# Recent Findings, Moss Landing

*By John Benson*

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## 1. Introduction

*After a thermal runaway set the world's largest battery storage facility on fire last winter near Monterey, Ivano Aiello and his colleagues at San José State University had some detective work to do.*[1]

*The fire, which broke out at the Vistra Energy Storage Facility in Moss Landing on Jan. 16, 2025 burned for days, producing a plume of black smoke that was visible for miles (see image on the next page).*

*"There was obvious debris related to the fire pretty much all over the place, so it was evidence that something came out from the smoke plume," said Aiello, a professor and chair at Moss Landing Marine Laboratories.*

*To understand exactly what the fire spread, Aiello and his colleagues began to investigate. Their results, published in the journal Scientific Reports, were released Monday.*

*When the fire broke out, they had already been collecting soil samples from nearby Elkhorn Slough, a sanctuary for endangered wildlife, so they had baseline data for comparison. After the fire, they tested for nickel, manganese and cobalt — the primary elements used in lithium-ion batteries.*

*Using a powerful electron microscope, they saw tiny beads of those metals in the soil. "That was pretty much a smoking gun," Aiello said.*

*Concentrations of the metals were between 10 and 1,000 times greater than they had been before the fire.*

*They also found that the correlation of nickel to cobalt followed a strict 2:1 ratio — the same proportion used in manufacturing the batteries at the Vistra facility.*

*"Now we are using that fingerprint to trace how those metals are moving through the environment," Aiello said.*

*Preliminary test results from another team of San José State scientists give some indication that the metals, which can be toxic above certain concentrations, have entered the food chain in the nearby estuary.*

*But the concern is not only for the local wildlife, which includes the southern sea otter, a threatened species still struggling back from the brink of extinction. Many agricultural fields are also close to the Moss Landing battery plant.*

[1] Katherine Monahan, KQED, "Scientists Trace Heavy Metals Spread by January's Huge Battery Fire Near Monterey," Dec 2, 2025, https://www.kqed.org/science/1999445/scientists-trace-heavy-metals-spread-by-januarys-huge-battery-fire-near-monterey Note that both Monterey and San Jose are in Central Coastal California, just south of San Francisco. San Jose is the largest city in the San Francisco Bay Area.

*And, there's another piece of detective work still to be done. Aiello and his colleagues calculated that the heavy metals they found in the soil amounted to less than 2% of the metals contained in the burned batteries.*

*"Where is the other 98%?" Aiello said. "Some of it might have gone straight to the ocean, but some of it might have traveled elsewhere because those particles are very, very tiny."*

Moss Landing Battery Energy Storage System Fire

*Vistra Corporation, which operates the Moss Landing battery plant, said in a statement that a different study conducted in October showed heavy metals found in soil near the battery plant were mostly within approved levels, and not necessarily related to the fire. (Above Photo: Moss Landing Battery Energy Storage System Fire on January 16, 2015. This image by Guy Churchward is licensed under CC BY 2.0.)*[2]

*"The safety of our employees, the environment, and the surrounding community remains our top priority," said Jenny Lyon, a spokesperson for Vistra. "We will continue to work closely with local officials and community partners in the Moss Landing community."*

*Aiello hopes that as electric energy becomes more common, his work will help create a different approach to how we go about setting up battery storage facilities: "Maybe we can think better when we locate some of those storage facilities, which have the potential to contaminate soils and also the food."*

## 2. NAML

*The Never Again Moss Landing (NAML) Stakeholder Group, …has released a new report titled, "Why and How Findings by the Central Coast NAML Investigation Team." The report details findings of their 120-day investigation into how and why the Vistra Energy battery facility at the Moss Landing Power Plant caught fire and destroyed itself during the period of January 16-22, 2025. "We are not volunteer stakeholders," the report states. "We were forced into it in late-January 2025 because our families, homes, farms, boats, and businesses, as well as the local sea and estuary were exposed to the massive pollution cloud carrying heavy metal, dioxins, and PFAs that washed across our communities while the Vistra lithium battery storage building burned to the ground."*

[2] Monterey Bay Environment News, Report: Why and How Findings by the Central Coast NAML Investigation Team, July 19, 2025, https://www.indybay.org/newsitems/2025/07/19/18878148.php

## 2.1. Six Operator-level Findings:

- *Vistra built and operated the largest indoor lithium battery storage facility in America from December 11, 2020 until January 16, 2025 where it stored 100,000 … lithium-ion nickel-manganese-cobalt batteries on the 1st and 3rd floors of its building.*
- *Multiple pieces of evidence verify that Vistra double-stacked & densely-packed batteries and row-units along the full length of the Phase-1 upper 3rd floor*
- *Storage facility operator (Vistra) installed and operated a single-building, high-quantity, indoor storage layout, that was prone to completely burn up all the batteries on a floor if uncontrolled thermal runaway erupted.*
- *The double-stacked densely-packed row-unit layout made it easier for thermal heating to jump across aisles and harder for the building's suppression system to suppress.*
- *On January 16, 2025, the storage building's suppression system failed to suppress and its containment system failed to contain. The suppression system either did not exist, did not rapidly initiate, was inadequate for the number of batteries exposed to thermal runaway heat, or it failed to operate.*
- *Vistra's Phase-1 Moss Landing indoor battery storage facility completely burned down after only one-fifth of its planned 20-year operating lifespan, with the complete loss of the building and its stored inventory.*

## 2.2. Four Operator Risk Findings:

- *Vistra followed a high-risk storage layout and operation strategy that failed and cost the company dearly.*
- *Vistra willingly chose to position its industrial operations in a coastal area, thus placing the Monterey Bay Coastal environment, tourism, agriculture, and citizens at high risk of being harmed.*
- *Vistra failed to protect and thus endangered the Monterey Bay Coastal environment, businesses, homes, and people from vaporized metal pollution cloud and surface residue.*
- *CEO Morgan was correct that Vistra's Moss Landing project would, as it is now, serve as the model for utility-scale battery storage for years to come. Unfortunately, the project became a model for what not to do as of January 16, 2025, when the "first" and largest single-building high-quantity, indoor battery storage facility in America burned down.*

## 2.3. Eight Regulator-Level Findings

- *California's PUC was the Regulator before the Vistra disaster and still is now. They have not issued installation, safety, and operating codes for single-building, high-density, indoor, lithium battery storage facilities, nor any codes for dealing with single-building thermal runaway events at the row-unit and building level.*

- *Regarding the Vistra public utility, the PUC regulator failed at its mission to protect the Central Coast people, businesses, and environment because it allowed too much do-what-you-want self-policing by the Vistra storage operator.*
- *The PUC knew or should have known that Vistra installed and operated a single-building, high-risk high-quantity, indoor storage layout, that was prone to completely burn up all the batteries on a storage floor if uncontrolled thermal runaway erupted.*
- *The PUC allowed Vistra to operate and put at risk Federal & State coastal sanctuaries/reserves, the Salad Bowl of America, Monterey Bay area tourism, and ten Central Coast cities/towns, including being built in a Tsunami flood zone.*
- *The PUC arrived at the huge Vistra Battery fire unprepared for such a fire to include not having a drone surveillance policy or plan to gather aerial samples of lithium battery hazards released during a lithium battery fire.*
- *No California state regulator or agency made any attempt to sample downwind vapor conditions for heavy metal and dioxin exposure beyond the fire site. Nor did they sample soil and residue samples inside or outside the perimeter of Vistra's industrial site.*
- *State regulators failed to gather and report heavy metal sampling data that might show dangers to the public and environment for "hazardous materials release" of heavy metals, dioxins, PCBs, chlorinated compounds, or polyaromatic hydrocarbons (PAHs) in the Moss Landing fire's vapor/cloud during the Vistra disaster. The only sampled for oxygen dioxide and hydrogen fluoride.*
- *Large lithium battery storage fires are common in California; they have occurred annually since April 2022.*

## 2.4. Coastal wetland deposition of cathode metals from the world's largest lithium-ion battery fire

**Author's comment:** The above title is a published paper reference below.[3] Excerpts from this paper follow. I have omitted secondary references and figures, so go through the link in the reference to see these.

*Rapid growth of distributed energy storage systems in recent years reflects the global need to store power from renewable energy sources and to regulate electrical systems. Lithium-ion batteries (LIBs) are the most widely used type of electrochemical energy storage, as they offer high energy and power density compared to other battery technologies. However, electrochemical energy storage and the use and disposal of LIBs involves inherent risks, such as thermal runaway which can lead to the release of potentially toxic compounds from battery materials, and localized deposition of battery-associated metals in adjacent ecosystems, with, potentially, long-term implications for terrestrial, aquatic, and human health.*

[3] Ivano W. Aiello[1], Charlie Endris[1], Steven Cunningham[1], Monique Fountain[2], Maxime M. Grand[1], Wesley Heim[1], Amanda S. Kahn[1] & Kerstin Wasson[2]; Author's Affiliations: 1-Moss Landing Marine Laboratories, San Jose State University, 2-Elkhorn Slough National Estuarine Research Reserve; "Coastal wetland deposition of cathode metals from the world's largest lithium-ion battery fire," November 26, 2025, https://www.nature.com/articles/s41598-025-25972-8

*Establishing robust environmental baselines in areas surrounding energy storage systems and achieving adequate spatial and temporal coverage to identify contamination after emergency release are both logistically difficult and often cost-prohibitive. In this context, portable and cost-effective technology such as X-ray fluorescence (FpXRF) offers a means of collecting high-density data, serving as a valuable complement to traditional laboratory-based analytical methods.*

*On 16 January 2025, a large fire engulfed the largest lithium-ion battery (LIB) Battery Energy Storage System (BESS) in the world, burning actively for at least 2 days. This was followed by a smaller reignition on 18 February 2025. Owned by Vistra Corporation, the BESS is in Moss Landing, California, immediately adjacent to Elkhorn Slough, a Ramsar site recognized as a wetland of international importance. The fire affected the core of the facility (Phase 1) which had a capacity of 300 MW/1200 megawatt-hours (MWh) and was equipped with LG Energy Solution's TR1300 battery rack systems. The fire destroyed approximately 75% of the facility and produced a smoke plume visible from tens of kilometers away, depositing ash and soot across the surrounding area. Due to potential toxicity, including possible exposure to hydrogen fluoride, evacuation orders and road closures were issued. Residents were permitted to return 2 days after the fire began.*

*Controlled experiments show Li-ion battery fires emit metal-bearing aerosols (notably Ni–Co–Mn) and other toxicants, which can deposit downwind. Three days after the fire, we rapidly mobilized to assess whether surface soils at Hester Marsh, a wetland restoration area within the Elkhorn Slough National Estuarine Research Reserve (ESNERR), only a few km from the Moss Landing facility had been affected by the fallout material from the smoke plume. Coincidentally, we had collected baseline surface soil elemental data in the same area for other research purposes with an FpXRF*[4] *in 2023.*

*The Moss Landing battery facility is located within a complex and vulnerable landscape. It sits adjacent to Elkhorn Slough, one of California's largest estuaries, near the town of Moss Landing, and is surrounded by intensively farmed agricultural land. The fallout from the fire's smoke plume raises serious concerns about contamination of soils, water, and vegetation in this region.*

*Here, we report on the extent and dynamics of cathode metal contamination in estuarine soils immediately following the world's largest lithium-ion battery fire. By combining rapid, high-resolution field surveys with laboratory validation, we tracked the deposition and short-term fate of battery-derived metals in a sensitive wetland ecosystem. Our findings provide rare real-world evidence of the environmental footprint of large-scale battery fires, underscore the value of having a baseline near industrial sites that pose contamination risks…*

*Specifically, we test whether the Moss Landing fire deposited a thin surface veneer of battery-associated metals in adjacent wetlands that differ relative to 2023 baseline conditions and whether composition is consistent with NMC cathode material...*

[4] FpXRF = Field Portable X-Ray Fluorescence; SEM/EDS = Scanning Electron Microscopy with Energy-Dispersive X-ray Spectroscopy; ICP-MS = Inductively Coupled Plasma Mass Spectrometry.

*Elkhorn Slough is a tide-dominated estuary that in the past 150 years has lost significant vegetated marsh area. At Hester Marsh, extensive diking and draining caused the area to subside and degrade to unvegetated mudflat. In 2018, Elkhorn Slough National Estuarine Research Reserve (ESNERR) initiated a restoration project to reestablish healthy marsh ecosystems through soil addition, creating a high elevation marsh plain that is only inundated by the highest tides.*

*To assess relationships between marsh plant health and soil composition, soil property analyses including elemental analysis with a portable Hitachi XMET 8000 XRF (pXRF), were conducted in 2023 along ten permanent transects also monitored for vegetation. These compositional data serve as a baseline for elemental concentrations in soils prior to the 2025 battery fire. Following the 16 January 2025 fire at the Moss Landing battery storage facility, three of the original transects were resampled at high spatial and temporal resolution between 21 January and 23 February 2025…*

*Rain and tide data were retrieved from the Moss Landing weather station operated by Moss Landing Marine Laboratories and wind data from the ESNERR meteorological station.*

### 2.4.1. Rapid detection of cathode metals with pXRF (see above)

*The sharp increase in (Ni, Mn, Co) metal concentrations detected in the surface soils of Hester Marsh between late January and early February 2025 is clearly attributable to the deposition of particulate matter from the smoke plume generated by the nearby battery storage facility fire at Moss Landing just days earlier. This interpretation is supported by multiple lines of evidence, including visible ash residues and soot, the presence of cathode-derived microparticles in surface soils, and distinctive geochemical patterns.*

*The key to early detection of cathode metal fallout immediately after the Moss Landing battery fire was the use of pXRF. While field measurements were not as accurate as lab measurements, they played a pivotal role in rapidly observing that maximum concentrations of the three metals increased by an order of magnitude after the fire, monitoring how quickly they decreased, and assessing how patchy the battery metal fallout was across the landscape. This key information could have been completely missed if we had relied only on a handful of samples taken in space and time. Metal co-variation patterns were consistent across methods (pXRF, ICP-MS), while absolute levels differed…*

*Subsurface samples remained near pre-fire levels and did not exhibit the post-fire ratio shift, indicating enrichment confined to a surface veneer. Notably, maximum surface concentrations of all three metals increased by several fold relative to pre-fire levels. Most post-fire surface samples analyzed with ICP-MS had Ni concentrations above 50 ppm, values that exceed thresholds associated with toxicity risks to plants and aquatic organisms.*

*The observed changes in surface concentrations of Ni, Mn, and Co across Hester Marsh and surrounding areas over time indicate the potential for rapid remobilization of these transition metals into estuarine soils and downstream waters. FpXRF transect data from February–March 2025 show that surface Ni concentrations dropped to near baseline within weeks of the fire, following early February rain and tidal inundation…*

### 2.4.2. Conclusions

*To our knowledge, this study represents the first field-based documentation of battery-associated metal fallout following a large-scale lithium-ion battery fire and offers a framework for assessing future events of this kind. Use of field instrumentation enabled immediate collection of hundreds of measurements, critical given the spatial patchiness of battery metal aggregates in an extensive fallout layer in the vicinity of the fire and given the rapidity with which the metals were transported downstream by tides and rain. As battery energy storage systems continue to expand in scale and density, the risk of both localized and widespread contamination will increase even as safety protocols improve…*

*Environmental response frameworks must also consider the potential offset between fire origin and deposition zones. In this case, the most significant contamination occurred not adjacent to the site of the fire, but several kilometers downwind. This spatial offset highlights the need for evacuation protocols and monitoring networks that integrate plume dispersion models, meteorological data, air quality monitoring and ground-based measurements of deposition.*

*Finally, findings from controlled laboratory battery burns provide additional context for interpreting field observations. Previous experiments have demonstrated that thermal decomposition of cathode materials can release substantial quantities of (Ni, Mn, Co) metals and other toxicants. These studies confirm that NMC-based batteries, when subjected to fire conditions, can emit airborne particles capable of traveling significant distances before settling onto the landscape. Field studies such as this one are essential to understanding how such deposition events unfold under real-world conditions.*

*Together, these results emphasize the need for proactive planning, site-specific risk assessment, and rapid, multi-scale environmental monitoring in the aftermath of battery fires. As battery technologies evolve, so too must the frameworks we use to track and mitigate their potential environmental impacts.*

### 2.4.3. Final Author's Comment

I have made many passes through the above excerpts, and have deleted words and phrases that I thought were misleading or confusing. I believe the above is now a fair and deserved critique of the organizations responsible for the management of this project.

There is no doubt that California (including your author), want to be at the leading-edge of the transition to renewable energy, and the infrastructure required to support this transition (like energy storage facilities), however until someone invents a time-machine, all we can do in the aftermath of an unfortunate event such as that described above, is to learn the lessons of our mistakes and apply those lessons going forward.