Texas A&M Engineering
TEEX
Extension Service

TEEX Electric Vehicle/Energy Storage Systems Summit Report

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Introduction

The prevalence of electric vehicles (EVs) and energy storage systems (ESS) has surged significantly since the last Texas A&M Engineering Extension Service (TEEX) EV/ESS conference in 2023. Lithium-ion batteries have become ubiquitous, powering everything from portable chargers to medical devices. In just two years, the number of electric vehicles on the road has skyrocketed, from just 2 million in 2023 to an expected 85 million by the end of 2025. That is an increase of 83 million electric vehicles in just two years. This exponential growth has also driven the expansion of EV infrastructure, including public and in-home EV charging systems. Similarly, Battery Energy Storage Systems (BESS) are expanding in rural and suburban areas and now play a critical role in power grid stabilization. As EVs, BESS, ESS and Li-ion batteries become increasingly prevalent and relied on, first responders and public safety personnel must stay informed about the evolving risks, challenges, and hazards associated with this dynamic technology.

In January 2025, TEEX hosted its 2nd annual EV-ESS Summit, bringing together leading experts, experienced professionals, researchers, and technologists to discuss real-world case studies, response strategies and policy implications.

The summit facilitated engagement between fire departments, state and federal agencies and private sector leaders focusing on improving emergency response tactics and sharing best practices. Attendees included representatives from 42 different fire departments, agencies, and organizations such as:

- Texas A&M Engineering Extension Service (TEEX)
- Texas A&M Transportation Institute (TTI) and the Texas A&M Engineering Experiment Station (TEES)
- National Laboratories UL Research Institute Energy Security Agency (ESA)
- Southwest Research Institute
- Shell, HEB, Pierce Mfg., Peterbilt
- Texas Commission on Fire Protection and the Texas State Fire Marshal's Office
- Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF)

Over two days, the summit featured ten presentations by leading industry experts[1], covering key topics such as lithium-ion battery hazards, battery chemistry, suppression techniques, regulatory updates and emergency response tactics. The event included a networking session at the end of the first day, enhancing collaboration between industry professionals and summit attendees.

As a result of the summit, TEEX updated its list of current best practices for responding to EV and ESS incidents. These findings will aid government officials, emergency responders and policymakers in developing, implementing and improving prevention and response strategies. The

[1] For the full list of speakers, see Appendix II at the end of this report.

report compiles key insights from the 2025 summit, offering a structured overview of lessons learned, operational tactics, ongoing challenges and future focus areas.

Background

Purpose:

This report aims to document the collaborative efforts from the January 2025 TEEX EV/ESS Summit and highlight optimal strategies to assist those responsible for EV and ESS prevention, response, training and policy creation.

Methodology:

TEEX brought together nationally recognized experts with experience responding to and preventing Li-ion battery incidents. During the summit, experts:

1. Shared information, case studies, experiences, testing policies, procedures and protocols with Li-ion batteries and their products.
2. Identified tactical, storage and response concerns surrounding Li-ion batteries.
3. Shared lessons learned and identified gaps in knowledge, current practices and workable solutions.
4. Shared research findings and implications of Li-ion battery fire, gas and heavy metal exposure.
5. Shared current EV/ESS training resources for first responders[2].
6. Collected additional information from subject matter experts.

Problem

The rapid adoption of Li-ion batteries with electric vehicles and energy storage systems has outpaced the training and preparedness of first responders. In 2023, there were 270 Li-ion battery incidents in the United States, resulting in 18 fatalities and 150 injuries. At the New York Fire Department (NYFD), the busiest fire department in the Western Hemisphere, Li-ion battery fires are now the leading cause of fire and fire-related deaths[3].

According to the International Energy Association (IEA) annual 2024 Renewable Report by 2030, renewables could account for nearly 50% of all electricity. There are currently 3.5 million registered electric vehicles on the road, and experts predict that by 2030, this number will exponentially increase to 30-42 million[4]. As these technologies become increasingly available,

[2] For additional EV/ESS resources, see Appendix I at the end of this report.

[3] https://www.tpr.org/science/2025-02-18/lithium-ion-batteries-are-a-major-fire-threat-heres-why-and-what-consumers-can-do

[4] https://www.iea.org/news/the-energy-world-is-set-to-change-significantly-by-2030-based-on-today-s-policy-settings-alone

fire departments, emergency management agencies and policymakers continue to struggle with response strategies, suppression techniques and safety concerns for first responders and the public.

One of the most critical issues raised during the 2025 TEEX EV/ESS Summit was the lack of standardized training and response protocols for energy-related emergencies. Unlike hazmat or confined space rescues, fire departments do not have a dedicated emergency response discipline for Li-ion battery incidents, often leaving responders to rely on outdated or improvised mitigation techniques.

However, the absence of nationwide training standards means that response capabilities remain inconsistent across different jurisdictions, putting firefighters and the public at unnecessary risk. The increasing frequency and severity of EV and ESS incidents further complicate emergency response efforts. Thermal runaway events, where Li-ion batteries self-heat and ignite due to overcharging, physical damage or manufacturing defects, continue to present a significant challenge. These fires can reach temperatures exceeding 2,000 degrees Fahrenheit, causing explosions, projectile hazards and the release of toxic and flammable gases such as hydrogen fluoride (HF) and hydrogen sulfide, carbon monoxide (CO) and carbon dioxide, and multiple volatile organic compounds and heavy metals. Despite increased research and testing in the field, there is not a single extinguishing agent or methodology developed to date that is fully effective against Li-ion battery fires. While some suppression tools may temporarily cool the battery or contain the fire, stranded energy within the battery cells can cause reignition of fire conditions hours or even days after the initial incident. This unpredictability makes EV and ESS fires among the most difficult and hazardous incidents faced by first responders.

Beyond fire suppression, toxic chemical exposure presents a long-term health risk to firefighters and emergency personnel. Recent studies conducted by the Southwest Research Institute (SwRI) determined that Li-ion battery fires release ultra-fine toxic particles that can penetrate personal protective equipment (PPE), exposing firefighters to hazardous heavy metals such as cobalt, nickel, copper and lead. Current bunker gear decontamination methods have been found to be only partially effective, meaning that firefighters may carry contaminants in their gear long after an incident, with the highest contamination present in self-contained breathing apparatus (SCBA) straps. Without proper mitigation strategies, exposure to these chemicals could result in chronic health effects, including respiratory illnesses and neurological damage, putting first responders at severe risk during and after a Li-ion battery fire response.

The lack of infrastructure and regulatory oversight of Li-ion batteries further complicates the risks associated with EV and ESS incidents. Many communities do not have clear codes or signage requirements for large-scale battery storage sites, EV charging infrastructure or damaged, defective and recalled (DDR) battery shipments. In emergencies, poor labeling and inconsistent hazard markings put first responders' safety at risk by denying them critical information at the onset of the response. Additionally, fire departments often have no direct communication (lack of pre-planning) with energy providers and lack general knowledge about the existing Li-ion infrastructure in their jurisdictions, leading to delays in critical decision-making at the onset of the response. Case studies of substation and transformer fires have highlighted poor coordination

between fire departments and energy companies, resulting in preventable injuries and property damage.

The transportation and disposal of DDR Li-ion batteries has also introduced new fire hazards on highways, railways, ships and aircraft. Recent reports indicate that DDR batteries are involved in an increasing number of transportation-related fires, primarily due to mislabeling, improper packaging and regulatory inconsistencies. In many cases, drivers are unaware they are transporting Li-ion batteries and the associated risks. Further, fire departments are often unaware of how to properly handle or dispose of Li-ion battery waste, leading to unsafe storage conditions in salvage yards, recycling centers and warehouses. In the past year alone, there have been multiple highway incidents involving trucks carrying improperly labeled Li-ion batteries, as well as airline fires attributed to damaged battery shipments, with many experiencing reignition during cleanup or disposal post-incident. As EVs become more prevalent, the question of how to safely transport and dispose of crashed cars looms. On the maritime front, mis-declared batteries have caused fires, resulting in billions of dollars in damage, as seen in the 2020 Costco Pacific fire and the 2024 Port of Miami explosion.

Despite these increasing risks, most first responders have not received comprehensive training on how to safely handle EV and ESS incidents. Many fire departments lack the necessary equipment to detect off-gassing, temperature profiles of battery packs, electrical shock hazards or structural vulnerabilities, putting their first responders' safety at risk. Additionally, existing firefighter PPE is not designed to provide long-term protection against Li-ion battery exposure. This means that if the gear is not properly cleaned, first responders could still be at risk even after an incident has been resolved. The Energy Hazard Guide aims to address some of these training gaps, but without mandated national training standards and increased dissemination of research, fire departments will continue to experience inconsistent levels of preparedness.

“First responders have no training; Nothing has changed.” – Chris Greene

Discussion

The following section includes current practices, recommendations and future areas of focus for preventing and responding to EV/ESS events, as identified at the summit.

Prevention: Recommendations and Future Areas of Focus

Signage, Code Enforcement and Regulations

- Develop local and regional regulations for Li-ion battery storage, charging and transport.
- Mandate standardized hazard labeling for energy storage sites, charging stations and DDR battery storage facilities.

- Require manufacturers to incorporate input from subject matter experts and first responders in EV/ESS development and infrastructure planning.
- Strengthen building codes related to EV charging stations, home energy storage systems and battery storage facilities.
- Coordinate with NFPA and local agencies to enforce emergency stop regulations at EV charging stations (NFPA 70).

Education, Training, Communication and Awareness

- Implement mandatory energy hazard training for first responders, including firefighters, law enforcement officers and emergency medical service personnel.
- Develop a national web-based central site to consolidate best practices, case studies and training materials for EV/ESS emergency response.
- Launch a public awareness campaign on the hazards of Li-ion batteries and how families can be proactive against Li-ion fires through things like stickers on garage doors and equipment maintenance.
- Strengthen communication between Li-ion entities and first responders to ensure awareness of hazards in each jurisdiction.
- Encourage partnerships between fire departments, utility companies and EV manufacturers to discuss real-world training opportunities and direct access to manufacturer emergency response guides.

Response: Current Practices

When a Li-ion battery goes into thermal runaway, current suppression tools include undercarriage nozzles, battery intrusion devices, Li-ion-rated fire blankets and submersion tanks. While these techniques can be used for fire suppression, they are not practical long-term solutions to combat Li-ion fires.

Prior to an Event

- Identify and document high-risk locations such as energy storage facilities, solar farms, recycling centers, EV storage lots, wrecker yards and impound yards in collaboration with dispatch systems.
- Ensure first responders have rapid access to energy emergency response guides (IAEF Energy Hazard Guide).
- Develop protocols for necessary cooling time or amount of water usage.
- Establish safety protocols for post-incident decontamination of gear, equipment and personnel exposed to Li-ion battery fires.

During an Event

- Always wear full PPE with a face mask and positive pressure SCBA and establish an appropriate incident command structure.
- Upon arrival, conduct a tactical pause to assess the incident from an uphill or upwind location, and determine if an EV or internal combustion engine is involved. Use thermal imaging cameras (TICs) to detect off-gassing, heat buildup or an active fire if possible.
- Position apparatus and teams in an up-wind location.

- Consider exposure protection when dealing with Li-ion battery fires. If critical infrastructure is at risk (e.g., parking garage, overpass), consider moving the battery hazard away from the exposure, use water coverage to protect exposures and limit personnel contact with the hazard.
- Never assume the vehicle is powered off. Keep key fobs and starting devices at least 25 feet from the vehicle to avoid unexpected movement. This may include cell phones that have remote start applications.
- When safe, chock wheels to prevent unintended movement, as EV motors are active unless disconnected. Consider using an EV Emergency Plug if operations must be conducted in the immediate vicinity of the EV.
- EV/ESS have power management systems that should shut down after an impact or crash. Do not reenergize these high-voltage systems.
- If high-voltage damage is suspected, disconnect the low-voltage battery.
- Use the vehicle response guide to find the battery package and high-voltage cable disconnect location, as well as SRS locations.
- Determine the Li-ion battery's charge level and understand that a higher charge level means higher risk, a more prolonged incident and greater challenges to dissipating energy or containing a fire. Vehicle operators may have information about the vehicles' state of charge on their phones.
- Be aware that all Li-ion batteries contain hazardous materials and heavy metals, but there may also be additional hazardous materials unique to the manufacturer and battery type or battery chemistry.

In Case of Off-Gassing

- Recognize the early warning signs of thermal runaway, including off-gassing (white smoke), heat buildup, bulging and a "sweet" electrical burning odor.
- If a Li-ion battery is off-gassing but not yet on fire, monitor and isolate the affected area.
- TICs/FLIR technology can help determine where off-gassing and thermal runaway are coming from, highlighting them as hotspots on the device.
- Use a multi-gas meter to detect elevated levels of CO and HF.
- If safe to do so, move affected battery devices or vehicles away from structures, flammable materials and other vehicles.
- Consider using water spray for vapor mitigation and personnel protection.

In Case of Fire

- If an active fire is present, apply water to cool surrounding exposures and limit flame spread.
- When safe and practical, allow a burning battery to burn itself out in a controlled manner.
- Fire blankets can be used to suppress and shield adjacent exposures from igniting.
- Expect and be prepared for multiple reignitions post-suppression.
- Use undercarriage nozzles or specialized battery cooling devices when available.
- Be aware of the impact of contaminated runoff and fumes.
- Always operate in an upwind/uphill posture.

After an Event

- Inform the towing company of hazards regarding Li-ion battery packs and reignition potential.
- Store EVs at least 50 feet away from buildings, other vehicles and combustibles.
- Monitor battery temperatures and gas emissions for at least 24 hours after a fire.
- A fire engine may need to escort the tow truck to the storage facility in case of a reignition emergency.
- Be aware and alert of reignition potential in high-traffic areas.
- Fire and law enforcement agencies should coordinate with insurance companies to discuss reimbursement for equipment use, decontamination and prolonged fire suppression operations.
- Fire departments should establish standardized decontamination procedures following Li-ion battery incidents.
- Remove and isolate contaminated gear and properly clean bunker gear to prevent cross-contamination. Consider NFPA 1851 water-based and liquid CO2 cleaning methods. Each cleaning method has its own efficiency rating.
- SCBA should be worn throughout an EV/ESS incident, including overhaul and post-fire investigations.
- Departments should evaluate advanced PPE cleaning methods, including liquid CO2 decontamination, which has shown a >99% efficacy in removing heavy metals and battery-related toxins.
- Specific cleaning efficiencies can be found in the TEEX Lithium-Ion Battery Fire and Emissions Characterization report.

Response: Recommendations and Future Areas of Focus

Signage, Code Enforcement and Regulations

- Require adequate signage and warning labels where Li-ion batteries are stored, transported, charged or utilized. This will ensure first responders know what they are responding to and can appropriately alter tactics.
- Encourage displaying standardized labels when EVs are stored at private residences.
- Develop standardized codes and regulations for Li-ion transport that disclose charge levels, the number of batteries present, the damages, and their origin.
- Develop standardized codes for ESS and BESS systems.
- Pursue stricter enforcement of regulations at DDR facilities and Li-ion recycling centers to prevent large-scale incidents.

Education, Training, Communication and Awareness

- Continue frequent and up-to-date dissemination of information regarding Li-ion batteries, EVs, ESSs and BESSs.
- Encourage standardized training and education on response tactics for first responders, local government and parties storing, transporting or using Li-ion batteries or related energy equipment.

- Update training and response tactics from past Li-ion incidents to ensure first responders are educated and safe when responding.
- Enhance collaboration between first responders, Li-ion battery EV manufacturers, and other energy entities to ensure risks are thoroughly understood and communicated.

Conclusion

The 2025 TEEX Electric Vehicle/Energy Storage Systems Summit further identified many challenges and first responder risks associated with Li-ion battery fires and incidents, including prevention, response and code enforcement issues. As this technology evolves and becomes increasingly prevalent, the challenges associated with EV/ESS emergencies are rapidly changing.

As part of the TEEX mission to provide training, develop practical solutions and save lives, TEEX is committed to remaining at the forefront of this issue. To this end, TEEX will continue to engage stakeholders, incorporate emerging EV/ESS incident response best practices into first responder training and share information with the public. As TEEX completes testing and receives new information, updates will be provided on the TEEX website.

Appendix I: Resources and Information

Texas A&M Engineering Extension Service (TEEX)

- Current Practices: Electric Vehicle and Energy Storage Systems
- TEEX Li-ion SWRI Research Report

Energy Security Agency (ESA)

- Energy Security Agency serves manufacturers, public/private organizations, first responder communities, and end-users by providing recommendations and training for safe battery handling.
- ESA houses the most extensive library of EV Emergency Response Guides provided by manufacturers.
- Risk Analysis and Guidance for First Responders
- Risk Analysis for Towing and Recovery Professionals
- Telephone: 855-ESA-Safe (855-372-7233)

European Environment Agency

- Electric Vehicles from Life Cycle and Circular Economy Perspectives

EV Rescue – Response Guide Application

- Apple Store Application: EV Rescue-Electric Vehicles (EVR)

Fire Safety Research Institute (FSRI)

- Take Charge of Battery Safety

International Association of Fire Chiefs (IAFC)

- Lithium-ion and Energy Storage Systems Resources

National Fire Protection Agency (NFPA)

- Emergency Response Guides from more than 35 alternative fuel vehicle manufacturers for free download.

National Transportation Safety Board (NTSB)

- Report on Safety Risks to Emergency Responders from Lithium-Ion Battery Fires in Electric Vehicles

U.S. Fire Administration (USFA)

- Battery Fire Safety Tips

Appendix II: Summit Speakers

Chris Greene - "The Energy Battleship"
Captain (Retired), Seattle Fire Department

Dr. Imad Khalek and Gordon Lohmeyer - "SwRI Li Battery Testing and Contamination"
Dr. Imad Khalek, Southwest Research Institute
Gordon Lohmeyer, Texas A&M Engineering Extension Service (TEEX)

Chris Pfaff - "DDR Battery Shipments, Codes, and Placarding"
Fire Marshal, West Pierce Co.

David Brannon - "City of Pasadena's Energy Codes and Enforcement"
Fire Marshal, Pasadena, Texas

Tompall Glaser - "Battery Energy Storage Systems: Installation, Safety and Plans in the Event of Failure"
Jupiter Power

Dalan Zartman - "Large Scale Li-ion Emergencies: Pre- and Post-Incident Planning"
Energy Security Agency

C. Todd Smith - "Li-ion Battery Toxicity Concerns"
Bureau of Alcohol, Tobacco, Firearms and Explosives (Retired)

Dr. Sean Thompson - "Li-ion Environmental Remediation and Cleanup"
Washington State Department of Ecology

Dan Buchanan - “Training for Energy Emergencies (EM-ESV Software)”
Texas A&M Engineering Extension Service

Lance Bullard - “TTI Crash Testing of Vehicles”
Texas A&M Transportation Institute