Date: October 16, 2025
Subject: CRA Supplemental Memo
Project No: 866-006

Fire and Risk Alliance, LLC (FRA) was contracted by Key Capture Energy (KCE) to perform a community risk assessment (CRA) for the proposed BESS installation in Blendon Township, Ottawa County, Michigan (referred to herein as KCE MI4) to evaluate potential offsite impacts from a flaming (i.e. fire) and/or non-flaming (i.e. battery venting from propagating thermal runaway) BESS failure event. KCE MI4 is designed to utilize Canadian Solar's SolBank 3.0 BESS product. This supplemental memo is intended to provide a high-level summary of the approach, methodology, and results of the CRA for the general public.

Proposed Site

The proposed KCE MI4 project is located within Blendon Township, Ottawa County, Michigan. Based on a review of the site plan, the project is anticipated to include 110 SolBank3.0 BESS containers, with room for future augmentation of up to 22 additional containers, and an adjacent connected substation, as shown in Figure 1.

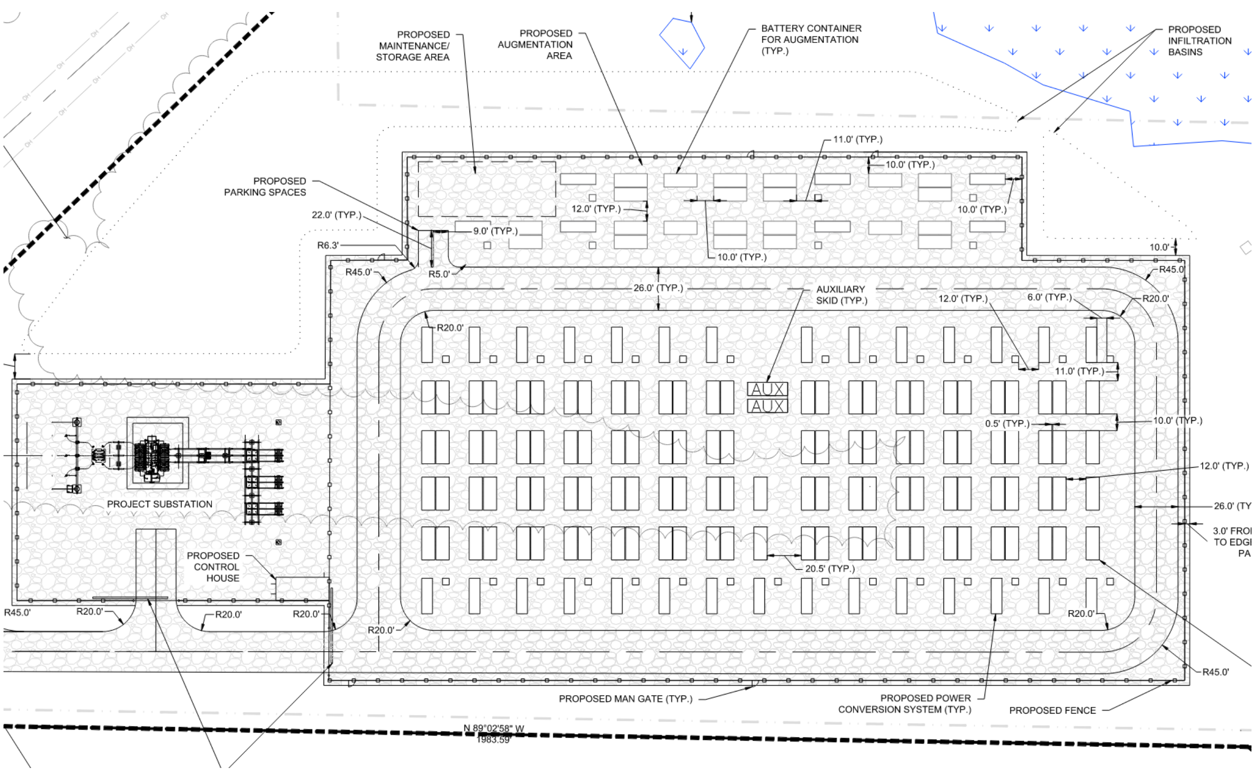

Figure 1. MI4 BESS site layout

A perimeter fence will surround the site with a 20 ft wide fire apparatus access road located throughout the facility for emergency response access. The facility is expected to have an estimated energy capacity of 100 MW / 400 MWh. Additional equipment coupled with BESS containers onsite include inverters, medium voltage transformers, switchgears, and a project substation. Adjacent property land uses include low-density residential development, agricultural parcels, and vacant land. An electrical substation is positioned directly west of the project site. The distance from any KCE MI4 BESS container to the nearest sensitive receptor (METC high voltage transmission corridor) is approximately 426 ft (130 m). The nearest residence on a non-participating property is located south on Polk Street, approximately 1,000 ft (300 m) from the closest proposed BESS unit, as shown in Figure 2. These distances were used to measure the potential for offsite impacts.

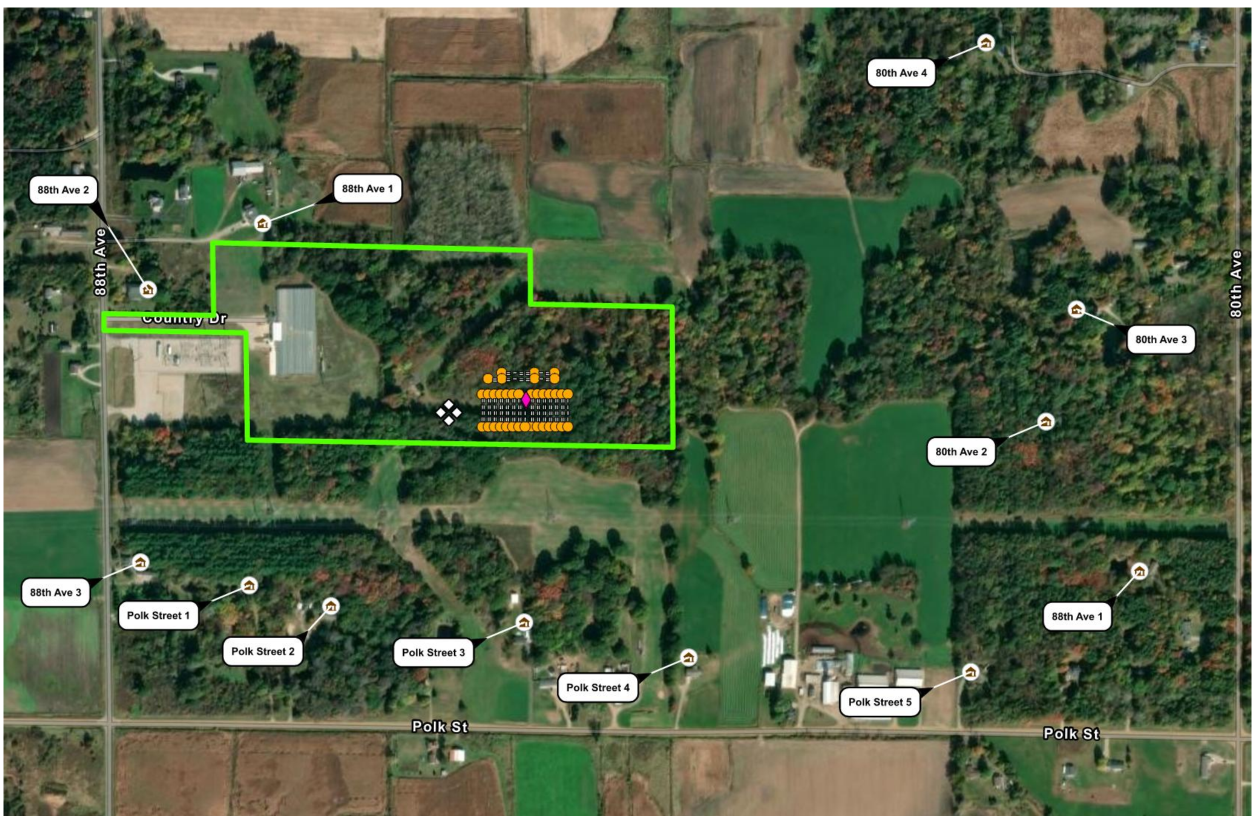

Figure 2. Site aerial map

Approach

The CRA evaluated flammable and toxic gas extents for specific BESS failure scenarios to evaluate the potential for off-site impacts from both flaming (fire) and non-flaming (non-flaming thermal runaway) BESS failure events using the Process Hazard Assessment Safety Tool (PHAST) developed and maintained by DNV. This model is highly validated against experimental data for releases of mixed gases of various compositions, densities, flammable properties, and toxicity. PHAST is also one of the few modeling software authorized for use in modeling flaming and non-flaming BESS failures by jurisdictions nationally with official state level requirements for analysis in specific jurisdictions.

Computational models are only as sound as the data and methodology employed. For this analysis, all data on battery vent gas composition utilized as inputs for modeling efforts came directly from UL9540A testing (UL battery test standard) and destructive Large Scale Fire Test (LSFT) data (NFPA test standard) provided by Canadian Solar, the required standards for conducting battery cell/module/unit and installation level destructive testing. Toxic threshold levels to determine the maximum extents for toxic components, namely carbon monoxide and hydrogen fluoride, were evaluated based on Immediately Dangerous to Life and Health (IDLH) values published by the National Institute for Occupational Safety and Health (NIOSH). The IDLH values are widely accepted as the standard for evaluating inhalation hazards for acute and chronic exposure to toxic components. Heavy particulate matter was not evaluated in this analysis, as the primary hazard to the general public from battery thermal runaway venting is from toxic gas components, like CO or HF. Particulates generated during venting are heavier than the gas phase and would settle near the source rather than disperse to far distances of interest.

While this analysis focuses on the potential consequences from a flaming and/or non-flaming BESS failure, it is important to note that this analysis did not incorporate the likelihood of occurrence for a failure leading to thermal runaway induced battery venting (non-flaming) or to a fully involved BESS fire (flaming). Rather, this analysis takes a conservative approach by assuming failure occurs and does not lower the overall offsite risk profile by incorporating the likelihood of a failure occurring or the likelihood of occupancy in potential impacted areas. Essentially, this analysis assumes that a BESS failure occurs and that any potential areas of impact are occupied.

The methods utilized in this analysis are conservative when applied to the gas generation rate for flaming and non-flaming scenarios. Conservatism is achieved by assuming a constant gas release rate at the measured and/or calculated peak gas release rate from UL 9540A and LSFT collected data for both flaming and non-flaming failure scenarios. These peak gas generation rates, while not maintained for significant portions of time during the documented tests, are nonetheless utilized to ensure PHAST calculated values exceed measured values when compared to testing data, and to provide a safety factor for the extent of potential impacts. Additionally, various weather conditions and wind speeds (long-term average data from the West Michigan Regional Airport weather station) were modeled and compared as to the potential impact offsite. The wind speeds resulting in the farthest extent of impact were utilized for the analysis and evaluation of impacts.

The potential consequences of flaming and non-flaming failures examined in this analysis include:

- The extent of the flammable portion of the vapor (gas) cloud, determined by the Lower flammability limit (LFL) and ½ LFL vapor cloud extent
- The extent of toxic component concentrations in the vapor cloud including carbon monoxide (CO) and hydrogen fluoride (HF), determined by concentration vs. distance and IDLH concentration extent (CO IDLH = 1200 ppm; HF IDLH = 30 ppm)
- Additionally, hazards from ignition of the flammable cloud were examined, determined by the flashfire extent

Non-Flaming (Thermal Runaway) Scenarios

Extent of the Flammable Vapor Cloud (flammable gas)

The maximum extent of impact from the flammable vapor cloud (4.05% ½ LFL) was 6.17 m from the involved SolBank 3.0 for a worst-case non-flaming release from an entire 48 module BESS (Scenario 4), where all of the battery vent gas is released to atmosphere within 65-minutes. This represents a highly conservative gas release rate that can only be achieved by simultaneous battery venting of all 48 modules, a highly unlikely event.

Results for this worst-case failure showed no significant impact on the nearby METC high voltage transmission corridor or the nearby residences from flammable battery vent gas dispersion, with all releases remaining well within the 130 m (425 ft) offset distance from the nearest BESS. As such, conclusions from the PHAST calculated results for flammable battery vent gas dispersion indicate that there would be no significant impacts offsite impacts to sensitive receptors.

Extent of the Flash Fire Envelope

All non-flaming release scenarios included modeling of potential flash fires from an assumed ignition point leading to the largest extent possible effected area while taking into account ignition location and timing. The flash fire envelope did not extend beyond 7.94 m for any PHAST modeled scenario. Even within the affected area, the duration of heat flux values sufficient to ignite flammable clothing or cause second-degree burns to exposed skin is not more than one to three seconds (NFPA defines the upper limit of a flash fire to be three seconds) in any single location within the flash fire envelope.

Results for all non-flaming failure scenarios show that the maximum extent of the flash fire envelope at any time does not impact nearby METC high voltage transmission corridor or the nearby residences from flammable battery vent gas dispersion, with all releases remaining well within the 130m (425 ft) offset distance from the nearest BESS. As such, results indicate that there would be no significant risk to persons or property from a flash fire resulting from any of the modeled scenarios.

Carbon Monoxide IDLH extent

CO was the only toxic component documented in the non-flaming test data (UL 9540A) with an undiluted concentration greater than the component IDLH value, meaning no other measured gas components had the potential for toxic exposure hazards. All PHAST modeled non-flaming releases resulted in potential exposure times greater than the IDLH required 30-minute exposure duration. PHAST modeling results for all non-flaming failure scenarios showed that the maximum CO IDLH (1,200 ppm) extent was 18.73 m, well within the distance to nearby sensitive receptors (130 m to high voltage transmission line and 300 m to nearest residence). Anyone remaining in this affected area for 30-minutes or longer may experience minor effects (slight headache) from exposure. Given the area is open to the outdoors, 30-minutes provides sufficient time to evacuate from the affected area on-site.

As this worst-case CO IDLH extent is contained within close proximity to the KCE MI4 site, results indicate that there would be no significant offsite impacts from carbon monoxide dispersion.

See the below quote from the Centers for Disease Control and Prevention CO IDLH publication as reference for exposure effects.

"It has been stated that a 1-hour exposure to 1,000 to 1,200 ppm would cause unpleasant but no dangerous symptoms, but that 1,500 to 2,000 ppm might be a dangerous concentration after 1 hour [Henderson et al. 1921a, 1921b]. In general, a carboxyhemoglobin (COHb) level of 10-20% will only cause slight headaches [NIOSH 1972] and a COHb of 11-13% will have no effect on hand and foot reaction time, hand steadiness, or coordination [Stewart and Peterson 1970]. At a COHb of 35%, manual dexterity is impaired [Stewart 1975]. At 40% COHb, mental confusion, added to increasing incoordination, precludes driving an automobile [Stewart 1975]. A 30-minute exposure to 1,200 ppm will produce a COHb of 10-13% [NIOSH 1972]."

Flaming (Fire) Scenarios

The composition of the smoke plume for a BESS fire is directly related to battery chemistry as the electrolyte and anode/cathode composition determine the available combustion reactants and post-combustion products (gases and other compounds resulting from a primary, secondary, and/or tertiary combustion reaction). Other flammable components within the BESS are limited to small contributions of common plastics such as polypropylene used for wiring sheaths, seals, and other small components. The cells utilized for the SolBank3.0 are Lithium-iron-phosphate (LFP) cells, which do not contain any heavy metals such as nickel, manganese, or cobalt (found in other battery chemistries such as NMC and NCA batteries) within the anode, cathode, or electrolyte solution. As such, there is no potential for wet or dry deposition of heavy metals related to burning or off gassing of the SolBAnk3.0 LFP batteries from a flaming or non-flaming failure event.

Toxic Component IDLH Extents

LSFT data taken from gas sampling of the smoke plume during the full-scale destructive testing, captured the peak gas generation rates for two toxic components, CO and HF. These peak CO (8.56 L/s) and HF (1.02 L/s) gas generation rates were only documented for small portions of the total burning duration of the fire, however to ensure a high level of conservatism the generation rates were assumed to be constant for the full modeled peak burning duration of 5 hours[1]. This is a conservative assumption as it assumes a constant high volumetric release rate throughout the 5 hours. In contrast, actual fire intensity and emissions would decrease over time as fuel is consumed.

Modeling results for flaming scenarios showed that the calculated IDLH concentrations for HF (30 ppm) and CO (1200 pm) extended to a maximum distance of 12.79 m (HF) and 6.66 m (CO), respectively, for a fully involved fire of an entire 12-rack SolBank 3.0 BESS. Consequence extents are shown in Figure 3. All PHAST calculations for flaming failure scenarios utilized the same wind conditions and conservative approach as for the non-flaming failure scenarios, with predicted values being consistent with the documented LSFT peak measured values.

Results for worst-case flaming failure scenarios show that the maximum extent of CO and HF within the smoke plume do not impact nearby sensitive receptors such as the METC high voltage transmission corridor or the nearby residences from flammable battery vent gas dispersion, with all releases remaining well within the 130m (425 ft) offset distance from the nearest BESS. As such, flaming scenario modelling results indicate no significant offsite risk from HF or CO exposure for any modeled scenario.

[1] Corresponds to the sustained flaming period from the peak intensity through fire decay from the LSFT.

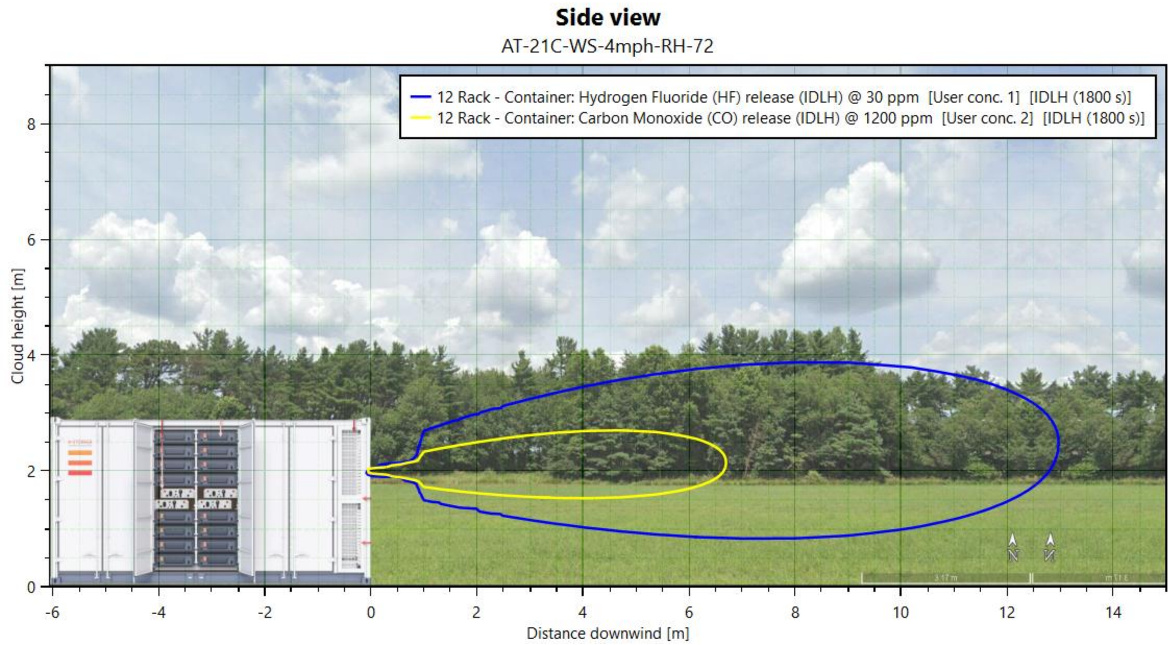

Figure 3.HF (blue) and CO (yellow) IDLH maximum vertical extent (12-rack post combustion)

Minimum Approach Distance (based on toxic exposure)

The Minimum Approach Distance (MAD) for emergency response personnel (ERP) based solely on potential for toxic exposure to CO and/or HF shall be governed by the component with the largest IDLH footprint. For non-flaming release scenarios where all battery vent gas is released via venting from container (48-module) level thermal runaway conditions alone, the component with the largest IDLH footprint is CO (1200 ppm). The extent of the CO IDLH cloud was ~18.73 m a worst-case scenario of a full 48-module BESS venting simultaneously over a 65-minute period. As such, it is recommended that by incorporating a 1.5x safety factor, the MAD for ERP for non-flaming release scenarios be a minimum of 28 m directly downwind (staging locations upwind may be located within proximity to the involved BESS, to be determined by emergency responder incident command).

For a flaming failure scenario representing a fully involved BESS fire, the toxic component with the largest IDLH footprint is HF (30 ppm). The maximum extent of the HF IDLH concentration within the smoke plume was calculated to be ~12.79 m for a fully involved BESS fire with a 5-hour duration. As such, it is recommended that by incorporating a 1.5x safety factor, the MAD for flaming post-combustion gaseous release conditions be a minimum of 19 m directly downwind (staging locations upwind may be located within proximity to the involved BESS, to be determined by emergency responder incident command).

It should be noted that the MADs determined and established above are for distances directly downwind of a BESS involved in a flaming and/or non-flaming failure event and represent a narrow effect zone due to dispersion dynamics. However, all MADs shall be based on the direction of the incident response officer taking into account site conditions, weather conditions, suitable ERP, and overall evaluation of response tactics.

Conclusion

FRA conducted a CRA utilizing PHAST modeling to evaluate potential offsite impacts from multiple potential flaming and non-flaming BESS failure scenarios, including for bounding theoretical worst-case failure scenarios. Analysis results for all flaming and non-flaming failure events showed that all potential impacts from dispersion of the flammable vapor cloud, extent of toxic concentrations for CO (1200 ppm IDLH) and HF (30 ppm IDLHG), and flash fire extents did not extend beyond the offset distance to the nearest sensitive receptors of 130 m for any failure event. Therefore, the conclusions of the CRA based on the available testing data provided, site-based weather conditions, and described conservative flaming and non-flaming failure scenarios are of no significant offsite risk for any modeled failure scenario.

Additionally, distinction can be made between the magnitude of a BESS failure event in regard to the quantity of impacted BESS units, battery modules, battery cells, cell chemistry (LFP vs NMC/NCA) and associated fuel (battery gas) consumed for outdoor containerized BESS installations, such as for the KCE MI4 project, in comparison to indoor open-rack non-containerized BESS facilities with NMC chemistries such as Moss Landing. For outdoor containerized BESS facilities, like the KCE MI4 project, BESS spacing is tested and modeled to ensure limited propagation from an initiating BESS fire to adjacent BESS containers, thus limiting the maximum severity of a failure, as represented in failure scenarios examined and described in this analysis.