



Standards &
Engagement



INSIGHTS AND RESOURCES

Addressing Battery Fire Risks Through Standards

Letter from the Executive Director



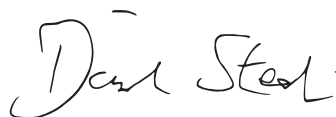
Devastating fires caused by e-bike and scooter batteries have been in the headlines and on the mind of government leaders. New York City, in particular, has had a high number of incidents that led its City Council to take legislative action last year. The issue has also earned the attention of Capitol Hill, with multiple bills introduced in the House and Senate.

UL Standards & Engagement wants to be a resource to government and community leaders who want to look into opportunities to better protect their constituents from the dangers of lithium-ion batteries. Our safety expertise is rooted in 120 years of standards development that has yielded more than 1,700 standards and documents that make our homes, communities, and modes of transportation safer and more sustainable.

There are more than 80 UL standards to address lithium-ion battery risks. They offer a layer of protection for the consumer who is largely unaware of the risk, as the study we have included in these materials reveals. Ensuring that relevant standards are required for e-bikes and scooters helps overcome this dangerous awareness gap.

We developed the following materials to inform and support government and community leaders interested in learning about lithium-ion battery issues and considering legislative action.

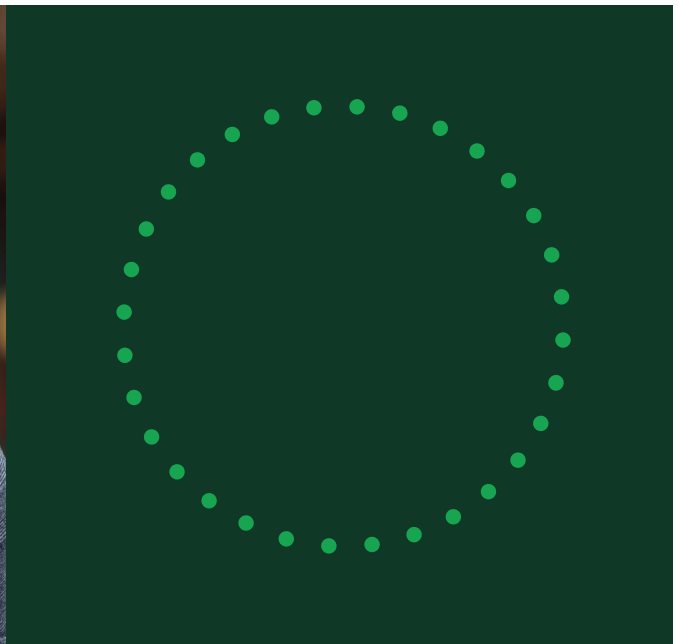
UL Standards & Engagement seeks to be a resource and trusted partner in helping you better protect your communities.

A handwritten signature in black ink that reads "David Steel". The signature is written in a cursive, flowing style.

Dr. David Steel
Executive Director
UL Standards & Engagement

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Keeping Life in Progress Through Battery Safety Standards



As society moves toward clean, renewable, and sustainable energy sources, lithium-ion batteries have become a critical power source. These rechargeable batteries are small and compact, yet still capable of storing large amounts of energy. They are also ubiquitous, found in everything from smartphones and e-bikes to electric vehicles and large-scale energy grid storage systems. Standards help prevent the risks and hazards inherent to lithium-ion battery power and support technological progress in clean energy.

Lithium-Ion Battery Hazards



Thermal Runaway

Thermal runaway is a phenomenon in which a lithium-ion cell enters an uncontrollable, self-heating state. This reaction can be caused by substandard quality and design, poor components, physical abuse, and improper charging or discharging. Thermal runaway can result in extremely high temperatures, violent cell venting, fire, and explosion.



Stranded Energy

Stranded energy refers to the remaining energy in a battery after it has been damaged or removed from service. If batteries are not properly managed, stranded energy can lead to thermal runaway and hazards such as electrical shock, fire, and explosion.



Off-Gassing

Off-gassing is the act of releasing gases from a battery during charging or discharging. Off-gassing at a minor scale can be a normal part of battery operation, but it can accelerate to dangerous levels if the battery is damaged, overcharged, or overheated. These gases can be flammable and toxic. Off-gassing poses an elevated safety risk if it occurs in a confined space, or one that is not properly ventilated.

Standards

Our catalog includes more than 80 standards that reduce the risks associated with lithium-ion batteries and the devices that rely on them, such as electric vehicles and e-mobility devices, charging systems, grid energy storage, drones and robotic equipment, audio/video and virtual reality equipment, and household electronics and appliances.

e-Mobility

- 1 Personal e-Mobility Devices | UL 2272
- 2 e-Bikes | UL 2849
- 3 Light Electric Vehicles | UL 2271
- 4 Light Electric Rail | UL 1973

Batteries and Electrical Systems

- 5 Household and Commercial Batteries | UL 2054
- 6 Batteries for Electric Vehicles | UL 2580

Charging and Energy Storage and Distribution

- 7 Electric Vehicle Supply Equipment | UL 2594
 - 8 Charging System Equipment | UL 2202
 - 9 Plugs, Receptacles and Couplers | UL 2251
 - 10 Protection Devices in Charging Systems | UL 2231-1, UL 2231-2
 - 11 Energy Storage Systems | UL 9540
- Test Methods for Evaluating Thermal Runaway Fire Propagation in Battery ESS | UL 9540A
- 12 Energy Management Equipment | UL 916



CASE STUDY

How Governments Are Reducing E-Bike Fires with Standards

Problem:

Ownership of e-bikes and scooters has soared since the pandemic, offering a cost-effective, and environmentally friendly way to get from point A to point B. However, the lithium-ion batteries that power these devices and allow them to be rechargeable have the potential to cause extreme damage if they go into thermal runaway, an uncontrollable, self-heating state that can result in fire or even explosion.

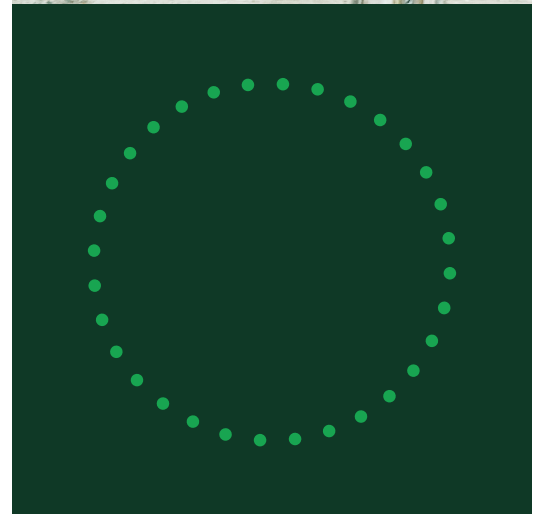
Lithium-ion battery fires are intense, fast, and difficult to extinguish. The Fire Safety Research Institute of UL Research Institutes conducted an e-bike fire test in partnership with the FDNY, finding that it took less than 20 seconds from when the first smoke appeared from the e-bike to completely engulf the room in flames.

Instances of these devastating fires have been reported across the country. They present a unique risk in cities, as more densely populated areas can result in fires that spread quickly from apartment to apartment or building to building.

Solution:

At UL Standards & Engagement, we are working with stakeholders to achieve a safer, more sustainable world through standards. Standards are guidance documents for manufacturing and testing a product's safety, developed by a committee of experts from industry, manufacturing, government, academia, and more.

For e-bikes and scooters, ULSE has three standards that cover the devices and the batteries that power those devices: UL 2849, the standard for e-bikes; UL 2272, for personal e-mobility devices; and UL 2271, the standard for lithium-ion batteries in e-mobility devices. These standards are designed to protect against thermal runaway and the devastating fires it can produce.



How are governments handling this issue?

From local to federal government, a variety of approaches are being used to curb deadly lithium-ion battery fires. While each solution is unique, leveraging UL standards as part of the solution is common to all of them.



At the Federal Level

Several pieces of legislation are currently pending in Congress that aim to reduce risk of lithium-ion related fires, including two bills introduced in March 2023.

The Safe Charging Electric Bikes and Scooters Act (H.R. 1685 and S. 881) would direct the Department of Transportation to create grants for local governments to install charging and storage stations for e-mobility devices. Additionally, the Setting Consumer Standards for Lithium-Ion Batteries Act (H.R. 1797 and S. 1008) would direct the Consumer Product Safety Commission to require all e-mobility batteries be tested to multiple ULSE safety standards.



New York City, NY

In New York City — where fires more than doubled from 2021 to 2022 and have become the leading cause of deadly fires — the increasing problem required action. The signing of Local Law 39 on March 30, 2023, took a critical step forward in protecting consumers by prohibiting the sale, lease, or rental of e-mobility devices and their batteries that did not meet specific ULSE's safety standards (UL 2849, UL 2272, and UL 2271).

In an effort to remove e-mobility devices that do not conform to safety standards, the city council approved a trade-in program for residents which will allow them to purchase certified products at a lower cost. Additionally, the city approved a separate e-bike trade-in program specifically for delivery workers so that they can safely do their job without worrying about a cost burden.



Washington, D.C. and Denver, CO

Denver and Washington, D.C. created e-bike programs to make devices more accessible. As the programs were developed, both the city governments took safety into account, including the requirement that e-mobility devices are certified to ULSE standards.

Taking Legislative Action to Drive E-Bike Safety

The e-bike and scooter market has grown significantly in recent years. As of 2021, commuters and tourists have access to 202,000 micromobility devices across 273 cities. More than 65,000 gig workers rely on e-bikes and scooters to make deliveries in New York City alone.

With this rapid growth has come a rise in the number of battery fires. In 2023, New York City experienced a record number of deaths and fires caused by e-bike batteries. We can and must be smarter about how e-mobility devices are powered, charged, and stored, or fear could give way to bans and restrictions.

A better alternative is creating safer devices that can accommodate the strong demand for e-bikes and scooters that are popular among tourists and commuters, and a means of livelihood for delivery workers.

The existence of a growing market does not negate the existence of the problem.

UL Standards & Engagement has more than 80 standards focused on reducing the risk of lithium-ion battery-related fires. As lawmakers consider the transition to cleaner energy, safety must be a priority. This is true for every component of micromobility, from battery to charging to use.



A few considerations when making a policy decision:

- 1** Evaluate what makes the most sense based on your jurisdiction's unique challenges, including but not limited to number of incidents, e-bike usage, and existing and current infrastructure such as charging networks and availability.
- 2** Look holistically at what should conform to standards. Both the micromobility device and its battery should be tested and certified with an accredited, nationally recognized testing laboratory. At minimum, e-mobility devices should conform to the following:
 - UL 2849, the Standard for Electrical Systems for e-Bikes
 - UL 2272, the Standard for Electrical Systems for Personal E-Mobility Devices
 - UL 2271, the Standard for Batteries for Use In Light Electric Vehicle Applications
- 3** Ensure that the policy covers sales, rentals, and leases of e-bikes and scooters.



Standards & Engagement

Consumer Perceptions of Lithium-Ion Battery Safety

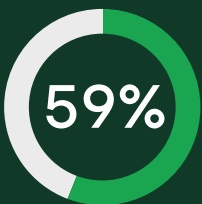
Lithium-ion batteries pose a significant threat when they are counterfeit, misused, or don't conform to safety standards. According to UL Standards & Engagement surveys, an alarming awareness gap was found that can have devastating consequences.



Lithium-ion batteries take only 20 seconds from the first sign of smoke to a room being engulfed in flames.

A traditional fire typically takes about three minutes, according to tests conducted by Fire Safety Research Institute.

A lack of awareness of the risks associated



don't believe that they are at risk of lithium-battery incidents



of consumers are aware of risks associated with lithium-ion batteries

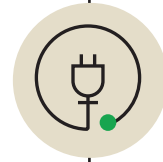
A lack of consumer education

More than 1.9 million have experienced a battery-related fire or electric shock incident as result of using or charging their e-bike or scooter.



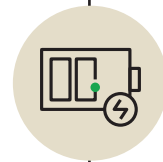
69%

have not looked up information on how to safely charge their device and 72% did not review the vehicle manual provided



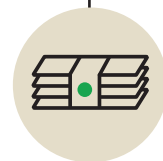
49%

are charging their e-mobility device inside their home, and 26% charge when they're not there



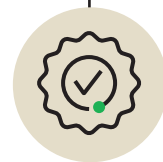
41%

admit to charging their e-mobility device overnight, increasing the risk of thermal runaway



40%

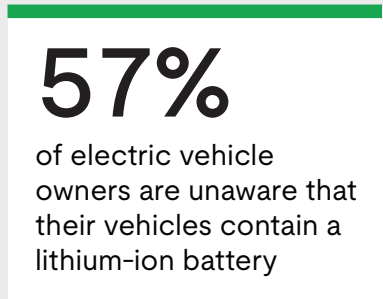
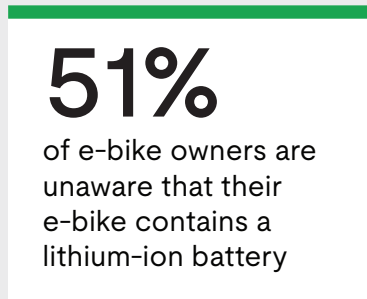
admit to using the most affordable replacement chargers of batteries regardless of manufacturer



28%

of people check to see if products meet safety standards

A lack of awareness of what a lithium-ion battery powers



*Results from UL Standards & Engagement December 2023 and January 2024 surveys.

Deep Dive: Understanding the E-Bike Market and Consumer Awareness Gaps

Market growth of e-bikes and scooters has outpaced consumer understanding of the products they are buying and renting. With e-bike and scooter sales and rentals on the rise — often used to support work-related needs — riders have limited awareness about the lithium-ion batteries that power their devices and best practices for charging and storage, increasing the risk of thermal runaway and underscoring the need for standards to support safer products.

Below is a more in-depth look at two of UL Standards & Engagement studies:

1. E-bike Safety Study: Survey of 2,228 U.S. adults, administered by BV Insights between January 8-12, 2024.
2. Battery Safety Study: Survey of 2,015 U.S. adults, administered by BV Insights between January 22-26, 2024.

A Growing Market: The U.S. e-bike market — inclusive of sales and rentals — continues to grow as more Americans are drawn by the convenience and cost savings offered by electrified micromobility options.

Market Size: ULSE's e-bike study estimates **11% of U.S. adults (~26.4 million) own or lease an e-bike today** (another 9% own an e-scooter). 26% of electric vehicle owners mention owning or leasing an e-bike. E-bike sales in the U.S. leaped by 269% between 2019 and 2022 according to analyst firm Circana, with the market size expected to have grown further in 2023, to be worth \$2.59bn. E-bikes also drive a strong rental market via bike share programs: **12% of U.S. adults (~28.8 million) rent e-bikes once a month or more often, 4% once a week or more often.**

Reason for Riding: The three most important reasons why e-mobility owners buy their vehicles are **convenience of charging** their e-bike or e-scooter at home (85%), **saving money** on gas (81%), and saving money on commuting costs (77%). For 53% of current owners (~14 million), they purchased it to **support work-related tasks** such as delivery gigs via Grubhub.

Frequency of Riding: The same January 2024 ULSE survey found that for those who ride, there is a deep reliance on their e-bike or e-scooter: **66% ride once a week or more often and 14% ride daily.** Moreover, 48% of riders say they are using their e-bike or e-scooter more often this year than last year.

Limited Awareness and Education Among E-Bike Owners: Consumer education continues to lag behind market growth. Many riders do not even know what powers their device and are uninformed about battery safety or best practices for charging and care.

Lack of Education: ULSE's battery safety survey found that 51% of e-bike owners are unaware that a lithium-ion battery powered their device. ULSE's e-bike survey finds there are missed opportunities for safety education during the sale of vehicle. **Nearly one in five (19%) owners or lessees (~5 million) never received any info** about battery safety or best practices for charging. Further, large swaths of e-mobility users have never researched safe battery charging practices or reviewed the user manual: **70% have not looked up information on how to safely charge** their e-bike or e-scooter on the internet, and **72% did not review the vehicle manual** provided by the manufacturer, retailer, or dealership.

Need for Best Practices: Many e-mobility users admit to not checking the battery health of their vehicle regularly, or inspecting the vehicle or the attached battery for signs of wear or damage: **58% do not check the battery health** of their e-bike or e-scooter, while **61% do not regularly inspect their e-bike or e-scooter for signs of wear or damage** to the battery or electrical components.

Charging Behavior: Moreover, **half of e-mobility users leave their vehicle plugged in even after it's fully charged**, and two in five charge their vehicle overnight:

- **53% do not unplug their e-bike or e-scooter once it is fully charge.**
- 41% typically charge their e-bike or e-scooter overnight.
- 26% charge their e-bike or e-scooter in their home while not there.

Underrated Risk: Though most e-bike and scooter riders are aware of the risks associated with damages to the lithium-ion batteries that power those vehicles, for many their lack of awareness translates to miscalculating the relevance of those risks and hazards to themselves.

A quarter (25%) of e-mobility users are unaware of the risk of electric shock or potential electrocution from damaged or overcharged batteries that power an e-bike or e-scooter. Among non-owners, that figure climbs to 52%.

- Similarly, 27% of riders are unaware they can be exposed to toxic vapors and gases from damaged or overcharged batteries. Again, that figure for non-owners rises to 55%.

Nearly **half (49%) do not feel they are at risk of fire or electric shock** from their e-bike or e-scooter charging cable and/or charging unit being damaged, not correctly installed, or operated.

- A similar share (**48%**) **do not feel they are at risk of electric shock or potential electrocution from damaged or overcharged batteries.**

E-bike and e-scooter owners point to **manufacturers of the vehicles** (73%), **manufacturers of the batteries** (and associated charging equipment) (68%) and **retailers** (60%) as primary stewards of safety.

Methodology:

These results are taken from two ULSE Insights surveys: *Battery Safety January 2024* and *E-Bike Safety January 2024*. Both studies were designed and formulated by UL Standards & Engagement.

Both online surveys were administered by BV Insights. As a member of the Insights Association and ESOMAR (the European Society for Opinion and Marketing Research), BV Insights adheres to industry ethics and best practices, including maintaining the anonymity of respondents.

After data collection was completed, interviews were weighted by five variables: age, sex, geographic region, race, and education to ensure reliable and accurate representation of the total U.S. population, 18 years of age and older. In the analysis and presentation of some data, calculations reference U.S. online adult population estimated at 240.2 million using two sources of publicly available data: 2020 wave of the U.S. Census for U.S. adult population estimate of 258.3 million, and Pew Research Center's Internet/Broadband Fact Sheet which estimates 93% of U.S. adults use the internet, as of 2021.

The margin of sampling error at 95% confidence for aggregate results is +/- 2.2%. Sampling error is larger for subgroups of the data. As with any survey, sampling error is only one source of possible error. While non-sampling error cannot be accurately calculated, precautionary steps were taken in all phases of the survey design and the collection and processing of the data to minimize its influence.

Note: All numbers are percentages unless otherwise noted. Figures may not total 100% due to rounding.



Working for a safer world



UL Research Institutes, UL Standards & Engagement, and UL Solutions are three organizations united by one mission: working for a safer world. Together, we offer diverse expertise required to confront current and emerging safety challenges.

Each organization has a distinct focus.



UL Research Institutes advances safety science by sensing risk and conducting rigorous independent research that accelerates discoveries.



UL Standards & Engagement mobilizes that powerful science into action through advocacy and standards.



UL Solutions brings safety science to life, helping businesses solve pressing challenges and innovate with confidence.

Our organizations are uniquely positioned to address today's increasingly complex safety challenges.

Since 1894, we have diligently identified risks to humanity and our planet and countered them with science-based knowledge designed to benefit people everywhere. We have the experience, the expertise, and the partnerships to advance public good through innovative research, methodologies, technologies, tools, services, and solutions.

Our capacity to create change is amplified by the partners who join us — the researchers, scientists, engineers, technologists, legislators, and business leaders who reach across disciplines and sectors to create and act on safety knowledge.

Together, we work to build a safer and more sustainable world.

UL Standards & Engagement: 120 years in standards development

UL Standards & Engagement is a nonprofit standards development and advocacy organization that translates safety science into practical, action-oriented standards, from toasters to life jackets, and lithium-ion batteries to solar power.

The organization also serves as a vital resource for policymakers and shares knowledge, advances partnerships, and advocates for standards and policies to create a safer, more sustainable world.

What is safety science?

Safety science engages the ingenuity of top minds across scientific fields to engineer a safer and more sustainable world in which every individual can thrive.

What is a standard?

A standard is a document of best practices for manufacturing and testing the safety, security, and sustainability of a product or system, developed and voted on by experts across industries and interests.

How are standards developed?

UL Standards & Engagement convenes technical committees comprised of experts from manufacturing, government, academia, nonprofits, and other relevant groups to determine a standard. Technical committee members review proposals for new or revised standards and work together to achieve consensus through balloting in a fair and transparent process.

What happens after a standard is published?

All standards are free to view. Manufacturers and innovators can develop products, which can then be tested and certified that they conform to our standards to ensure they are as safe as possible. UL Standards & Engagement is continuously monitoring and revising standards to address a changing risk landscape and emerging technologies.



Fast Facts:



1,700+ standards and documents in use today



4,000+ individuals serve on ULSE Technical Committees



40+ countries are represented through our Technical Committees



81 MOUs with agreements in several countries and regions



ULSE is the only standards organization accredited to publish for the U.S., Canada, and Mexico



For more information or to discuss how we can partner, please contact David McKnight, Head of Partnerships, at David.McKnight@ul.org