NAMIC® ADVOCACY

INSURING THE FUTURE: ELECTRIC VEHICLES

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NAMIC®
ISSUE ANALYSIS

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Immediately prior to joining NAMIC, Cotto served as an executive advisor in Kentucky Gov. Matt Bevin's administration, where he oversaw legislative and regulatory reform efforts across more than 35 agencies and licensing boards, including the Department of Insurance. Before his service in state government, Cotto advised insurance entities in private practice as a managing associate at the law firm of Frost Brown Todd, which followed a five-year stint as financial policy and legislative counsel at the NAIC. He also served as counsel to the U.S. Senate Permanent Subcommittee on Investigations advising the ranking member at the time, Sen. Tom Coburn, M.D., R-Okla., and as associate general counsel at the U.S. Department of Commerce in the George W. Bush administration.

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The National Association of Mutual Insurance Companies consists of more than 1,500 member companies, including seven of the top 10 property/casualty insurers in the United States. NAMIC member companies write $391 billion in annual premiums and represent 68 percent of homeowners, 56 percent of automobile, and 31 percent of the business insurance markets.

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SPARKS OF INNOVATION OR SPUTTERS OF CONCERN?

The buzziest of buzzwords in conversations around vehicles today is undoubtedly "electrification." While there is plenty to buzz about, it may surprise casual observers to learn that as of this writing, fewer than 1 percent of vehicles on U.S. roads are electric vehicles (EVs). Interested stakeholders and government agencies continue to push a future when EVs replace traditional internal combustion engine (ICE) powered cars and trucks, offering generous government subsidies, incentives, and tax credits while advocating eventual mandates – and yet, of the nearly 20 million cars sold nationwide in 2022, only approximately 800,000 were EVs. While that number is growing quickly and likely eclipsed 1 million for the first time in 2023 as manufacturers continue to introduce new models and options with promises of massive take-up over the remainder of the decade, it will still be less than 5 percent of all cars sold all year.

While consumers have not embraced these vehicles at nearly the scale predicted by some EV industry advocates, amazing technological advancements and expanding options from manufacturers are all but ensuring that EVs will be an increasingly significant part of the future of the U.S. vehicle fleet. As it has through the history of vehicles and driving, the property/casualty insurance industry will play an important role in identifying, analyzing, qualifying, and quantifying the different risks posed by such vehicles and their features. In doing that, it will be crucial to separate fact from fiction where EVs are concerned so that policymakers and policyholders have a more realistic understanding of these vehicles, including the opportunities and risks they create, as well as the potential safety impact they pose for their owners, passengers, and other road users. Insurers should not be limited in their ability to treat ICE and EV models differently; it is critical to preserve the freedom to underwrite and rate consistent with the risks the vehicles pose.

This NAMIC issue analysis aims to explain the basics of EV operation, highlight considerations for insurers as they identify and price EV risks, and outline some of the realities and potential challenges of further electrification for carriers and consumers. Insurers will play a role in the partial fleet transition already underway, embracing the upside and identifying the risks of EVs, always keeping policyholder interests front and center.

BASIC BUILDING BLOCK: WHAT IS AN EV?

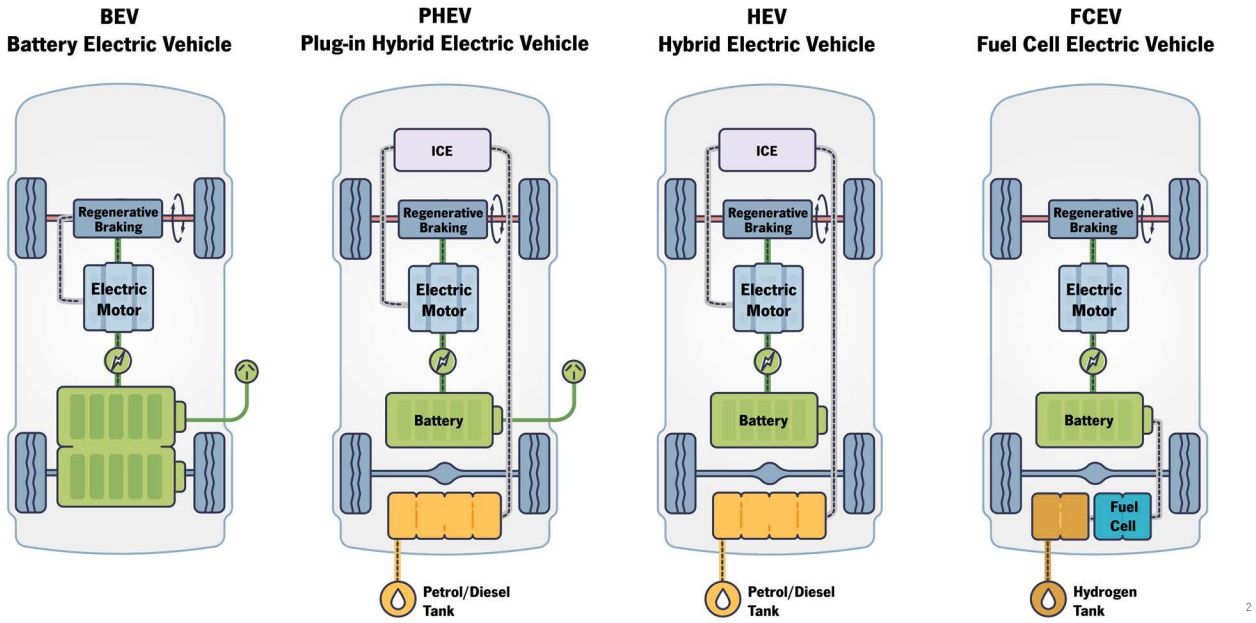
TERMINOLOGY

As with most policy discussions, it is critical to start with a common framework and understanding of key terms. Most simply put, EVs are vehicles that use electricity as their primary fuel – there is no requirement that they be fully electric[1]. EVs can be further broken into several subcategories:

- Battery Electric Vehicle (BEV): A rechargeable battery is used to power an electric motor without an alternative fuel source. The battery requires recharging from an external charge port. Sometimes called an "all-electric vehicle."
- Hybrid Electric Vehicle (HEV): A rechargeable battery and gas engine are alternatively used to power an electric motor.

[1] Even the U.S. government is not in complete agreement on terminology. While the U.S. Department of Energy uses this definition, the U.S. Department of Transportation does not consider HEVs to be EVs because their batteries cannot be recharged from an external source. For purposes of this paper, EVs will be used in its broadest sense, with specific subsets identified where necessary.

- Fuel Cell Electric Vehicle (FCEV): A rechargeable battery fueled by compressed hydrogen gas is used to power an electric motor.
- Plug-in Hybrid Electric Vehicle (PHEV): A rechargeable battery and gas engine are alternatively used to power an electric motor. Differs from a hybrid in that the battery can receive additional power from an external charge port. A PHEV can be operated solely with gasoline.



[2]

WORKING PRINCIPLES OF AUTO MOVEMENT

Across all vehicles, the basic requirement for propulsion is the power to rotate wheels, which is generated from different sources and controlled by differing mechanisms. In ICE vehicles, the fuel tank delivers small amounts of gasoline to the engine, which turns a gearbox that powers the wheels; the same is true of HEVs and PHEVs, but for those vehicles the battery provides the initial power before relying on the fuel tank. PHEV fuel engines function primarily when the battery is depleted, during rapid acceleration, at high speeds, or when intensive heating or air conditioning is required. BEVs on the other hand generally do away with pistons, cylinders, alternators, and fans, drawing power from a reducer rather than a gearbox. While BEVs have a simplified primary motor and drivetrain, unlike other vehicles, they often have additional motors situated close to the location where specific power is used – motors that need to be kept cool by running coolant through the entire body of the vehicle.[3]

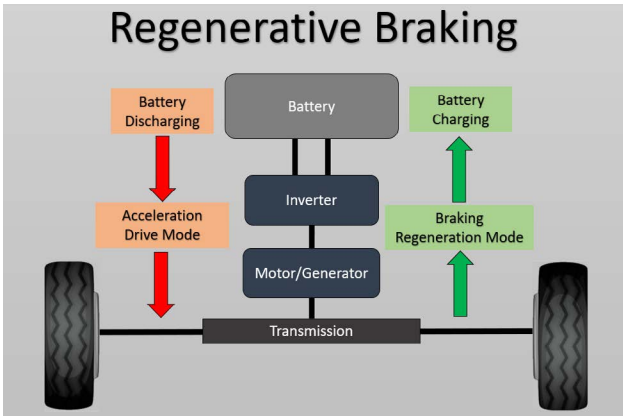
[2] https://intellipaat.com/blog/types-of-electric-vehicles/
[3] https://www.propertycasualty360.com/2022/12/15/a-colossal-shift-coming-evs-auto-claims-underwriting/

Across the spectrum of vehicles, the rate at which movement is possible is also a question of power (usually measured in kilowatts or horsepower) and torque (usually measured in newton-meters or pound-feet). Where the transmission of power in ICE vehicles is slightly delayed, EVs feature instantaneous generation of torque – which necessarily produces a large amount of heat rapidly at even a very low speed. This is the primary difference experienced by drivers, for whom it can take months to adjust to the different feeling and features of driving an EV. Other important considerations when comparing the basics of ICE and EVs internal operations include the efficiency of converting electrical energy into mechanical energy, the complexity and chemical state of cooling mechanisms, and the sheer size of machinery needed to operate multiple motors in a single vehicle.

TECHNOLOGY SPOTLIGHT: REGENERATIVE BRAKING

Regenerative braking is the technology that allows EVs to capture kinetic energy normally lost during braking by using the electric motor as a generator and storing captured energy in the battery – as much as 90% of the energy usually lost through heat during braking. It works by the electric motor reversing direction when the driver moves their foot from the accelerator pedal to the brake pedal. By reducing the need for traditional friction brakes, regenerative braking is also likely to extend the life of brakes and could mean as many as 100,000 miles between brake service. However, regenerative brakes are not as good as friction brakes for emergencies requiring a rapid complete stop – this is why most EVs typically still have both types of braking systems.

[4]



[5]

VEHICLE STRUCTURE AND OPERATION COMPARISONS

Beyond their power-generating mechanisms, EVs continue to share many features with their ICE counterparts when it comes to structural and safety components, and they are held to the same Federal Motor Vehicle Safety standards by the federal government.[6] There is no question EVs have fewer moving parts than ICE vehicles, which have complex thermo-mechanical systems with hundreds of components to accompany a relatively simple fuel system.

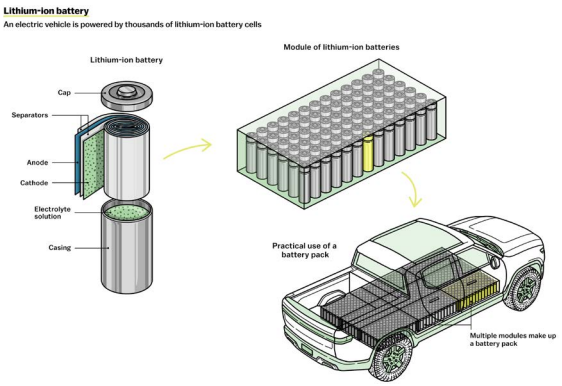
[4] https://www.energy.gov/energysaver/how-regenerative-brakes-work
[5] https://www.linkedin.com/pulse/regenerative-braking-what-how-works-shradha-jadhav/
[6] https://afdc.energy.gov/vehicles/electric_maintenance.html

And while EVs do not require motor oil to reduce friction like an ICE engine, they still require transmission fluids and synthetic lubricants or thermal management fluids that can withstand high temperatures and resist oxidation in the "fill for life" approach to EV parts. As noted above, EVs have a simpler motor made from fewer parts with fewer fluids to change, but they can also have thousands of additional electrochemical components.

As Mark Mills of the Manhattan Institute observed during a major public debate on EVs in October of 2023, "they aren't simpler, they're just differently complex."[7] That different complexity may actually signal an opportunity for more rather than less labor needed to build and maintain these vehicles in the future, according to several published research reports.[8]

Current studies show that EVs weigh 20% to 30% more than their ICE vehicle counterparts. Where steel and iron used in combustion engines and their supporting parts make up 85% of the weight of a conventional ICE vehicle, most of EV weight is found in the minerals relied upon for battery energy: copper, aluminum, lithium, nickel, cobalt, manganese, and neodymium.

A typical EV battery weighs about 1,000 pounds and is made from a range of the energy minerals mentioned above.[9] The majority of these are lithium-ion batteries, similar to the batteries found in a common smartphone. Lithium is very reactive, which allows it to hold high voltage and makes for an efficient and dense form of energy storage. EV batteries are densely packed collections of hundreds or even thousands of electrochemical cells, usually shaped like small cylinders or pouches where lithium ions "ping-pong" back and forth between the cell's cathodes and anodes.[10] It's not only the massive battery weight that differentiates these vehicles. The battery's size, shape, and location are important differences, as well – they are generally multiple times longer and wider than ICE batteries, creating a different type of risk.[11] EV batteries, rather than resting under a hood in the front of the vehicle as in a traditional ICE vehicle, are generally concentrated in the floorboards underneath the passenger compartment with components sending pulses throughout the vehicle structure. This is also what requires a coolant system that runs throughout the vehicle to protect the multitude of motors within an EV from overheating.



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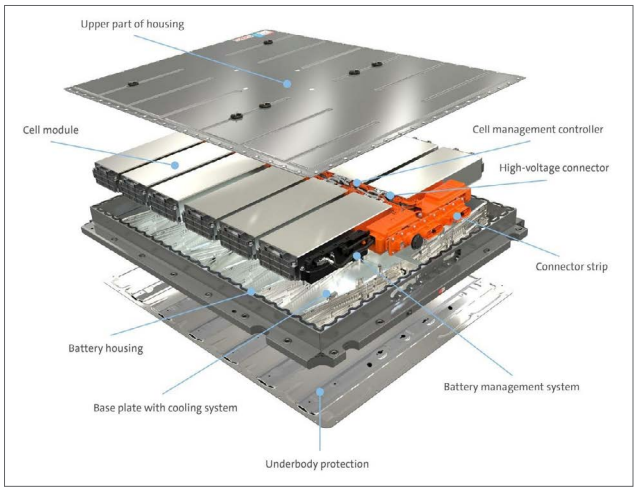
[7] https://www.realclearenergy.org/articles/2023/10/25/the_political_risks_of_mandating_evs_for_everyone_988506.html
[8] https://heatmap.news/electric-vehicles/evs-trump-uaw-jobs-evidence
[9] https://crsreports.congress.gov/product/pdf/R/R47227
[10] https://www.technologyreview.com/2023/02/17/1068037/how-do-ev-batteries-work/
[11] https://motorandwheels.com/electric-cars-battery-sizes/
[12] https://www.vox.com/recode/23027110/solid-state-lithium-battery-tesla-gm-ford
[13] https://www.carmagazine.co.uk/electric/ev-car-battery-capacity-tech/

Having laid out the basics of what EVs are and how they work, it is appropriate to move next into why insurers should be particularly invested in their development and then exposing some harsh realities of the EV market facing manufacturers, retailers, and ultimately policyholders.

INSURER CONSIDERATIONS SPECIFIC TO EVS

A comprehensive study by British firm Thatcham Research concluded that "there is no part of the motor insurance claims process which is unaffected by BEVs."[14]

This is undoubtedly true; from effects on crash rates to repair costs, fire risks, and salvage processes, insurer efforts to assess and price for the risks consumers want to offset moving forward will be fundamentally altered by the increasing number of EVs on our roads. We first consider EVs' effects on insurance-specific processes, followed by exposing general concerns and realities about the EV market and its future.



UNDERWRITING AND RATING

In every instance, the financial risks created by an EV today are different than those created by even the most closely comparable ICE vehicle. It is imperative that carriers (more specifically underwriting departments) be permitted to consider these risks in their decisions about whether to offer coverage for vehicles and at what price. At a minimum, carriers must be allowed to consider factors such as weight, high-voltage risks, extended repair periods, parts availability, parts costs, and crash severity trends in their coverage and pricing decisions. Carriers should be permitted to implement coverage limitations and develop customized EV enhancements for base policy language and coverages to be provided at appropriate rates. Any legislative or regulatory effort to mandate equal treatment of ICE and EV models by insurers should be rejected outright, as it would represent an intentional divergence of risk from rate. Over time, it is also safe to expect the presence of EVs in the broader vehicle fleet to place upward pressure on all auto premiums, as even ICE policyholders now find themselves at increased risk of suffering a crash involving an EV.

CONSUMER KNOWLEDGE, MAINTENANCE RECORDS, AND DRIVING EXPECTATIONS

The more consumers know about their cars, the better. Proper and timely vehicle maintenance can significantly decrease crash risks and reduce problems; the JD Power 2023 U.S. Tech Experience Index Study revealed that EV owners experience more technology problems and lower satisfaction with their vehicles than ICE owners.[15] This makes more sense since, in addition to being powered by newer technology, EVs tend to have more advanced driving assistance systems, which present a learning curve for drivers of older ICE vehicles lacking those features.

[14] https://www.thatcham.org/wp-content/uploads/2023/07/Impact-of-BEV-Adoption-on-the-Repair-and-Insurance-Sectors-report-Innovate-UK-and-Thatcham-Research-FINAL.pdf
[15] https://www.jdpower.com/business/press-releases/2023-us-tech-experience-index-txi-study?hss_channel=tw-46775492

Heavier reliance on advanced technology and complex electrical systems could render EV maintenance potentially more important than for their ICE counterparts; software and technology not updated in a timely manner leave an EV, its occupants, and anyone coming into contact with the vehicle more susceptible to damages that are preventable; insurers may need to consider whether maintenance of technology systems should be part of pricing assessments moving forward.

Early EV adopters are also reporting the need to replace even EV-specific tires with greater frequency – a logical consequence of the significantly greater weight of EVs.[16] [17] On the other hand, in the short term, the minimal maintenance requirements for EVs may be a feature rather than a bug – a 2021 study by industry analysts at WePredict found that in the first year of ownership, EV owners spent only $7 on maintenance compared to $30 for ICE vehicles.[18]

Additionally, driving behaviors that would not necessarily pose a problem for ICE vehicles may pose great danger for EVs, particularly batteries – for instance, a hard bounce off a speed bump or a tire strike to a large pothole that would have no meaningful effect on an ICE vehicle might cause significant damage to the undercarriage where the EV battery resides. Insurers will need to carefully consider appropriate policy languages and whether such incidents should be viewed as single-vehicle crashes, potentially covered by comprehensive auto policies.

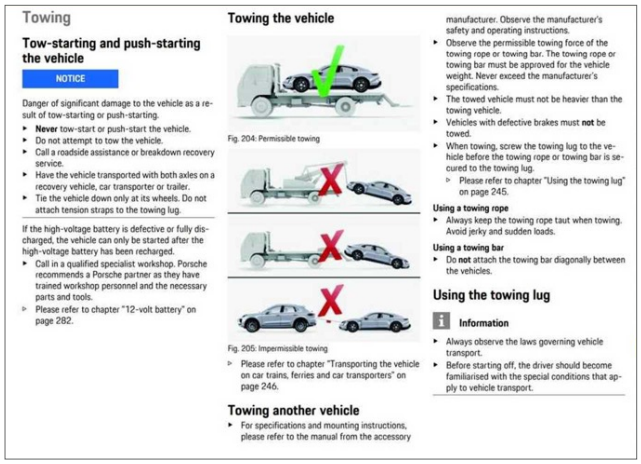
CRASH CLAIMS PROCEDURES

From first notice of loss to the repair and return or salvage of a policyholder's vehicle, the fact that it is an EV will affect every step of the claims adjudication and repair process. As body shops or adjusters assess the viability and pricing of repairs, they must consider not only the details and time required for the work to be performed, but also the availability of parts, technician qualifications, specific mandated processes or tools, and post-repair calibrations. A rear-strike fender bender that would barely merit attention and hammering out on an older ICE vehicle or require a handful of repairs on a newer ICE vehicle could very well affect up to a dozen powered systems in a comparable EV, entailing numerous hours of repair work and re-calibration.

EV crashes also complicate questions for policyholders and first responders regarding the extinguishing of fires, post-crash transport, storage, and repairability or salvage issues. Because of current limitations on the ability to repair or recycle the battery, the largest and most expensive component of an EV, total loss claims may become more frequent despite the high-dollar value of vehicles, frustrating both carriers and policyholders. EV battery fires are notoriously difficult and time-consuming to extinguish, which is likely to motivate local and state governments to pursue accident response fee programs to recover some of their costs, if they deem the fires worth putting out at all.[19] Analyses by the American Chemical Society and the Federal Emergency Management Agency suggest an ICE vehicle will burn up to about 1,500 degrees Fahrenheit and require 500 to 1,000 gallons of water to extinguish, while an EV battery fire can reach higher than 2,500 degrees Fahrenheit and take up to 20,000 gallons of water.[20, 21] Additionally, EVs are susceptible to thermal runaway, a dangerous chain reaction within a battery cell that often results in fires or explosions that burn hotter and longer than conventional fires due to the proximity and connected nature of battery cells.

[16] https://arstechnica.com/cars/2022/12/heres-why-electric-vehicles-need-ev-specific-tires/
[17] https://www.sciencefriday.com/segments/electric-vehicle-tires-wear-out/
[18] https://www.cnet.com/roadshow/news/evs-are-cheaper-to-maintain-but-can-cost-more-to-repair-research-says/
[19] https://www.wsj.com/business/autos/best-way-to-extinguish-a-flaming-electric-vehicle-let-it-burn-f1fa2b53
[20] https://www.acs.org/pressroom/reactions/library/why-are-electric-vehicle-fires-so-hard-to-put-out.html
[21] https://www.usfa.fema.gov/prevention/vehicle-fires/electric-vehicles/

The safety measures required for towing an EV will also differ from towing an ICE vehicle, as it is recommended the battery be disconnected in advance and the tires not touch the ground during the towing process because the act of allowing them to spin may generate an undesired charge, even while in neutral or "transport mode."[22] The most logical and safest way to tow an EV is to raise it onto a flatbed with a winch to keep the wheels from spinning – this will limit the number of towers capable of completing tows and likely increase their cost.
(Example from Porsche Taycan owner instruction manual)[23]



Towing

Tow-starting and push-starting the vehicle

NOTICE

Danger of significant damage to the vehicle as a result of tow-starting or push-starting.

- **Never** tow-start or push-start the vehicle.
- Do not attempt to tow the vehicle.
- Call a roadside assistance or breakdown recovery service.
- Have the vehicle transported with both axles on a recovery vehicle, car transporter or trailer.
- Tie the vehicle down only at its wheels. Do not attach tension straps to the towing lug.

If the high-voltage battery is defective or fully discharged, the vehicle can only be started after the high-voltage battery has been recharged.

- Call in a qualified specialist workshop. Porsche recommends a Porsche partner as they have trained workshop personnel and the necessary parts and tools.
- Please refer to chapter "12-volt battery" on page 282.

Towing the vehicle

Fig. 204: Permissible towing

Fig. 205: Impermissible towing

- Please refer to chapter "Transporting the vehicle on car trains, ferries and car transporters" on page 246.

Towing another vehicle

- For specifications and mounting instructions, please refer to the manual from the accessory manufacturer. Observe the manufacturer's safety and operating instructions.
- Observe the permissible towing force of the towing rope or towing bar. The towing rope or towing bar must be approved for the vehicle weight. Never exceed the manufacturer's specifications.
- The towed vehicle must not be heavier than the towing vehicle.
- Vehicles with defective brakes must **not** be towed.
- When towing, screw the towing lug to the vehicle before the towing rope or towing bar is secured to the towing lug.
  - Please refer to chapter "Using the towing lug" on page 245.

Using a towing rope

- Always keep the towing rope taut when towing. Avoid jerky and sudden loads.

Using a towing bar

- Do **not** attach the towing bar diagonally between the vehicles.

Using the towing lug

Information

- Always observe the laws governing vehicle transport.
- Before starting off, the driver should become familiarised with the special conditions that apply to vehicle transport.

On the storage front, once damaged, EVs pose an increased fire risk and are best stored in isolated bays or outdoors away from other vehicles – again, increasing the costs to insurers and policyholders. Finally, salvage and scrap yards are still developing their own approaches to EVs, which will affect insurer treatment in the future. An analysis by salvage yard leader U-Pull-It sees opportunities for salvage yards that invest in new tools and training, but also warns of extensive safety concerns including shocks to staff or customers, thermal runaway, and toxic fumes.[24]

REPAIR PROCEDURES AND PARTS

While ICE vehicles and EVs have many common features, the processes to repair them will be extremely different. At the outset, not all repair shops are equipped to repair EVs after a crash, whether for lack of tools, technicians, or access to necessary replacement parts. Insurers' existing direct repair programs will need to be re-evaluated and adjusted in some instances to consider a shop's specific EV repair capabilities. Early indications are that EVs transmit twice as many fault codes as comparable ICE vehicles; they require 1.7 additional hours for collision damage appraisals and 0.9 additional hours for refinishing.[25] It is also worth noting that the level of heat required for repainting a vehicle would most properly also require a complete discharging of the vehicle battery.[26]

[22] https://www.makeuseof.com/electric-vehicle-towing-explained/
[23] https://insideevs.com/news/403116/evs-harder-tow-depends-manufacturer/
[24] https://www.u-pull-it.com/the-impact-of-electric-cars-on-salvage-yards/
[25] https://www.propertycasualty360.com/2023/05/17/evs-see-small-uptick-in-repairable-claims-frequency-in-q1/
[26] https://rts.i-car.com/collision-repair-news/crn-1927.html

Experts across the vehicle repair community agree that EV batteries should be drained to work on a vehicle safely; just because an engine is not on does not mean the EV is de-energized. Electric fault malfunctions remain a high risk until the battery is drained, a process that often takes more than one hour. Once the actual repair process begins, EVs tend to include as much as a 50% greater average number of parts per estimate and labor costs at double the ICE vehicle rate, resulting in a total **average** cost of repair approaching $6,600.[27] Even when damage to EV systems is not readily apparent to a technician's naked eye, many shops require them to undergo a series of scans and calibration tests, further driving up the cost of the repair.

Another challenge arises related to repair parts – the majority of EV parts are not readily available directly to consumers and aftermarket alternative parts are not yet being produced. More than 90% of EV repair parts being OEM parts makes them more expensive – generally by about 25%. While the most frequently replaced parts are more expensive than comparable parts on comparable ICE vehicles, EV parts are less expensive than those parts for luxury ICE vehicles.[28] The outlier to that general rule is the battery – repairing or replacing a damaged high-voltage battery is still an extremely expensive challenge.

The batteries used to power EVs are complex. As such, they present costly challenges. Batteries are the most expensive part of an EV and were particularly prone to setbacks like the pandemic and Ukraine conflict-fueled semiconductor chip shortage because EVs use thousands of such chips. There are increasing concerns over the raw materials needed to make the batteries: lithium, cobalt, and nickel – since 70% of the price of an EV battery comes from the price of these materials, increases in their costs alone is predicted to lead to a 22% increase in EV battery costs between 2023 and 2026.[29] Complicating matters, the lithium-ion batteries that power most EVs present fire hazards in the event a short circuit, overheating, or overcharging.[30,31]

In the very limited real-world experience insurers have so far with EV crashes and claims, the severity of crashes appears to be higher when an EV is involved – this is not surprising considering EV features, expenses, and weight. An analysis by industry consulting firm Mitchell found that on average, EVs require more replacement parts than ICE cars, and those parts are often more expensive and take as many as three hours longer to install. The same analysis included some positive news regarding total-loss likelihood – in the data it reviewed, Mitchell found EVs were designated "non-drivable" at a slightly lower frequency than their ICE counterparts.[32]

[27] https://cccis.com/news-and-insights/insights/will-electric-vehicle-regulations-continue-to-force-change/
[28] https://cccis.com/news-and-insights/insights/electric-vs-ice-vehicles-unpacking-repair-cost-impacts/
[29] https://www.cnbc.com/2022/05/18/ev-battery-costs-set-to-spike-as-raw-material-shortages-drags-on.html
[30] https://www.nfpa.org/Public-Education/Fire-causes-and-risks/Lithium-Ion-Battery-Safety
[31] https://www.nyc.gov/assets/fdny/downloads/pdf/codes/dangers-of-lithium-ion-batteries.pdf
[32] https://www.mitchell.com/plugged-in-q2-2023-report

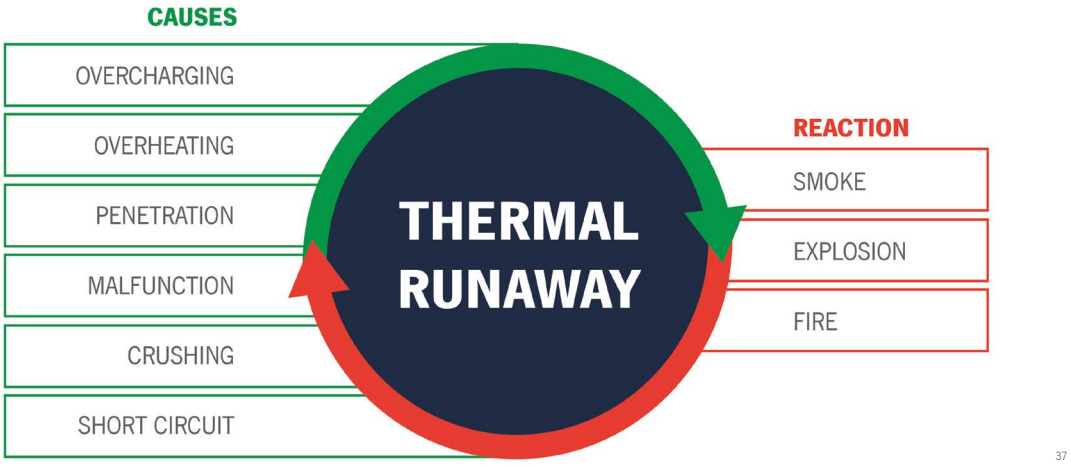
ADDITIONAL POST-CRASH CHALLENGES

To the extent EVs can be safely repaired, the lengthier duration of those repairs (an average of 58 days for EVs vs 23 days for ICE vehicles as of this writing) has downstream effects on insurers that find themselves covering longer rental car periods, with consumers often exhausting the 30-day maximum set forth in their policies.[33] Insurers may need to consider additional coverages providing longer rental periods in EV-specific policies accompanied by appropriate rate modifications.

Parts disposals and salvage costs for EVs are also unlikely to follow the same patterns as ICE vehicles, again in particular where batteries are concerned. Properly disposing of a lithium-ion battery can cost as much as $15,000; while innovators are hard at work trying to develop and improve battery recycling and repurposing capabilities, it is extremely challenging and is not happening at meaningful scale yet.[34] Also, BEVs can catch on fire days or even weeks after a crash if not stored correctly – as the chain of ownership and title processes on a damaged or salvage EV run their course, questions of liability for subsequent fires will need to be clarified.

SCIENCE EXPLAINER: "THERMAL RUNAWAY"

"Thermal runaway" is the term describing a chain reaction of events within a battery cell where heat builds up faster than it can be dissipated that can escalate into a dangerous and uncontrollable release of energy often resulting in fires or explosions. This phenomenon can be triggered by a range of factors, from a short circuit to inadvertent overcharging, and can lead to temperatures in excess of 2,500 degrees Fahrenheit, according to the U.S. Fire Safety Administration.[35] Thermal runaway fires burn hotter, longer, and less predictably than conventional fires – they can burn for hours or even days and can reignite after apparent dousing – one fire department reported a total of four hours and 20,000 gallons of water to extinguish such a fire.[36]

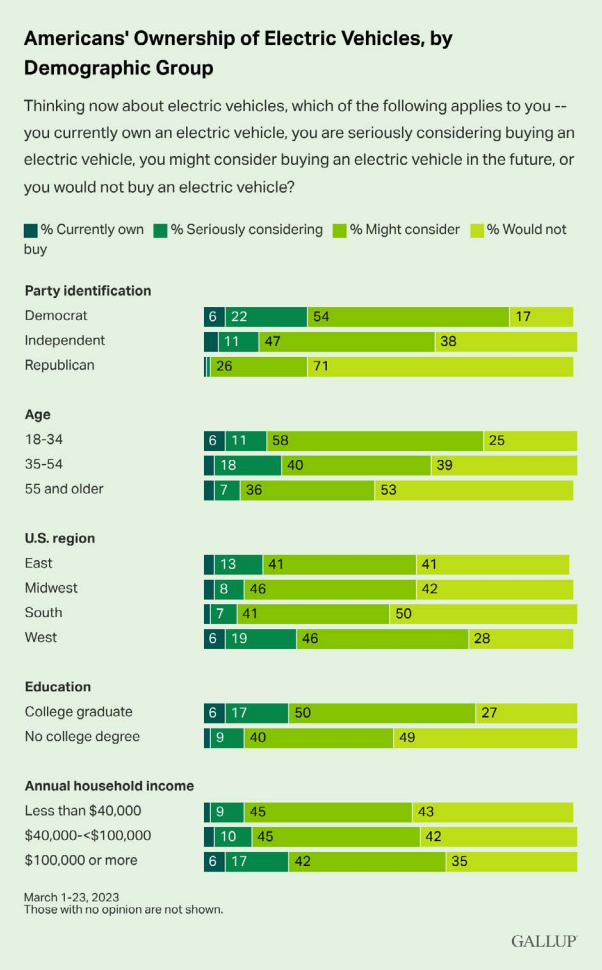


[37]

[33] https://www.theinformation.com/articles/the-electric-the-nightmare-cost-of-repairing-your-wrecked-ev
[34] https://www.caranddriver.com/features/a44022888/electric-car-battery-recycling/
[35] https://www.usfa.fema.gov/blog/ig-062322.html
[36] https://nfsa.org/2023/01/12/lithium-ion-battery-fires/
[37] https://batteryfiresafety.co.uk/what-causes-lithium-ion-battery-fires/

ZOOMING OUT ON THE EV ROAD BEYOND INSURANCE: ROUGH REALITIES AND CHALLENGES AHEAD

Insurers gladly embrace and endorse technological advancements, particularly those that have the potential to enhance policyholders' safety, but they are also in the business of pricing for vehicles and drivers on the roads facing the reality of risks as they are today. Some of the specific risk considerations for EV owners and insurers moving forward will include:



CONSUMER HESITANCY AND MISMATCHED EXPECTATIONS

The Wall Street Journal noted in October 2023 that the auto industry's efforts to boost sales of EVs were running into a cold, hard reality that buyers are simply not interested.[38] Electric car inventory continues to pile up on dealership lots as the growth curve declines following early adoption by enthusiastic and wealthy EV purchasers, leading some dealers to turn away EV inventory.[39] While the new car inventory of ICE vehicles on dealer lots is around a 54- day supply, EVs are sitting on lots for more than three months at a 92.2 day supply.[40] Turn rate on some electric models, like the Ford Mach-E, dropped to 27% in the second quarter of 2023 while GM's Hummer EV has seen nationwide sales decline by 85% in 2023.

Some dealers now fear that the production rate is out of step with consumer demand.[41] A study by the Energy Policy Institute at the University of Chicago found that nearly half of Americans say they would not even consider purchasing an EV as their next car.[42] This supply and demand mismatch becomes even more pronounced when political considerations are introduced, with 71% of Republicans saying they would not consider owning an electric vehicle in response to a 2023 Gallup poll.[43] However, the same poll further revealed that college graduates and those with annual household incomes of at least $100,000 are far more likely to say they may own an EV.

[38] https://www.wsj.com/business/autos/electric-vehicle-buyer-interest-67b407cb
[39] https://www.businessinsider.com/dealers-turning-away-evs-velectric-cars-demand-cools-inventory-2023-8
[40] https://www.businessinsider.com/auto-dealerships-inventory-electric-vehicles-gas-cars-key-problems-2023-6
[41] https://www.businessinsider.com/ford-electric-vehicle-inventory-problem-trying-to-beat-tesla-2023-7
[42] https://www.cnbc.com/2023/04/11/nearly-half-of-americans-say-its-unlikely-theyll-buy-an-ev-next-poll.html
[43] https://news.gallup.com/poll/474095/americans-not-completely-sold-electric-vehicles.aspx

Political control will also likely affect automakers' strategic decisions in this sphere – Stellantis CEO Carlos Tavares told reporters in December 2022 that he was prepared to adjust his company's EV strategy "if political and public opinion tends toward fewer EVs," further noting that "we have plans for this."[44]

Politics aside, it also appears that would-be EV purchasers make up a particular segment of the population with very different expectations from not only vehicles themselves, but the vehicle purchasing and ownership processes. McKinsey & Company's study of consumer attitudes toward vehicle purchasing revealed that the segment of consumers most interested in EVs is also more likely to prefer digital interactions and online shopping, although only 24% say they want an entirely human-free experience. Across all vehicle categories, 87% of consumers still want to test drive before purchasing. Additionally, EV-inclined consumers express significant concerns about insufficient personalization options and the lack of transparent pricing in the purchasing process.[45]

These consumer trends have led numerous automakers to pump the brakes on previously announced investments into their EV transitions.[46] Notably, General Motors has delayed three model launches; Ford announced postponing $12 billion in EV investments and high-profile battery plants in Michigan and Kentucky "due to evolving EV demand"; and Honda announced it was ending plans to develop "affordable" EVs.[47]

Mercedes-Benz CFO Harald Wilhelm described the EV market as a "brutal space" in November 2023[48], and Toyota chairman Akio Toyoda explained his company's "wait and see" approach that has continued to focus on hybrids and PHEVs rather than pure BEVs:

"I have continued to say what I see as reality. Someone needs to convey to the industry what will make car buyers most happy and if regulations are created based on ideals, it is regular users who are the ones who suffer."[49]

[44] https://europe.autonews.com/automakers/stellantis-ceo-tavares-readies-automaker-slower-ev-ramp#
[45] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/electric-vehicle-buyers-demand-new-experiences
[46] https://jalopnik.com/automakers-are-pumping-the-brakes-on-the-ev-transition-1850974028
[47] https://www.dailysignal.com/2023/10/27/automakers-wake-up-reality-electric-vehicles/
[48] https://fortune.com/2023/10/26/mercedes-benz-harald-wilhelm-earnings-electric-vehicle-ev-market-brutal-unsustainable-tesla-auto-strikes/
[49] https://jalopnik.com/toyota-s-chairman-is-having-his-i-told-you-so-moment-1850958887

LITHIUM: "WHITE GOLD" POWERING THE FUTURE

Lithium, the lightest of all alkali metals, often referred to as "white gold" due to its market value and silver color, is actually abundant in the earth's crust but is very finely distributed. In 2022, 47 percent of global lithium demand was met by mining solid rock in Australia's open-pit mines, 35% from South America's salt lakes, 15% from China, ; and just under 1% each from Zimbabwe, Portugal, and North America. While abundant, it is time and resource consuming to mine – extracting one ton of lithium by evaporative mining requires about 132,000 gallons of water and lowers regional water tables, drying up lakes and wetlands. The rapidly increasing demand for the mineral has led to a worldwide price spike – current prices are 590% higher than at the start of 2021, causing increasing understandable angst among battery manufacturers around the globe.

EVS ARE VERY EXPENSIVE FOR CONSUMERS AND MANUFACTURERS, DESPITE GOVERNMENT INCENTIVES

Even with price slashing by dominant market player Tesla, anticipated price reductions as EV technology has become more commonplace have not come to fruition.[50] To oversimplify, this is at least partly because all cars remain near historic highs in price – Cox Automotive's market report indicates that average new-vehicle prices for September 2023 were down to $47,899 for ICE vehicles with EVs at $52,212. While this is still extremely high, it is a slight reduction from earlier in the year when prices peaked at nearly $50,000 across all ICE vehicles and $65,000 for EVs.[51] On average, EV base prices remain between 15 percent and 30 percent more than comparable ICE counterparts – for the Ford F-150, the most popular vehicle in the U.S., the basic work truck spec Lightning EV version starts at $56,000 while the same-level gas F-150 starts at $34,000. Even at current prices, manufacturers are losing money on EV investments – one report indicated that Ford lost about $36,000 for every EV it sold in Q2 of 2023.[52]

[50] https://cars.usnews.com/cars-trucks/advice/why-are-electric-cars-so-expensive
[51] https://www.coxautoinc.com/market-insights/kbb-atp-september-2023/
[52] https://money.com/why-americans-not-buying-electric-cars/

The federal government and several states have aggressively pushed EVs as a matter of policy through benefits like tax credits or with proposed vehicle emission mandates. The Infrastructure Investment and Jobs Act of 2021 provides funding for eight programs related to EV battery development[53]:

- Battery and Critical Minerals Mining and Recycling Grant Program ($125 million)
- Earth Mapping Resources Initiative ($320 million)
- U.S. Geological Survey – Energy and Minerals Research Facility ($167 million)
- Battery Materials Processing and Battery Manufacturing Recycling ($2.8 billion)
- Electric Drive Vehicle Battery Recycling and 2nd Life Apps Program ($200 million)
- Advanced Energy Manufacturing and Recycling Grant Program ($750 million)
- Future of Industry Program and Industrial Research and Assessment Centers ($550 million)

The 2022 Inflation Reduction Act further extended and expanded several related grants and credits, including the most widely known "Clean Vehicle Tax Credit."[54] Following the Treasury Department's issuance of formal guidance on April 18, 2023, only six widely available 2022–2024 BEV models qualified for a full $7,500 credit, while another four models qualified for a half credit of $3,500.[55] The law governing these tax credits stipulates that vehicles can only qualify if they meet certain battery requirements and pricing thresholds, and are made in North America. New guidance issued on Dec. 1, 2023, further disqualifies a vehicle from receiving the credit if just one of its suppliers has ties to Beijing, such as producing parts in China or having 25% of board seats controlled by China.[56] Qualifying vehicles as of this writing are listed below, noting that even after tax credits are applied, the average price of these vehicles is more than $67,000[57]:

BEVs Qualifying for $7,500 Credit	BEVs Qualifying for $3,500 Credit	PHEVs Qualifying for $7,500 Credit	PHEVs Qualifying for $3,500 Credit
Cadillac LYRIQ	Ford E-Transit	Chrysler Pacifica	Ford Escape Plug-In
Chevrolet Bolt	Ford Mustang Mach-E	Lincoln Aviator Grand Touring	Jeep Grand Cherokee PHEV 4xe
Ford F-150 Lightning	Rivian R1S*		Jeep Wrangler PHEV 4xe
Tesla Model 3* Performance	Rivian R1T*		Lincoln Corsair Grand Touring
Tesla Model Y*	Tesla Model 3 Standard		
Volkswagen ID.4			

**Pricing requirements do not apply to all-electric manufacturers like Tesla and Rivian because there is no comparable ICE vehicle for comparison.*

[53] https://rmi.org/the-ev-battery-supply-chain-explained/
[54] https://electrificationcoalition.org/work/federal-ev-policy/inflation-reduction-act/
[55] https://www.fueleconomy.gov/feg/taxcenter.shtml
[56] https://home.treasury.gov/news/press-releases/jy1939
[57] https://money.com/electric-vehicles-qualify-tax-credits-2023/?ref=/why-americans-not-buying-electric-cars/

Lawmakers at the federal level have pushed back, where H.R. 1435, the Preserving Choice in Vehicle Purchases Act, sponsored by Rep. John Joyce, R-Pa., passed the U.S. House of Representatives by a 222-190 vote on September 14, 2023.[58] The bill, strongly supported by the U.S. Chamber of Commerce, would amend the Clean Air Act to prevent the Environmental Protection Administration from waiving a prohibition on state governments' limiting the sale or use of new motor vehicles with internal combustion engines; such waivers are already a subject of ongoing litigation.[59, 60] Rep. Doris Matsui, D-Calif., called the bill "a love letter to Big Oil – legally mandating that Americans think first of the internal combustion engine before considering air quality or public health," while the White House issued a statement of administration policy in opposition to the bill focused on supporting California's authority to regulate emissions.[61] The Senate Companion Bill, S. 2090, currently has 16 co-sponsors and has been referred to the Committee on Environment and Public Works with no further action announced.[62]

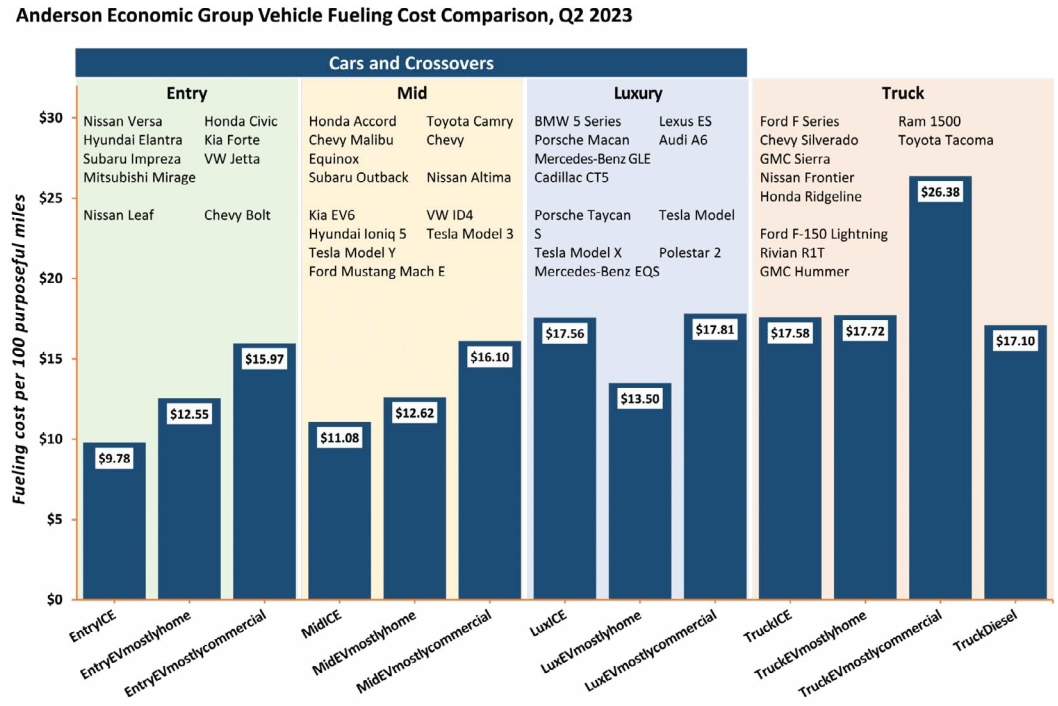
Congressional concerns are not rising in a vacuum – the California Air Resources Board has issued a rule to mandate that only zero-emission EVs be sold by 2035.[63] The mandate was promptly followed by an order from the California energy grid operator to restrict the charging of EVs due to high demand for electricity during a summer heat wave – these kinds of poorly coordinated government actions could certainly cause consumer whiplash.[64] Based on California's EPA waiver under the Clean Air Act, 15 states have set a number or percentage of new vehicles sold that must be zero emissions.[65]

Additionally, policymakers at the state level have already started to plan for a decrease in fuel tax revenue from EV drivers who are using public roads without gas power.[66] The concept of mileage-based taxes or road-usage charges (RUC) is not entirely novel; Oregon has been testing the concept through its "OREGO" project since 2015; and in addition to its RUC program, Utah instituted an alternative fuel vehicle fee in 2018. A dozen other states have federal grants for similar pilot programs in the works.[67]

ELECTRICITY IS COSTLY

An August 2023 study by the Anderson Economic Group found that for entry- and mid-priced cars, crossovers, and trucks, ICE vehicles were more economical to fuel than their EV counterparts.[68] The study did find that for EV luxury vehicles, charging per purposeful mile was less, but only if the vehicles were charged at home rather than commercially –as most ICE luxury vehicles require premium grade gasoline.

[58] https://www.congress.gov/bill/118th-congress/house-bill/1435/actions?s=1&r=1&q=%7B%22search%22%3A%22hr+1435%22%7D
[59] https://www.uschamber.com/infrastructure/transportation/u-s-chamber-key-vote-letter-on-h-r-1435-the-preserving-choice-in-vehicle-purchases-act
[60] https://thehill.com/opinion/energy-environment/4206509-congress-must-take-california-out-of-the-drivers-seat-on-electric-car-mandates/
[61] https://www.whitehouse.gov/wp-content/uploads/2023/09/HR-1435-SAP.pdf
[62] https://www.congress.gov/bill/118th-congress/senate-bill/2090/actions
[63] https://www.gov.ca.gov/2022/08/25/california-enacts-world-leading-plan-to-achieve-100-percent-zero-emission-vehicles-by-2035-cut-pollution/
[64] https://www.newsweek.com/californians-told-not-charge-electric-cars-gas-car-sales-ban-1738398v
[65] https://www.epa.gov/state-and-local-transportation/vehicle-emissions-california-waivers-and-authorizations
[66] https://www.bridgemi.com/michigan-government/michigan-eyes-miles-traveled-charge-roads-evs-cut-fuel-tax
[67] https://www.autoweek.com/news/a45222372/ev-mileage-tax-details/
[68] https://www.andersoneconomicgroup.com/many-gas-powered-cars-cheaper-to-fuel-than-electric-in-2023/



As a general matter, after nearly a decade of stability, U.S. electricity prices per kilowatt hour in 2023 are up nearly 20% over the last year.[69] While the U.S. Department of Energy suggests charging a car at home could cost as little as $60 per month, there is significant variance based on geography and charging times. An October 2023 analysis by the Texas Public Policy foundation found that EV owners are usually charged normal, flat rates for electricity load, but an EV charge can pull up to eight times as much as an average home draws, resulting in a socialized cost of approximately $11,000 per EV over 10 years.[70]

[69] https://fred.stlouisfed.org/series/APU000072610#
[70] https://www.texaspolicy.com/wp-content/uploads/2023/10/2023-10-TrueCostofEVs-BennettIsaac.pdf

CHARGING STATION CHALLENGES AND CHARGING ANXIETY

The power supplied to EVs comes most frequently from tapping into the established electrical grid; solar, wind, and hydro-charging are not yet widely available and involve expensive, bespoke installations. While some commercial "fast charging" can provide direct current power directly, the majority of home-charging units will deliver alternating current power to a vehicle, which the onboard equipment converts into the DC power necessary to build the battery's charge. These often 110-volt variety chargers operate from a standard three-prong electrical outlet. Faster charging is possible with upgrades to 240-volt chargers, which require a dedicated circuit that frequently costs more than $1,000, plus installation fees. In some states and localities, installation of such a charger in a garage may require a specific permit that could increase costs. While relatively rare to date, home garage chargers have been linked to multiple high-profile fires resulting in extensive property damage. Moving forward, home insurers will certainly take the presence of EVs and their related charging needs, along with accompanying risk reduction measures, into consideration when assessing and pricing coverage for such structures, even though as of this writing fewer home structure fires are attributed to EV's than kitchen appliances on an annual basis.[71]

While many of the affluent single-family homeowners who have made up the first wave of EV adopters also have garages where they can install chargers, this is not the case for most Americans. Condominium and apartment building residents may struggle to find access to chargers; even if the landlord or building management installs some, how their use is regulated and shared may prove a nuisance, while also increasing fire risks for the entire structure.

This is not to say that chargers are not being built and infrastructure is not improving – businesses across the country are installing charging stations to satisfy consumer demand, and in a major announcement in November 2023, Hilton Hotels committed to installing 20,000 EV charging stations at 2,000 of its North American properties, with a minimum of six per hotel.[72] The Biden administration, in conjunction with corporate sponsors like Wal-Mart, Uber, and Zipcar, announced in the spring of 2023 its intention to have an additional 100,000 public chargers by 2024, nearly doubling the current number of 135,000.[73] The U.S. Department of Energy is home to the Alternative Fuels Data Center, which maintains databases of EV laws and incentives,[74] as well as fuel station maps and a vehicle cost calculator. Despite $5 billion in funding toward a national charging network, EV owners still can't charge in most places.[75]

While public charging and wait times are often identified as a nuisance, the payment process for charging is viewed as a bright spot – when a consumer plugs into a public charger, the charger identifies the vehicle, validates the charge, and starts the charging process with automated payment and billing upon completion. Despite the satisfaction with payment processes and promises of additional charging infrastructure and government grants, customer satisfaction with charging remains on a significant decline.[76] Some consumer surveys show charging anxiety eclipsing range anxiety as EV shoppers' top concern.[77] Recharging an EV takes more than 45 minutes, even with a so called "Supercharger," which costs two to three times more than a gasoline pump to install and requires much more power than an overnight home charger.

[71] https://energycentral.com/c/ec/reducing-risk-housefires-ev-charging
[72] https://viewfromthewing.com/hilton-adding-20000-ev-charging-stations-to-2000-north-american-hotels/
[73] https://www.marketwatch.com/story/biden-adds-more-ev-charging-across-u-s-with-pledges-from-uber-walmart-pg-e-and-others-81e20ffc
[74] https://afdc.energy.gov/laws/
[75] https://www.npr.org/2023/09/10/1187224861/electric-vehicles-evs-cars-chargers-charging-energy-secretary-jennifer-granholm
[76] https://www.jdpower.com/business/press-releases/2023-us-electric-vehicle-experience-evx-public-charging-study
[77] https://www.tomtom.com/newsroom/behind-the-map/charging-anxiety-for-ev-drivers/

RANGE ANXIETY IS WELL-FOUNDED FOR SOME MODELS AND SOME TRIPS

When Americans are asked the reasons for their reluctance to enter EV ownership, they typically answer they are worried over when and where to recharge the battery and the fear of getting stranded and requiring a tow. A ValuePenguin survey of drivers considering EVs found range anxiety trailing only to cost and the lack of charging stations.[78] While EV mileage ranges continue to improve, with some updated offerings approaching 400 miles per charge; the average U.S. driver only covers 37 miles per day; yet, studies continue to show that range anxiety and range reduction from battery degradation or inclement weather present some of the greatest challenges for the peace-of-mind of would-be EV purchasers.[79]

Additional concerns over range accuracy and estimates certainly appear justified, as a Consumer Reports test found that even "when driven at a constant highway speed of 70 mph, some vehicles we tested fell up to 50 miles short of their advertised ranges, while others exceeded their advertised ranges – one by more than 70 miles."[80]

Particularly BEVs suffer from severe range reductions due to extreme temperatures because the same battery that powers the engine also powers climate-control systems. A study by truck manufacturer Autocar shows that EVs lose, on average, a third of their range in the winter, going from a 240 miles to 160 miles.[81] At the other end of the spectrum, batteries also lose additional range in weather above 85 degrees, and the hotter it gets the greater the battery drain, which is particularly concerning in light of the importance of air conditioning in hot weather.[82] Additionally, just like other battery-powered devices, annual degradation can be expected at a pace of 3% per year with higher rates of decay accompanying higher temperature, cycle, and time uses.[83]

Long-term battery degradation is also a valid concern for potential EV owners and further contributes to range anxiety – no matter how careful owners are, EV batteries will age and range will be reduced in contrast to original performance.

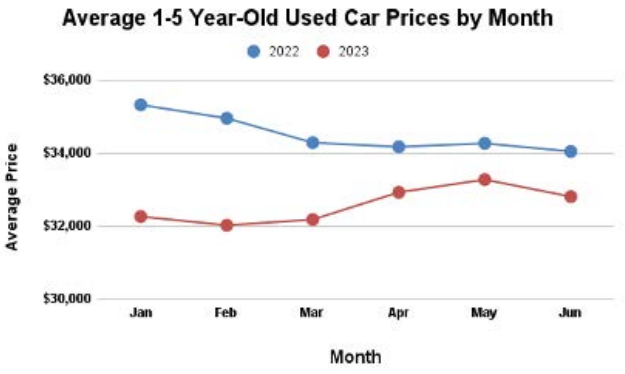

[84]

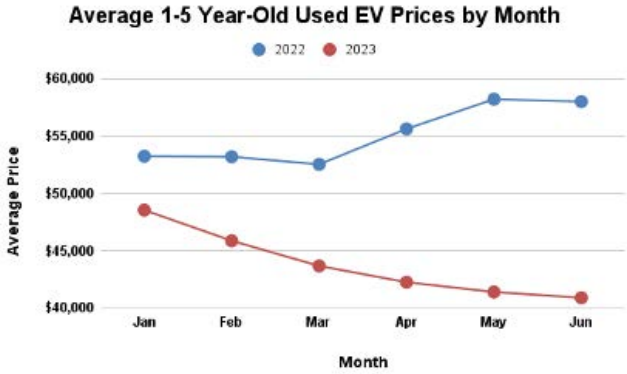
The Society of Automotive Engineers conducted a study using its Battery Lifetime Analysis and Simulation Tool for Vehicles and found that degradation is affected by driver patterns, climate, overcharging, deep discharges, corrosion, lack of use, and most of all, the climate in which a battery operates.[85]

[78] https://www.valuepenguin.com/electric-vehicle-concerns-survey
[79] https://www.forbes.com/wheels/news/range-anxiety-very-real-jd-power-evs-survey/
[80] https://www.consumerreports.org/cars/hybrids-evs/real-world-ev-range-tests-models-that-beat-epa-estimates-a1103288135/
[81] https://www.autocar.co.uk/car-news/move-electric/electric-vehicle-range-test-reveals-20-drop-winter
[82] https://cars.usnews.com/cars-trucks/advice/what-ac-does-to-your-ev-range
[83] https://www.evconnect.com/blog/how-long-does-an-electric-car-battery-last
[84] https://www.change-climate.com/Transport_Land_Sea_Sustainable/SMART_Hybrid_EV_Energy_Service_Networks/Range_Anxiety_Electric_Vehicles_Recharging_Times_Journey_Delays.htm
[85] https://www.jstor.org/stable/26268745

REALITY: EV DEPRECIATION IS OUTPACING ICE VEHICLE DEPRECIATION

The average used EV price dropped nearly 20% in the first half of 2023 while the overall average used car price went up by 2%.[86] Potential EV buyers have good reason to worry their cars won't hold their value well as technology improves. The used market is not as strong for electric vehicles, and, as a result, the depreciation is higher. While this experience reflects a recency bias because EVs have simply not been in the market for long and since there are fewer used ones available, it is at a minimum a trend worth monitoring for insurers.





REALITY: PRIVACY AND CYBERSECURITY ARE GENUINE CONSUMER CONCERNS

Cybersecurity incidents in the automotive industry rose 225% from 2018 to 2021; that growth is expected to continue as more consumers engage with connected cars, whether EVs connecting to the electricity grid or through over-the-air updates.[87] EVs contain extensive technology that generates large amounts of data that may be of interest to thieves: telematics systems, battery tracking software, GPS navigation, and infotainment systems to name a few. Hackers may target this information for use against either OEMs or vehicle owners directly. EV manufacturers will face challenges as they try to stay on top of the most up-to-date cybersecurity protocols, guidance, and requirements from vehicle and data regulatory agencies, such as NHTSA's 2022 Cybersecurity Best Practices for the Safety of Modern Vehicles[88] and ISO/SAE standard 21434 Road Vehicles: Cybersecurity Engineering.[89]

[86] https://www.iseecars.com/used-car-prices-study#v=2023-06
[87] https://innovationatwork.ieee.org/the-continuing-evolution-of-automotive-cyber-security/
[88] https://www.nhtsa.gov/sites/nhtsa.gov/files/2022-09/cybersecurity-best-practices-safety-modern-vehicles-2022-pre-final-tag_0_0.pdf
[89] https://www.iso.org/standard/70918.html

At the same time, EV manufacturers will have to take great care not to run afoul of emerging privacy laws across the state landscape. While consumers generally relinquish some specified privacy expectations by signing the manufacturer's privacy policy at the time of purchasing the vehicle, domestic and international laws may come into play anytime the vehicle collects, stores, or transfers information about the driver or passengers.

[90]

In addition to the vehicles themselves, charging stations represent another potentially sensitive data collection point. EV charging stations are connected to the internet, and they collect and transmit data to and from the EV during the charging process, as well as processing electronic payments, thereby creating another potential risk. A single cybersecurity attack on such a charging station could have significant implications not only for the immediate EV and its driver, but for the local power grid and all the subsequent EVs that use the same charger. Cybersecurity researcher Jay Johnson lays it bare: "It is potentially a very catastrophic situation for this country if we don't get this right."[91] Insurers are carefully monitoring these risks that give rise to potential claims, whether through a hacked vehicle or ransomware introduced through a charger that subsequently connects to an on-board cellular telephone. Future policies and coverages will need to take these novel risks into account.

[90] https://terranovasecurity.com/blog/electric-vehicle-cyber-security/
[91] https://www.wired.com/story/electric-vehicle-charging-station-hacks/

COMMERCIAL AND RENTAL FLEET TRANSITIONS WILL POSE UNIQUE CHALLENGES

While most of the discussion has focused on private passenger-owned EVs, the dramatic changes are also sure to affect both commercial and rental fleets of vehicles. For instance, rental car giant Hertz pledged early in 2023 to have 25% of its 500,000 vehicle fleet be electric by the end of 2024.[92] That pledge has already been scaled back, and the transition is reportedly hurting the company's earnings due to increased damage costs and higher depreciation rates as was discussed above in the context of privately owned EVs.[93] All the aforementioned consumer reluctance issues are also coming into play in the rental space. While rental agreement fine print has been updated to include EV idling fees and charging requirements, many reports of consumer experiences with EV rentals range from mediocre to nightmarish, particularly when the consumer did not ask for an EV at the time of reservation and has no experience driving one.[94] [95] [96] Commercial fleet managers are similarly wary of buying into the coming transition too aggressively – charging infrastructure and grid capacity in particular present concerns, as fleets will promptly become the heaviest consumers of electricity putting strain on supply and cost. Further transition will also force challenging modifications to route planning, maintenance schedules, driver training, and the cost of commercial insurance.[97] [98]

THE ROAD AHEAD IS FULL OF EXTENSIVE AND UNCLEAR RISKS THAT ACCOMPANY TREMENDOUS EV POTENTIAL

The future of American transportation will certainly include increasing numbers of EVs, and there will be opportunities for the insurers that develop ways to successfully provide coverage and financial peace of mind at an appropriate rate for their owners. Even if EVs never make up more than 7% to 10% of the U.S. vehicle fleet, which would still represent more than 20 million cars sharing roads with conventional ICE vehicles. Early indicators from insurance industry research are EVs are at least as safe as their ICE counterparts for vehicle occupants and make less attractive theft targets. Only time will truly tell the full story of EVs on U.S. roads in this new era of risk; insurers will undoubtedly remain policyholders' indispensable partners in every conversation about protecting their vehicles and families riding in them.

[92] https://www.cnbc.com/2023/05/14/hertz-is-going-electric-with-big-implications-for-ev-and-auto-market.html
[93] https://www.forbes.com/sites/rrapier/2023/10/31/hertz-hurt-by-electric-vehicle-challenges/?sh=7e33b85e4878
[94] https://www.theatlantic.com/technology/archive/2023/06/electric-vehicle-rental-cars-hertz-chargers/674429/
[95] https://cleantechnica.com/2023/11/05/its-another-ev-rental-car-nightmare/
[96] https://www.cbsnews.com/chicago/news/electric-car-traps-mom-daughter/
[97] https://www.ftsgps.com/resource-center/ev-fleet-challenges/
[98] https://newsroom.hertz.com/news-releases/news-release-details/hertz-electrifies-launches-denver-new-public-private-partnership

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