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NFPA®

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Stranded energy

This is the term coined for the dangerous situation where an incident results in damaged batteries containing energy with no means to empty this out as electricity. This is a major challenge in e-vehicles but also in energy storage facilities. In an incident in Sunrise, Arizona, at an electricity utility lithium-ion energy storage site, eight firefighters were injured when a battery container exploded without warning, during monitoring, hours after heat and smoke first appeared. Lithium ion batteries are estimated to have a failure rate of one in ten million to one in forty million (i.e. risk of failure during the battery lifetime). Because energy storage containers have maybe 100 000 battery cells inside, this means a risk of maybe one in a hundred for each container. High contained energy means damaged batteries need spraying with water for hours, or even days (see above) posing questions of water supply and runoff pollution risks. The only identified solution to stranded energy to date is to submerge in salt water. Netherlands firefighters tow shipping containers to EV accident sites, fill the box with water, then lift the compromised battery or vehicle into the bath.

NFPA Journal Jan-Feb 2020 " " and " "

Beyond EVs

Stranded energy is a concern across all energy storage technologies

STRANDED ENERGY AND problems like thermal runaway are not exclusive to batteries in electric vehicles (EVs). Both can occur in any battery, including stationary energy storage systems (ESS), which are being installed around the world in residential and office buildings, utility-owned industrial parks, and even private homes.

The devices are in demand because they can store energy created from renewable sources like wind and solar for use later. Battery energy storage is also becoming increasingly critical for utilities because stored energy reduces the need to build additional power plants to meet growing energy demands. The recently released NFPA 855, *Standard for the Installation of Stationary Energy Storage Systems*, includes detailed installation guidelines that take into account the needs of emergency agencies during incidents involving these systems.

The potential dangers posed by these large battery systems were revealed last April when firefighters were called to a utility-owned lithium-ion ESS in Surprise, Arizona, after heat and smoke were detected inside the battery. Out of caution, firefighters opted to monitor the situation for hours from outside of the battery container when, without warning, the battery exploded. Eight firefighters were injured, including four with severe burns and one with life-threatening injuries. The cause of the thermal runaway, and subsequent explosion, are still under investigation. In the last six months, NFPA instructors have traveled to Surprise, Phoenix, and 10 other locations across the country to lead training events intended to help responders understand how to handle ESS incidents effectively. NFPA also has online ESS training for first responders.

As with EV, when ESS experience a fire or thermal runaway, response options are limited. Currently, there are no good ways for responders to determine how much energy remains in a damaged battery, and no effective means to drain energy from a battery to reduce the threat. In addition, the environmental impact of fighting fires in batteries is also not well understood. According to the Fire Protection Research Foundation, firefighters may need in excess of 3,000 gallons of water and more than an hour of constant spray to prevent the threat of reignition.

That creates concerns over the runoff created by these incidents, according to

Cory Wilson, a chief at the Fremont (California) Fire Department. "Where does all that runoff water go? How bad is it for the environment? How do you collect that? Do you worry about collecting it?" Wilson said. "These are all issues that I think we're going to have to start working through as you see more and more of these vehicles on the road." *—J.R.*

NO GOOD OPTIONS

The primary challenge faced by Mountain View firefighters that day was stranded energy, a widely overlooked issue with little scientific literature, according to researchers interviewed for this story. Stranded energy is any scenario where electrical energy remains in a battery without an effective means to remove it. This typically happens when the battery is damaged—by force, a coolant leakage, heat, or water intrusion—and normal function ceases. This can also lead to thermal runaway. How much energy remains in the battery when it's damaged can greatly affect the severity and duration of the reaction.

Hazard Assessment of Lithium Ion Battery Energy Storage Systems FINAL REPORT PREPARED BY: Andrew F. Blum, P.E., CFEI R. Thomas Long Jr., P.E., CFEI Exponent, Inc. 17000 Science Drive, Suite 200 Bowie,

February 26, 2016 1503637.000 2770 xiii Executive Summary In an effort to provide guidance to standards developers, authorities having jurisdiction (AHJs), emergency responders, and the energy storage system (ESS) industry, Exponent, in conjunction with FPRF, the Project Technical Panel, and industry sponsors, performed a fire hazard assessment of Li-ion battery ESSs. Currently, these entities do not have a clear direction regarding the fire hazards of ESS installations and have few, if any, technical studies, reports, or scientific literature to rely upon when making decisions regarding the safe installation of these systems. This report summarizes a literature review and gap analysis related to Li-ion battery ESSs, as well as full-scale fire testing of a100 kWh Li-ion battery ESS. The scope of work included, but was not limited to, the following four primary tasks: 1. A literature review and gap analysis related to Li-ion battery ESSs; 2. Development of a detailed full-scale fire testing plan to perform an