium ion batteries and is built to ensure its lifetime exceeds its warranty, and more.



Coming up with an exact answer to what a battery lifetime is complicated because:

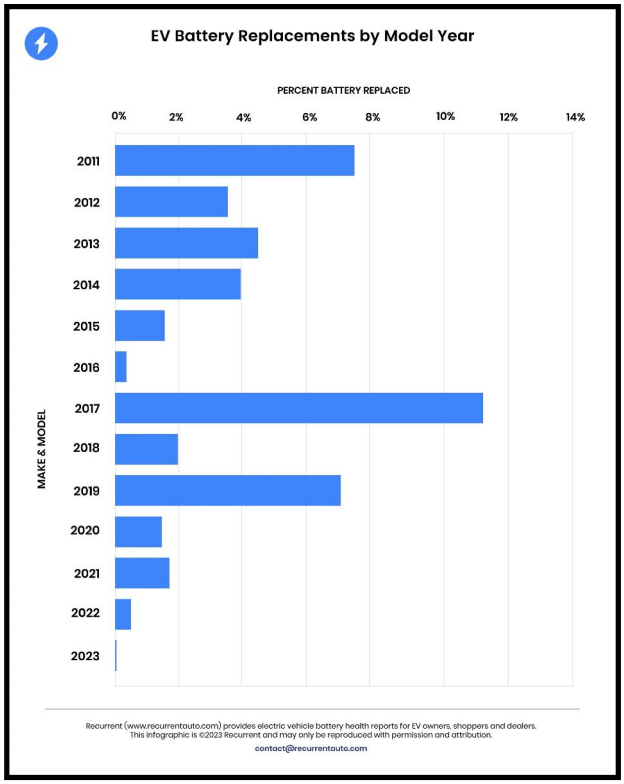
1. **Batteries are complicated systems.** We can't observe them directly, and have to rely on a computer interface to give us information about their state of health, state of charge, and more.
2. **We know more about battery cells than battery packs.** Most of the rigorous scientific tests on lithium ion batteries are done on individual battery cells, not the high-tech systems used in EVs.

But a lot of information can be gleaned from studies on older models of Nissan LEAF and Tesla Model S, both of which have been on the road for almost a decade. The study findings are encouraging: it looks like EV batteries have a lot of life in them.

Most EV batteries are still in cars

There have been two major battery recalls in recent years, both related to similar battery pack flaws in the Chevrolet Bolt EV & EUV, and the Hyundai Kona Electric. The remedy was a sweeping battery replacement program covered by the manufacturers. Other than these two recalls, battery replacements in the Recurrent community remain rare. In these two charts,

we show the number of owner-reported battery replacements in our community of ~15,000 drivers.



Other than the two notable cases of manufacturer warranties, the LEAF and the Model S unsurprisingly have the highest percentage of battery replacements, since they are some of the oldest models in our fleet. Below are battery replacements by model year.

The peak in 2017 battery replacements is due to the Chevrolet Bolt recall, in which the battery replacement priority was given to 2017 models. The Hyundai Kona EV recall was for 2019 and some 2020 models, explaining the spike in 2019.

What Affects Battery Life

Lithium ion batteries have been studied a lot. While most of the scientific foundations for this understanding comes from laboratory experiments on battery cells, the principles generally hold for the larger packs used in cars.

Batteries generate energy via chemical reaction. Since the chemical reactions happen in a physical cell, unwanted or waste reactions also occur. This is unavoidable and it doesn't mean there's anything wrong with the battery. Some of these side reactions can even help the battery last longer, if other conditions are favorable. Avoid battery degradation by reducing the physical stress of the chemical reactions or avoid things that speed up the chemical reactions.

Heat

Early LEAF batteries taught us something important about the longevity of lithium batteries. They do *not* like the heat. The earliest LEAF batteries had no active coolant, meaning that EVs in hot climates degraded more quickly than expected and many did need to have a battery replacement. Batteries last longer if they are kept as cool as possible. Since not all thermal management systems operate the same, this means parking in the shade, cooling your car before charging, and considering more active cooling if you live in a hot climate.

Charging

Charging your battery is a physical process that moves lithium ions and electrons around in the cells. The higher voltage that you use, the more forcefully the physical process happens, and the more physical stress or micro-damage occurs to the battery materials. With very high voltage charging, such as DC fast charging, a lot of heat is also generated, not ideal for battery longevity. DC fast charging is great on a road trip, but best to avoid everyday. Most batteries are built for regular Level 2, or 220V charging.

Depth of Discharge

Depth of discharge refers to how much battery you use in between charges. If you have a 100 kWh battery, an 80 kWh depth of discharge is 80% of the battery capacity. Laboratory studies show that battery cells last much longer if the depth of discharge is small, and conventional wisdom suggests keeping charge in the band around 50%, recharging well before you fully drain the battery.

Battery Second Life

What comes next for all these lithium ion batteries. The material and labor that goes into fabricating them is not insignificant, and many of the chemicals are expensive, toxic, and difficult to extract and reuse.

As batteries degrade, they reach a point where they are no longer useful for cars, but they still can store and generate electricity for other uses that don't require the same power. Nissan has projects to use old LEAF batteries to power streetlights, and GM uses batteries to back up data centers in Michigan. Linking together older EV batteries will provide storage for renewable energy, support grid resilience, or serve as emergency backup power, or expanding into other industries and working to electrify more than just vehicles.