

Sherpa Ref: 21717-LET-001-REV1

15 February 2024

Attention: Gerrit Prent

Equis Energy (Australia) Projects (Ngumi 4) Pty Ltd
Ground Floor, 36 Esplanade, Brighton
VIC 3186
Australia

Subject: Response to DPI Agriculture comment on Calala EIS Hazards (SSD-52786213)

Dear Gerrit,

As requested, Sherpa has prepared responses to the NSW Department of Primary Industries - Agriculture (DPI Agriculture) comment on the Calala Battery Energy Storage System (BESS) Environmental Impact Statement (EIS) submission on hazard impacts to the Tamworth Agricultural Institute (TAI). The following are included in this letter:

- Attachment 1 – DPI Agriculture comment on hazard impacts on the TAI
- Attachment 2 – Hazard impacts on the TAI (Fire)
- Attachment 3 – Hazard impacts on the TAI (Exposure to EMF)
- Attachment 4 – References.

Yours sincerely,



Ossy Alim
Principal Risk & Safety Engineer
Sherpa Consulting Pty Ltd

ATTACHMENT 1 – DPI Agriculture comment on hazard impacts on the TAI

Reference: DPI Agriculture letter (OUT23/20408) to the Director of Energy of Assessments of NSW Department of Planning and Environment, dated 13 December 2023.

Department of Primary Industries - Agriculture
Department of Regional NSW



OUT23/20408

Director - Energy Assessments
Department of Planning and Environment
C/- Major Projects Portal

Attention: Pragya Mathema

Calala Battery Energy Storage System – SSD-52786213

Dear Sir/Madam,

Thank you for your correspondence of 14 November 2023 and the opportunity to provide comment on the Calala Battery Energy Storage System (BESS) development.

The NSW Department of Primary Industries (DPI) Agriculture collaborates and partners with our stakeholders to protect and enhance the productive and sustainable use and resilience of agricultural resources and the environment.

I note the proposal is for the development of a 300 MW / 1200 MWh battery storage system and associated infrastructure including connection to the electricity grid.

I have reviewed the environmental impact statement (EIS) for the Calala BESS and particularly the land use conflict risk assessment (Appendix L) and the agricultural land capability study (Appendix M) in the context of potential impacts from the BESS on agricultural land and production.

The proposed BESS is located immediately to the west of the Department of Primary Industries' Tamworth Agricultural Institute (TAI). The EIS and supporting documents do not appear to have considered potential impacts of the BESS on the activities of the TAI. NSW DPI Agriculture requests that the following matters be addressed in the response to submissions.

Noise

The Noise and Vibration Assessment has considered the potential impact of the BESS on residential land uses however it does not appear to have addressed impacts on the operations of the TAI. It is requested that the potential impacts of noise from the BESS on livestock (sheep) grazing in adjacent paddocks and researchers undertaking field work (not operating machinery) are addressed.

Impact of TAI Activities on the BESS

The Land Use Conflict Risk Assessment has not addressed the potential impact of DPI activities at TAI on the BESS. Such impacts may include dust generated from agricultural machinery etc. It is requested that the potential for activities at TAI to impact on the BESS and any necessary mitigation

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measures that need to be implemented in the construction of the BESS are considered in the response to submissions.

Impacts on TAI Activities

The EIS does not indicate whether the location of the BESS will have any impact on future activities or infrastructure that may be undertaken at TAI. The potential for future buffer areas or easements around the BESS which may restrict the activities undertaken by NSW DPI at TAI or the establishment of new infrastructure on TAI is requested to be detailed in the response to submissions. It is strongly suggested that consultation with NSW DPI be undertaken in this regard to understand the potential activities that may occur at TAI.

Hazard impacts on TAI

The EIS and supporting studies have considered the potential hazards that may arise from the proposed BESS on the surrounding residential land uses however it does not appear to have considered the potential for hazardous impacts (fire, exposure to EMF) on TAI staff or activities. It is requested that the potential hazards that may be faced by TAI are addressed in the response to submissions.

Should you require clarification on any of the information contained in this response, please do not hesitate to contact me on 0429 864 501 or by email at landuse.ag@dpi.nsw.gov.au.

Sincerely



Paul Garnett
Agricultural Land Use Planning Officer
Ag Soil and Water
New England and North West Region
13 December 2023

ATTACHMENT 2 – Hazard impacts on the TAI (Fire)

A2.1 BESS fire impact estimation overview

Consequence analysis of a BESS unit on fire was completed to determine the potential for off-site impacts to the TAI. The following scenarios were analysed:

1. Fire involving a BESS unit (e.g. propagated thermal runaway resulting in a fully developed fire). The resulting heat radiation impact from the fire was modelled.
2. Toxic gas generation from decomposition of battery electrolyte due to fire. For lithium iron phosphate (LFP) batteries, there is a potential for hydrogen fluoride (HF) to be formed following electrolyte decomposition from a BESS fire event. In this study, as HF is considered to be the most toxic decomposition product, dispersion of HF was modelled to better understand the impact to receptors. The following Pasquill weather stability and wind conditions were used for the dispersion modelling:
 - Typical day condition (D5): Neutral (Class D) and wind speed of 5 m/s.
 - Typical night condition (F2): Very stable (Class F) and wind speed of 2 m/s.

Impact distances associated with heat radiation due to fire and dispersion of toxic gas were estimated to determine potential for off-site impacts to the TAI.

A2.2 BESS fire

A2.2.1 Modelling approach

Consequence modelling was undertaken based on the Stefan–Boltzmann correlation to analyse the heat transfer effect between two parallel planes, simulating a BESS unit on fire and the heat radiation exposure to a receptor, as shown in Figure 1. Distances to heat radiation levels in accordance with HIPAP No. 4 *Risk Criteria for Land Use Safety Planning*, Ref [1], were calculated.

To estimate the heat radiation generated from a BESS unit on fire, the emitted heat flux was calculated using the Stefan - Boltzman Law:

$$E_{emitted} = e\sigma T^4$$

where E is the radiant emittance, e is the emissivity, σ is the Stefan-Boltzmann constant and T is the surface temperature.

The heat flux received was estimated using the view factor method, where d is receiver distance to BESS unit on fire:

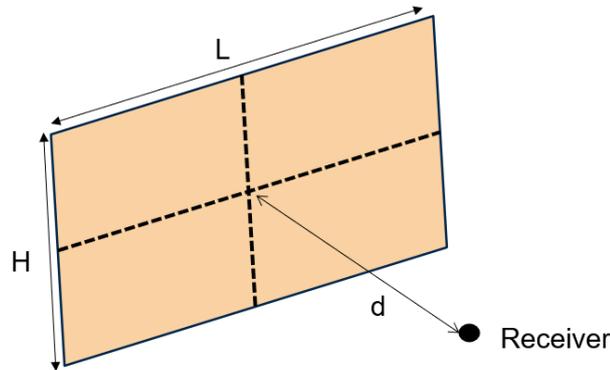
$$\phi = \frac{1}{2\pi} \left[\frac{a}{(1+a^2)^{1/2}} \tan^{-1} \frac{b}{(1+a^2)^{1/2}} + \frac{b}{(1+b^2)^{1/2}} \tan^{-1} \frac{a}{(1+b^2)^{1/2}} \right]$$

$$a = \frac{0.5 H}{d}, a = \frac{0.5 L}{d}$$

To calculate the heat radiation experienced by the receptor at height 1.5 m (approximately half of the BESS unit height and representative of a person), the surface area of the BESS unit (front aspect) is divided into 4 equal sections. Figure 1 illustrates the graphical depiction of the parameters used in the calculation.

$$E_{received} = 4 \phi E_{emitted}$$

Figure 1: The graphical depiction of the parameters (L, H, d)



A2.2.2 Input and assumptions

The modelling input and assumptions used were as follows:

- The flame temperature of the emitting surface was set at 1000°C, which is a value typical for lithium metallic fires, Ref [2].
- An emissivity value of 0.9 (a black body has an emissivity value of 1).
- Receptor height was set at 1.5 m.
- The heat radiation calculation was performed for the front aspect of the BESS unit and assumed a full planar fire. This is conservative as the front aspect has the largest surface area and consequently highest heat radiation impact. This approach is deemed appropriate to determine off-site impacts.

A2.2.3 Heat radiation criteria

Consequences of various heat radiation levels in accordance with HIPAP No. 4 *Risk Criteria for Land Use Safety Planning* are shown in Table 1. Distances to 4.7 kW/m² (injury), 12.6 kW/m² (fatality), and 23 kW/m² (structural failure) were calculated.

Table 1: Consequences of heat radiation

Heat radiation (kW/m ²)	Effect
1.2	Received from the sun at noon in summer
2.1	Minimum to cause pain after 1 minute
4.7	Will cause pain in 15-20 seconds and injury after 30 seconds' exposure (at least second degree burns will occur)
12.6	<ul style="list-style-type: none"> • Significant chance of fatality for extended exposure. High chance of injury • Causes the temperature of wood to rise to a point where it can be ignited by a naked flame after long exposure • Thin steel with insulation on the side away from the fire may reach a thermal stress level high enough to cause structural failure

Heat radiation (kW/m ²)	Effect
23	<ul style="list-style-type: none"> • Likely fatality for extended exposure and chance of fatality for instantaneous exposure • Spontaneous ignition of wood after long exposure • Unprotected steel will reach thermal stress temperatures which can cause failure • Pressure vessel needs to be relieved, or failure would occur

A2.2.4 Analysis results

The distances to the specified heat radiation levels are presented in Table 2. The analysis findings are as follows:

- The heat radiation level to injury threshold extends 8 m from the BESS unit on fire.
- The heat radiation at receptor height of 1.5 m at the eastern project boundary (34 m away) is estimated to be approximately 0.3 kW/m². This is considerably less than the injury threshold at 4.7 kW/m² (i.e. no injury effects to a person standing on the eastern project boundary).

Table 2: Heat radiation impact – BESS unit on fire

BESS	Size (W x D x H, m)	Surface T (°C)	Heat radiation at the eastern project boundary	Distance (m) at receptor height (1.5 m) to radiation levels		
				4.7 kW/m ² (injury)	12.6 kW/m ² (fatality)	23 kW/m ² (structural failure)
Wärtsilä GridSolv Quantum	2.1 x 3.2 x 2.5	1000	0.3 kW/m ²	8	5	4

A2.3 Dispersion of toxic gas

A2.3.1 Modelling approach

In the event of a BESS fire, there is a potential for toxic gas to be generated (1) from decomposition of the battery electrolyte and/or (2) as a result of combustion products. For LFP batteries, there is a potential for hydrogen fluoride (HF) to be formed following electrolyte decomposition from a BESS fire event. In this study, as HF is considered to be the most toxic decomposition product, dispersion of HF was modelled to better understand the impact to receptors.

Consequence modelling was performed using the Gexcon EFFECTS v11.5.2 software (Plume Rise from Fire model) to simulate HF dispersion during a BESS fire. The HF generation rate was based upon published experimental literature for LFP batteries. The downwind distances to the Acute Exposure Guideline Level (AEGL) concentrations for HF were determined.

A2.3.2 Input and assumptions

The modelling input and assumptions used were as follows:

- Hydrogen fluoride is considered the most toxic decomposition products from the batteries fire, Ref [3].
- A lithium-ion battery cell experiment, Ref [3], indicates that the HF quantity released from a 1 Wh battery varies between 20 mg and 200 mg, depending on the battery type and state of charge. As a conservative approach, generation rate of 200 kg per 1 MWh was adopted for the analysis. The HF generation rate was calculated based on the capacity a single BESS unit and fire duration of 1 hour. The resulting HF generation rate used for analysis is conservative as typically the fire duration is longer than 1 hour.
- Release is continuous, with concentration averaging time of 60 minutes used for reporting.
- Surface roughness factor of 0.1 m was used (represents low crops and occasional large obstacles).
- The heat release rate from the battery (with 100% state of charge) is estimated to be 882 kW/m², Ref [4].
- The plume was assumed to be released from the top of the BESS unit. This is viewed as a reasonable approach, based on observation from recent BESS fire incidents (e.g. Victoria Big Battery fire).
- Receptor height was set at 1.5 m
- Wind and weather stability conditions of D 5 m/s (D5) and F 2 m/s (F2) were used to represent typical day and night conditions, respectively.

A2.3.3 Dispersion criteria

The AEGL concentration levels (60-minute exposure) for HF are presented in Table 3. These concentrations were used to inform harm levels following exposure (irritation, injury and fatality).

Table 3: AEGL values for HF (60-minute)

AEGL level	Health effects	HF concentration (ppm)
AEGL-1	Irritation threshold	1
AEGL-2	Injury threshold	24
AEGL-3	Life-threatening health effects threshold	44

A2.3.4 Analysis results

The distances to AEGL concentrations at receptor height of 1.5 m are presented in Table 4. The analysis findings are as follows:

- As a conservative approach, distance to the irritation level (AEGL-1) was used to determine potential for impact to TAI personnel, which is approximately 20 m.
- As there is a 34 m separation from the BESS unit, there will be no irritation or injury effects to a person standing on the eastern project boundary.

Table 4: Toxic dispersion impact (HF) – BESS unit on fire

BESS	Capacity per unit (MWh)	HF generation rate (kg/s)	Heat release (kW/m ²)	Wind weather stability	Distance (m) at receptor height (1.5 m) to AEGL levels		
					AEGL-1 (irritation)	AEGL-2 (injury)	AEGL-3 (fatality)
Wärtsilä GridSolv Quantum	1.490	0.08	882	D5	20	6	4
				F2	2	1	1

A2.4 Findings

A summary of the analysis results is as follows:

- Fire involving a BESS unit: the heat radiation at receptor height of 1.5 m at the eastern project boundary is approximately 0.3 kW/m². This is considerably less than the injury threshold at 4.7 kW/m².
- Toxic gas dispersion: the distances to the injury (AEGL-2) and irritation (AEGL-1) levels at D5 condition are approximately 6 m and 20 m, respectively. For the plume rise from fire model, further downwind distance was observed at the D5 condition compared to F2 condition. As a conservative approach, the distance to the irritation level (AEGL-1) at D5 condition was used to determine potential impact to the TAI, i.e. 20 m.
- Based on the separation distance to the closest TAI boundary (34 m), the effects from a BESS unit fire are not expected to result in injury or irritation to the TAI staff standing on the boundary.
- A BESS unit on fire has the potential for escalation, affecting the entire BESS infrastructure. To minimise fire propagation between the BESS units and onto other adjacent infrastructure, the BESS configurations will follow the specified clearances required by the manufacturer and/or applicable standards. Wärtsilä has completed a UL 9540A unit level test¹ for the GridSolv Quantum. The test result found that all performance requirements for outdoor ground mounted equipment per UL 9540A were met, Ref [5]. The test results are as follows:
 - If the battery cells within a battery module go into thermal runaway, it would not propagate to adjacent modules or units.
 - The Lower Explosive Limit (LEL) remained below 25%, with no risk of deflagration.
 - No flaming occurred beyond the outer dimensions of the battery system enclosure (i.e. no external flaming).
 - No explosion hazards were exhibited.

¹ The UL 9540A testing is a destructive test method used for evaluating the thermal runaway impacts in a BESS and gathering data to assist in assessing or developing mitigation measures for the failure event, propagation of the failure, or consequences of an event, such as an explosion or fire. It is currently considered to be the most appropriate published methodology to provide comprehensive, consistent, and reliable data for battery failure testing.

ATTACHMENT 3 – Hazard impacts on the TAI (EMF exposure)

Assessment of EMF exposure from the Calala BESS and grid connection infrastructure was completed as part of the Preliminary Hazard Analysis (PHA), Ref [6], which forms a supporting study for the EIS. The assessment included the BESS, Power Conversion Unit (PCU), HV connection asset, and the underground transmission lines.

The PHA found that:

- EMF created from the Calala BESS development will not exceed the International Commission on Non-Ionizing Radiation Protection (ICNIRP) occupational exposure reference level.
- As the strengths of EMF attenuate rapidly with distance, the study determined that the ICNIRP reference level for exposure to the general public will not be exceeded and impact to the general public in surrounding land uses will be negligible. This includes the TAI, of which the closest site boundary is located 34 m away from the Calala BESS project extent boundary.

ATTACHMENT 4 – References

1. NSW Department of Planning, “Hazardous Industry Planning Advisory Paper No. 4 Risk Criteria for Land Use Safety Planning”, 2011.
2. Ouyang, D., Liu, J., Chen, M., & Wang, J. , “Investigation into the fire hazards of lithium-ion batteries under overcharging,” Applied Sciences, 7(12), p.1314, 2017.
3. Larsson, F., Andersson, P., Blomqvist, P., & Mellander, B. E., “Toxic flouride gas emissions from lithium-ion battery fires,” Scientific reports, 2017.
4. P. P. e. al, “Study of the fire behaviour of high-energy lithium ion batteries with full-scale burning test,” Journal of Power Sources, vol. 285, pp. 80-89, 2015.
5. Wärtsilä Corporation, “Wärtsilä marks energy storage fire safety milestone as GridSolv Quantum passes UL 9540A requirements,” 28 March 2023. [Online]. URL: <https://www.wartsila.com/media/news/28-03-2023-wartsila-marks-energy-storage-fire-safety-milestone-as-gridsolv-quantum-passes-ul-9540a-requirements-3254594>.
6. Sherpa Consulting Pty Ltd, ‘Calala BESS Preliminary Hazard Analysis’, 21717-RP-001, Revision 0, 2023.