Valley of the Winds

APPENDIX M
PRELIMINARY HAZARD ASSESSMENT

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UPC Renewables Australia Pty Ltd

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VALLEY OF THE WINDS
PRELIMINARY HAZARD ANALYSIS

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CONTENTS

TABLE OF TABLES

APPENDICES

1. INTRODUCTION

1.1 Background

UPC Renewables Australia Pty Ltd, operating as UPC\AC Renewables Australia (UPC\AC) (the Proponent), proposes to construct and operate the Valley of the Winds wind farm (the project).

The project would consist of up to 148 wind turbines and supporting infrastructure, including a potential battery energy storage system (BESS) with a capacity of 320MW/640MWh and a high voltage transmission line which would run approximately 13 kilometres from the Girragulang Road cluster to a connection point with the Central West Orana REZ Transmission line proposed by the NSW Government. The project would supply over 800 megawatts (MW) of electricity into the National Electricity Market (NEM).

A development application (DA) and environmental impact statement (EIS) will be submitted for the project under Part 4, Division 4.1 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act).

1.2 Purpose of the report

This Preliminary Hazard Analysis (PHA) has been prepared to consider and assess the potential hazards and risks posed by the project and the management measures proposed to address these potential hazards and risks in accordance with the requirements of the *Hazardous Industry Advisory Paper No. 4 – 'Risk Criteria for Land Use Safety Planning* (Department of Planning, 2011a)*; Hazardous Industry Planning Advisory Paper No.6 – Guidelines for Hazard Analysis* (Department of Planning, 2011b) (HIPAP), the *Multi-Level Risk Assessment* (Department of Planning, 2011c) and the *Hazardous and Offensive Development Application Guidelines Applying SEPP 33* (Department of Planning, 2011d) (SEPP 33 Guideline)

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1.3 Scope of works

1.3.1 Secretary's environmental assessment requirements

A list of the Secretary's Environmental Assessment Requirements (SEARs) relevant to the PHA and where they have been addressed in this report is provided in **Table 1-1**.

Table 1-1: SEARs and where each requirement has been addressed in this PHA

Requirement	Where addressed
General Requirements	
• a full description of the development, including: – all infrastructure and facilities, such as substations, transmission lines, construction compounds, concrete batching plants, internal access roads, and road upgrades (including any infrastructure that would be required for the development, but the subject of a separate approvals process); • an assessment of the likely impacts of the development on the environment, focusing on the specific issues identified below, including: – an assessment of the likely impacts of all stages of the development, taking into consideration any relevant legislation, environmental planning instruments, guidelines, policies, plans and industry codes of practice and including the *NSW Wind Energy Guideline for State Significant Wind Energy Development* (2016); – a description of the measures that would be implemented to avoid, mitigate and/or offset residual impacts of the development and the likely effectiveness of these measures, including details of consultation with any affected non-associated landowners in relation to the development of mitigation measures, and any negotiated agreements with these landowners; – a description of the measures that would be implemented to monitor and report on the environmental performance of the development, including adaptive management strategies and contingency measures to address residual impacts	**Section 4** and **Section 5**
Key issues	
The EIS must address the following specific matters:	N/A
• Hazards and Risks – including:	N/A
– Health – consider and document any health issues having regard to the latest advice of the National Health and Medical Research Council, and identify potential hazards and risks associated with electric and magnetic fields (EMF) and demonstrate the application of the principles of prudent avoidance	**Section 4**

1.3.2 Department of Planning and Environment comments

The Department of Planning and Environment provided comments regarding the requirement for assessment of potential hazards and risks associated with the project. The key issues raised by the Department of Planning and Environment and a response to each issue is provided in **Table 1-2**.

Table 1-2: Response to issues raised by the Department of Planning and Environment

Key Issues	UPC/AC Response
The Department of Planning and Environment requires the preparation of a Preliminary Hazard Analysis focussed on the BESS	The purpose of this document
The Preliminary Hazard Analysis does not need to be based on the final design of the BESS but rather an indication that the BESS is capable to be installed and operated safely (with consideration of relevant standards, codes, testing, and learnings from significant incidents) in view of site constraints	Refer to **Section** 2 and **Table 2-2**
If design flexibility is required, these flexibilities and possible variances should be included for consideration in the Preliminary Hazard Analysis	Refer to **Section 2**
The Preliminary Hazard Analysis should include actions/recommendations to be implemented for the final design, and the final design be specified in a post-approval fire safety study. This study would need to be reviewed by Fire and Rescue NSW.	Refer to **Section 5** and **Appendix 1**

1.4 Document structure

This report is structures as follows:

- **Section 1. Introduction** – provides background on the project and introduces the document purpose and structure
- **Section 2. The Project** – describes the project including the inherent management measures for the project
- **Section 3. Assessment Methodology** - provides an overview of the methodology used to assess the hazards and risks associated with the project
- **Section 4. Potential Impacts** – provides a detailed summary of the potential hazards and risks associated with the project
- **Section 5. Management and Mitigation Measures** – provides a summary of management and mitigation measures additional to those inherent to the project
- **Section 6. References.**

2. THE PROJECT

2.1 Key project elements

2.1.1 Project overview

The project would involve the construction operation and decommissioning of up to 148 turbines across three clusters, that would be connected electrically. These are:

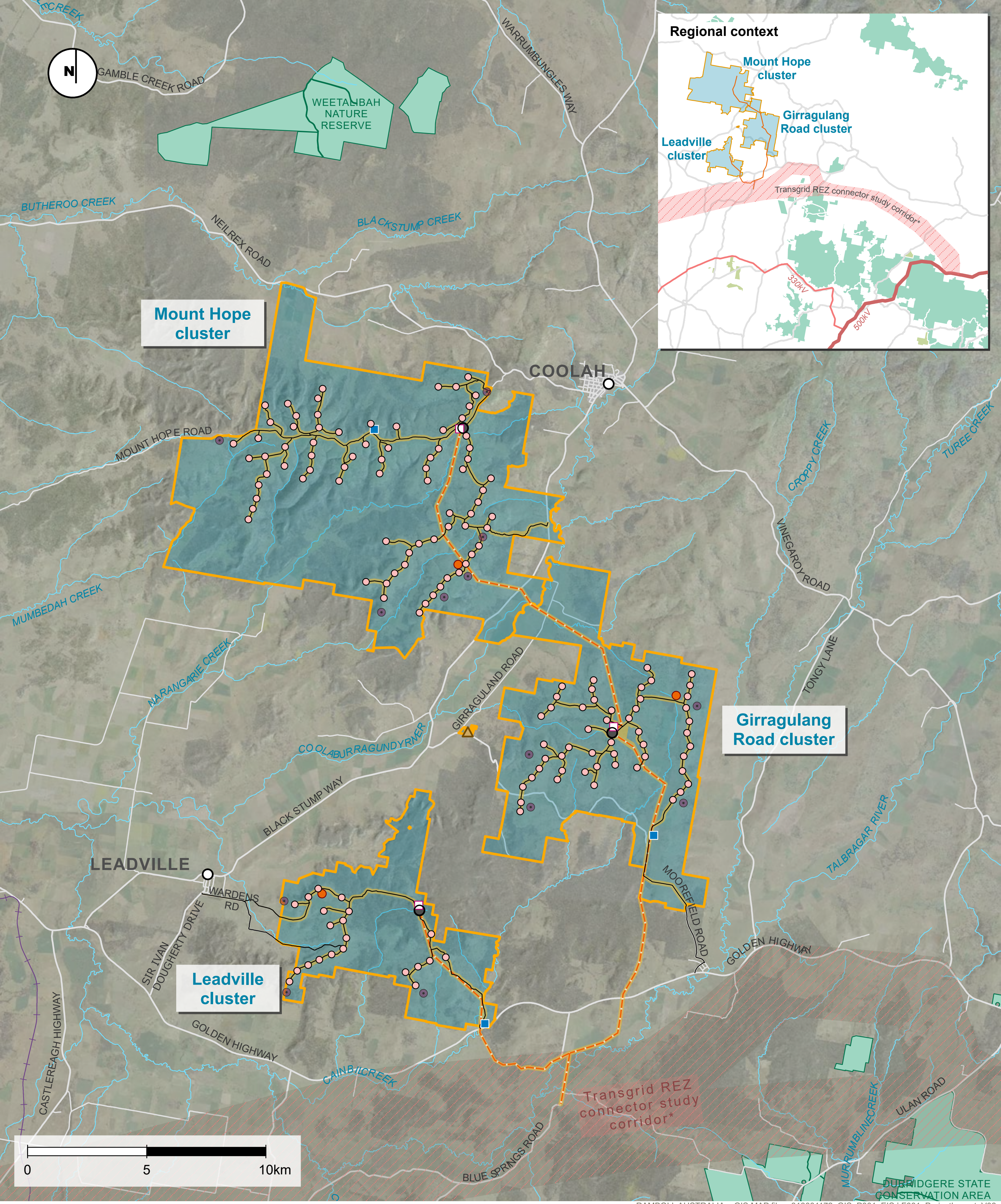
- Mount Hope cluster –76 turbines
- Girragulang Road cluster –51 turbines
- Leadville cluster –21 turbines.

Key infrastructure for the project (as shown in **Figure 2-1**) would be:

- up to 148 wind turbines with a maximum tip height of 250 metres and a hardstand area at the base of each turbine
- electrical infrastructure, including:
    - substations in each cluster and a step-up facility at the connection to the Central West Orana REZ Transmission line
    - where possible, underground 33 kilovolt electrical reticulation connecting the turbines to the substations in each cluster
    - overhead transmission lines (220 kilovolt or 330 kilovolt) dispatching electricity from each cluster
    - other electrical infrastructure as required, including a potential battery energy storage system (BESS) with a capacity of 320MW/640MWh
    - a high voltage transmission line (330 kilovolt or 500 kilovolt) connecting the wind farm to the Central West Orana Renewable Energy Zone Transmission line
- other permanent on-site ancillary infrastructure:
    - permanent operation and maintenance facilities
    - meteorological masts (up to thirteen)
- access track network:
    - access and egress points to each cluster from public roads
    - operational access tracks and associated infrastructure within each cluster on private property
- temporary construction ancillary facilities:
    - potential construction workforce accommodation on site
    - construction compounds
    - laydown areas
    - concrete batching plants
    - quarry sites for construction material (rock for access tracks and hardstands).

At the end of its practical life, the wind farm would be decommissioned, and the site returned to its pre-existing land use in consultation with the affected landholders.

The project is expected to require up to 400 full-time employees during peak construction and approximately 50 full-time employees during operation and ongoing maintenance of the wind farm.



RAMBOLL AUSTRALIA - GIS MAP file : 318001172_GIS_P001_EIS | F001_ProjectLayout_V08
Aerial photography from NSW Government Spatial Services

KEY

- Wind farm site
- Survey boundary
- Turbine location
- Access track
- Overhead transmission line
- Potential construction workforce accommodation
- Substation location
- Permanent operations and maintenance compound (also used during construction)
- Temporary construction compound
- Indicative quarry location
- Permanent meteorological mast location
- Railway
- National Parks and Reserves

*Approximate only

Figure 2-1 | Project overview

2.2 Potentially hazardous project elements

The Hazard Identification and Analysis presented in **Appendix 1** identifies the potential hazards in the project: the locations that they could occur; the potential event that could lead to the hazard; the potential cause/s of the potential event; the potential consequences; and the proposed controls. The following describes the key potential hazards.

2.2.1 Hazardous materials

Table 2-1 lists the hazardous materials to be handled during the project, and the potential hazards associated with each material. The majority of vehicle movements to transport the material listed in **Table 2-1** would either: only occur during construction and/ or commissioning of the project; or be substantially lower during operation of the project.

In addition to the hazardous materials described in **Table 2-1** the project would also require storage and use of the following chemicals:

- Transformer oil
- MCPA (2-methyl-4-chlorophenoxyacetic acid) (for use as herbicide/pesticide).

Table 2-1: Hazardous materials and potential hazard

Material/ Usage	Dangerous Goods Class	Hazardous material Category	Peak storage project stage
Liquefied Petroleum Gas (LPG)	2.1	Flammable gas	Construction
Refrigerant	2.2	Non-flammable Non-toxic gas	Operation
Gasoline	3 PG II	Flammable liquids	Construction
BESS	9	Miscellaneous dangerous goods	Operation

Both of these chemicals are not classified as hazardous material and are therefore excluded from the risk screening. They would not be stored with other flammable materials and therefore they are not considered to be potentially hazardous under *State Environmental Planning Policy (Resilience and Hazards) 2021* (Resilience and Hazards SEPP).

2.2.2 Other hazards and risks

UPC\AC has undertaken hazard identification with consideration of the following project factors:

- project infrastructure
- type of equipment
- hazardous materials present
- proposed operation and maintenance activities
- external factors.

Events with the potential to result in major consequence impacts to people (injury and/or fatality), the environment and project assets (excluding workplace health and safety hazards such as slips, trips and falls) were identified:

- **electrical**: exposure to voltage
- **arc flash**: release of energy

- **electromagnetic fields (EMF)**: exposure to EMF
- **fire**: infrastructure fire and bushfire
- **chemical**: release of hazardous materials
- **reaction**: battery thermal runaway
- **external factors**: bushfire, vandalism, lightning storm.

Electromagnetic fields
EMF occur both naturally in the environment and are produced wherever there is a flow of electricity. Electric fields are associated only with the presence of electric charge, whereas magnetic fields are the result of the physical movement of electric charge.

The project includes potential EMF sources. The final EMF levels would depend on the specific technology and supplier selected. EMF would only occur during the operational phase of the project, when the wind farm is in use and capable of generating electricity. Simulations of the magnetic field strength were performed by DNV for the medium voltage (33 kilovolt) underground electrical cables from the wind turbines. Only the magnetic field strength was considered for the underground cables as the electric field strength, once at ground level for these cables is expected to be negligible due to the attenuation effect of the ground cover (DNV, 2022).

Underground Medium Voltage cables
Details of the electrical reticulation cable network required for the project is described in Section 4.7.2 of the EIS. Medium voltage cables would be installed to connect the turbines to the substations in each cluster. The medium voltage reticulation network may be installed overhead or buried underground and would have a maximum capacity of 33 kilovolts.

A typical 33 kilovolt underground cable produces a maximum magnetic field of approximately 1 μT at one metre above ground level. The magnetic field density would be indistinguishable from the background magnetic field at distances greater than 20 metres from the cable.

Substations
A description of the substation for the project is provided in Section 4.7.2. There would be one 'collector' substation in each of the Mount Hope and Leadville clusters, and one 'central' substation within the Girragulang Road cluster. The substations would consist of an indoor switch room to house the medium voltage switchboard and circuit breakers, and an outdoor switch yard to house the transformer(s), gantries and associated infrastructure.

Main sources of magnetic fields within a large substation include transformer secondary terminations, cables to the switch room, capacitors, reactors, busbars, and incoming and outgoing feeders. In most cases the highest magnetic fields at the boundary come from incoming and outgoing transmission lines.

Generally, the application of electrical safety standards and codes (including the provision of fencing, enclosures and distance) result in exclusion of general public exposures from these sources. This is consistent with the reported typical magnetic field which ranges between 1 to 8 μT at a substation fence.

Overhead transmission lines
The following overhead transmission lines would be required:
- transmission line(s) of up to 330 kilovolts, that would dispatch electricity from the collector substation in the Mount Hope cluster and connect it to the central substation in the Girragulang Road cluster
- high voltage transmission line(s) of up to 500 kilovolts running generally south from the central substation in the Girragulang Road cluster, connecting the wind farm to the CWO-REZ Transmission line

- transmission line(s) of up to 330 kilovolts that would dispatch electricity from the collector substation in the Leadville cluster and connect it to the 500-kilovolt line running from Girragulang Road to the CWO-REZ Transmission line (a step-up facility from 33kV to 330kV would be required within the Leadville cluster).

The magnetic field from transmission lines would vary with configuration, phasing and load. The typical magnetic fields near 330 kilovolts overhead transmission lines measured at one metre above ground level range between 1 to 20 μT (directly underneath) and 0.2-5 μT (at the edge of a transmission line easement).

Battery energy storage system
A description of the BESS for the project is provided in Section 4.7.2. The BESS would likely be a centralised 'AC Coupled' BESS near the connection to the Central West Orana REZ Transmission line.

The centralised BESS would be housed in a secure compound adjacent to the substation at either the central substation, or at the connection to the CWO-REZ Transmission line.
The batteries would be housed in one of the following structures:

- A large building or buildings that would use materials similar in appearance and construction to agricultural sheds prevalent across the study area,
- Modified shipping containers or prefabricated switch rooms, or
- Smaller kiosk or outdoor-rated cabinet style enclosures.

The modified shipping containers and prefabricated switch rooms would likely be mounted on concrete footings, while the cabinets would likely be mounted on concrete slabs.

The electro-magnetic fields associated with a BESS varies depending on several factors including configuration; capacity; and type of housing. Due to the limited information on typical measurement of magnetic fields around utility scale BESS facilities, it has been assumed the typical magnetic field is similar to that of a substation given the proposed designs which include dedicated housing (enclosures).

The BESS would be installed in accordance with the relevant guidelines and standards and other electrical safety standards and codes, resulting in exclusion of public exposures from these sources.

Fire risk

Battery energy storage system
The Hazard Identification and Analysis in **Appendix 1** identifies the potential hazards due to fire risks generated within the BESS and associated infrastructure. The analysis also identifies the controls that would be implemented to (a) minimise the potential for fire ignition and (b) control fires (and the associated environmental and safety impacts) if a fire did occur.

These controls would be implemented through designing, constructing and operating the BESS in accordance with relevant standards and guidelines. **Table 2-2** identifies these standards and guidelines, how they are relevant, and how they are and would be addressed by the project.

Table 2-2: Guidelines relevant to BESS and how addressed

Standard/ Guideline	Relevance	How addressed
NFPA 855: *Standard for the Installation of Stationary Energy Storage Systems* (US National Fire Protection Association)	This standard provides the minimum requirements for mitigating the hazards associated with energy storage systems. It defines the design, construction, installation, commissioning, operation, maintenance, and decommissioning of stationary energy storage systems including BESS.	UPC\AC and its contractors will consider this standard in preparing the detailed design, where the designer determines the standard is relevant to the project. This has been included as an additional management measure (ID H8) in **Section 5**. Any relevant requirements from the standard would be documented in the Fire Safety Study to be prepared following the detailed design and after the project is granted development consent.
Australian Standard AS 5139:2019: *Electrical installations - Safety of battery systems for use with power conversion equipment* (Standards Australia)	This standard specifies requirements for general installation and safety requirements for BESS, where the battery system is installed in a location, such as a dedicated enclosure or room, and is connected with power conversion equipment (PCE) to supply electric power to other parts of an electrical installation.	UPC\AC will consider this standard in preparing the detailed design where the standard is relevant to the project. This has been included as an additional management measure (ID H8) in **Section 5**. Any relevant requirements from the standard would be documented in the Fire Safety Study to be prepared following the detailed design and after the project is granted development consent.
IEC 62897: *Stationary Energy Storage Systems with Lithium Batteries - Safety Requirements* (International Electrotechnical Commission)	This standard specifies general safety requirements for BESS with lithium batteries.	UPC/AC procurement procedures would require any lithium batteries to comply with this standard.

Standard/ Guideline	Relevance	How addressed
UL 9540: *Energy Storage Systems and Equipment* (Underwriters Laboratories)	This applies to energy storage systems intended to receive and store energy in some form so that the BESS can provide electrical energy to loads or to the local/area electric power system (EPS) when needed. The types of energy storage covered under this standard include electrochemical, chemical, mechanical and thermal.	UPC/AC procurement procedures would require batter suppliers to comply with this standard.
UL 9540A: *Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems* (Underwriters Laboratories)	The test methodology in this document evaluates the fire characteristics of a BESS that undergoes thermal runaway. The data generated will be used to determine the fire and explosion protection required for an installation of a BESS.	Item 8 of the Hazard Identification and Analysis (**Appendix 1**) discusses the controls to be applied to avoid and mitigate thermal runaway. Further detail would be provided in the Fire Safety Study to be prepared following the detailed design and after the project is granted development consent.
Development of Sprinkler Protection Guidance for Lithium Ion Based Energy Storage Systems (FM Global)	This document provides protection recommendations for Lithium-ion (Li-ion) BESS located in commercial occupancies, which have been developed through fire testing.	This standard primarily focuses on lithium ion-based BESS installed within existing commercial operations, and the need to assess: • whether existing fire sprinkler systems are suitable • what needs to be considered in the location of BESS within such a facility • what upgrades to the fire sprinkler system would be required. While this appears to not be directly applicable to the project, the principles of the guideline (in relation to space separation from combustible and non-combustible elements) will be considered during detailed design of the project. This has been included as an additional management measure (ID H8) in **Section 5**.

Bushfire risk

Cool Burn Fire and Ecology (2022) prepared the Bushfire Risk Assessment (Bushfire Assessment) which nominated the bushfire prone vegetation types surrounding the project. The associated fuel for each vegetation type was taken from the NSW RFS Comprehensive Vegetation Fuel Loads (NSW RFS, 2019) and based on the publication 'Ocean Shores to Desert Dunes' (Keith, 2004). The vegetation types and fuel loads surrounding the project are:

- Managed grasslands and rural enterprise are low threat vegetation (<4t/ha when managed)
- Native and derived grasslands (up to 4-6t/ha)
- Woodlands: Western Slopes Grassy Woodland (10.5t/ha surface/elevated – 18.3t/ha overall)
- Forests: Northwest Slopes Dry Sclerophyll Forest (14t/ha surface/elevated – 24.47t/ha overall)

The locality surrounding the project is undulating, and the turbine and access infrastructure is predominantly on slopes exceeding 5 degrees but less than 15 degrees. Some slopes 15-20 degree and exceeding 20 degrees will have significant impact on fire behaviour (particularly but not limited to the Mount Hope cluster).

The slopes surrounding the potential construction workforce accommodation are generally flat (0 degrees) to the north, south, and west and upslope (0-5 degrees) to the east.

The project is located in the Warrumbungle LGA which falls within the North-western NSW RFS Fire Weather District (District 13) and has a current Fire Danger Rating (FDR) classification of:

- Forest FDI = FFDI 80
- Grassland FDI = GFDI 110

3. ASSESSMENT METHODOLOGY

3.1 Preliminary risk screening

A PHA is required to be prepared in accordance with Resilience and Hazards SEPP for a potentially hazardous or offensive development. Appendix 3 of the SEPP 33 Guideline lists industries that may be potentially hazardous or offensive development. Appendix 3 of the SEPP 33 Guideline does not include energy storage facilities.

For developments where the applicability of Resilience and Hazards SEPP is not immediately apparent, a risk screening procedure is provided in Appendix 2 of the guideline as a checklist to identify other potentially developments that may be hazardous or offensive. The risk screening process considers the type and quantity of hazardous materials to be stored onsite, distance of the storage area to the nearest site boundary, as well as the expected number of transport movements.

'Hazardous materials' are defined in the SEPP 33 guideline as substances that fall within the classification of the Australian Dangerous Goods Code (ADGC) and have a Dangerous Goods (DG) classification. A development which exceeds the screening thresholds in the guidelines would be considered potentially hazardous and a PHA would be required.

As described in **Section 2.2.2**, the project is considering a centralised "AC Coupled" BESS adjacent to one the grid substation within the development footprint.

The major components of the BESS would comprise:

- **Batteries** – most likely a lithium-ion technology type
- **Inverters** – convert the DC electricity generated by the wind farm into AC.
- **Transformers** – there would be two types of transformers within the centralised AC Coupled BESS if this option is chosen: low-voltage to medium-voltage transformers and medium-voltage to high-voltage transformers (33kV/330kV) at the grid connection point (substation). The BESS connection will either share a transformer with a section of the wind farm or may be tied to a separate transformer within the substation, but this will only be determined in the detailed design.
- **Heating ventilation air conditioning** (HVAC) – the HVAC would maintain the batteries at a suitable temperature to optimise their lifetime, performance and to ensure safe operation. This could include small package units, large chillers or a liquid cooling system
- **Fire protection** – where required active gas-based fire protection systems would be installed within the BESS enclosure and thermal sensors and smoke/gas detectors would be installed and connected to a fire control panel.

The final BESS design would be assessed by a Fire Safety Study and other risk assessments post approval (and submitted for DPIE approval prior to construction). As a conservative assessment, this PHA has considered the maximum quantities of hazardous materials that would be onsite, as well as the potential for multiple locations.

3.2 Preliminary hazard analysis

The PHA was undertaken for the project in accordance with the HIPAP and *Multi-Level Risk Assessment* (Department of Planning, 2011c). A qualitative assessment has been undertaken for the PHA. The SEPP 33 Guideline says that a qualitative assessment can be undertaken if the criteria listed in **Table 3-1** are met (which is achieved by the project and this assessment).

Table 3-1: PHA qualitative assessment criteria and how achieved

PHA qualitative assessment criteria	How criteria has been achieved
Screening and risk classification and prioritisation indicate there are no major offsite consequences and societal risk is negligible	The quantities of hazardous materials to be stored onsite do not exceed the Resilience and Hazards SEPP threshold levels
The necessary technical and management safeguards are well understood and readily implemented	Technical and management safeguards are inherent to the project elements that store and use the hazardous materials
There are no sensitive surrounding land uses	The nearest residence is more than 1500 m from the proposed location of the hazardous material storage areas

The methodology applied for the PHA included:

- identification and analysis of potential hazards associated with the project
- analysis of the potential consequence of each of the identified hazards
- estimate the likelihood of each of the potential hazards occurring
- determination of a risk level for the project
- assessment against risk criteria
- outline relevant operational, maintenance and management procedures required to manage potential hazards associated with the project.

Details of the definitions used to define the consequence, likelihood and overall risk of identified hazards are included in **Appendix 1**.

3.2.1 Electromagnetic risk

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) is a federal government agency with the responsibility for protecting the health and safety of people and the environment from EMF. The ARPANSA website notes that "*exposure to ELF* (extremely low frequency) *EMF at high levels can affect the functioning of the nervous system*" but that "*Most of the research indicates that ELF EMF exposure normally encountered in the environment, including in the vicinity of powerlines, does not pose a risk to human health*". Generally, distances beyond 50 metres from a high voltage powerline are not expected to have higher than typical magnetic fields and for substations magnetic field levels at distances of 5 to 10 metres away are no higher than background levels in a typical home.

Therefore, the EMF risk assessment presented in this section addresses predominantly the effects of exposure to ELF magnetic fields associated with the proposed project infrastructure.

Typical exposure levels to EMF for the project infrastructure have been assessed against the International Commission on Non-Ionizing Radiation Protection (ICNIRP) *Guidelines for limiting exposure to Time-varying Electric, Magnetic and Electromagnetic Fields* (ICNIRP, 2020) (the ICNIRP Guidelines).

The ICNIRP Guidelines defines general public and occupational exposures as follows:

- **General public** – individuals of all ages and of varying health status which might increase the variability of the individual susceptibilities.
- **Occupational exposure** – adults exposed to time-varying EMF from 1 Hz to 10 MHz at their workplaces, generally under known conditions, and while completing their regular or assigned job.

The ICNIRP Guidelines reference levels for exposure to EMF at 50 Hz are presented in **Table 3-2**.

Table 3-2: Reference levels for EMF levels at 50 Hz

Exposure	ICNIRP Reference Levels	
	Electric field (V/m)	Magnetic field (μT)
General public	5,000	200
Occupational	10,000	1,000

3.2.2 Fire risk

The *Wind Energy Guideline* (NSW Department of Planning Industry and Environment, 2016)(Wind Guideline) lists fire hazard and risk associated with construction and operation of a wind farm as an issue to be considered. The *Hazardous Industry Advisory Paper No. 4, 'Risk Criteria for Land Use Safety Planning* (Department of Planning, 2011a) sets out considerations related to separation distances to on-site and off-site receptors to prevent fire propagation.

The Bushfire Assessment prepared by Cool Burn Fire and Ecology (2022) was prepared in accordance with the methodology and procedures outlined in Appendix 1 of *Planning for Bushfire Protection 2019* (NSW RFS, 2018) and clause 44 of the *Rural Fire Regulation 2013* (RF Regulation).

3.2.3 Statutory context, policy and guidelines

The hazard and risk assessment was undertaken in accordance with the following guidelines:

- *State Environmental Planning Policy (Resilience and Hazards) 2021* (Resilience and Hazards SEPP)
- *Hazardous and Offensive Development Application Guidelines Applying SEPP 33* (Department of Planning, 2011d)
- The *Hazardous Industry Advisory Paper No. 4, 'Risk Criteria for Land Use Safety Planning* (Department of Planning, 2011a)
- *Hazard Industry Planning Advisory Paper No.6 – Guidelines for Hazard Analysis* (Department of Planning, 2011b)
- *Multi-Level Risk Assessment* (Department of Planning, 2011c)
- *AS/NZS ISO 31000:2018 Risk Management – Principles and Guidelines*
- *Planning for Bushfire Protection* (NSW Rural Fire Service, 2019)
- *Guidelines for limiting exposure to Time-varying Electric, Magnetic and Electromagnetic Fields* (ICNIRP, 2020).

4. POTENTIAL IMPACTS

4.1 Preliminary hazard analysis

4.1.1 Risk screening

Table 4-1 identifies the hazardous materials to be stored on and transported to the study area and consideration of the applicable Resilience and Hazards SEPP threshold. None of the Resilience and Hazards SEPP threshold levels would be exceeded during any phase of the project.

Table 4-1: Resilience and Hazards SEPP Risk screening summary – storage and transport

Material/ Usage	Resilience and Hazards SEPP threshold (tonne)	Exceed threshold?
LPG	For above ground storage, the screening threshold is 10 tonnes.	No
Refrigerant	No threshold identified based on Resilience and Hazards SEPP and excluded from risk screening. Class 2.2 are not considered to be potentially hazardous with respect to offsite risk.	No
Gasoline	For quantity up to 5 tonnes, the amount is unlikely to represent a significant risk and therefore is not potentially hazardous.	No
BESS	No threshold identified based on Resilience and Hazards SEPP and excluded from risk screening. Class 9 is not classified as potentially hazardous material as per Resilience and Hazards SEPP.	No

Despite the conclusions of the preliminary risk screening, the SEARs require that a PHA be prepared, demonstrating that the BESS is suitably located and minimises risks to neighbouring land uses. The PHA includes consideration of the potential hazards presented by the BESS and the other materials in **Table 4-1**.

4.1.2 Potential hazards

Hazardous materials

The key risks associated with the materials are:

- **LPG**: flammable; containerised gas (under pressure) presents a risk of explosion if heated
- **refrigerant**: containerised gas (under pressure) presents a risk of explosion if heated
- **gasoline**: extremely flammable; may cause lung damage if swallowed; skin irritation; vapours can cause drowsiness and dizziness
- **BESS**: adverse reaction with water; contents harmful if swallowed or in contact with skin
- **transformer oil**: may be fatal if swallowed and enters airways
- **MCPA**: harmful if swallowed; causes serious eye irritation; toxic to aquatic life

Other hazards and risks

Appendix 1 presents the detailed outcome of the hazard identification process undertaken by UPC\AC. The Hazard Identification and Analysis table in **Appendix 1** identifies the following:

- the type of hazard:
    - electrical

    - arc flash
    - EMF
    - fire
    - chemical
    - reaction
    - external factors
- the infrastructure or area of the potential hazard
- the hazard event (for example, a switch room fire as a form of Fire hazard)
- the cause/s of the hazard event
- the potential consequences of the hazard event
- the Consequence Rating
- the controls to be implemented to mitigate or minimise the potential of the hazard event
- other comments (to assist in informing the basis of the analysis)
- the Likelihood Rating.

4.1.3 Consequence analysis

Hazardous materials

Table 4-2 identifies the hazardous materials that would be handled during construction and operation of the project, the key management approach and the potential residual consequence using the consequence assessment methodology described in the *Multi-level Risk Assessment* (Department of Planning, 2011c) and defined in **Appendix 1.**

Table 4-2: Proposed management and potential residual consequence of hazardous materials

Hazardous material	Management approach	Potential residual consequence	
		Onsite	Offsite
LPG	Protect from sunlight and store in a cool, well-ventilated place. Keep away from heat, sparks, open flames and hot surfaces. No smoking in the vicinity of the storage area. Use of personal protective equipment. Compliance with Safety Data Sheet.	Major	Insignificant
Refrigerant	Protect from sunlight and store in a cool, well-ventilated place. Use of personal protective equipment. Compliance with Safety Data Sheet.	Major	Insignificant
Gasoline	Store in a segregated and cool, well-ventilated place. Use of personal protective equipment. Compliance with Safety Data Sheet.	Major	Insignificant
Lithium batteries (BESS)	Store in a cool (preferably below 30°C) and ventilated area away from moisture, sources of heat, open flames, food and drink. Use of personal protective equipment.	Moderate	Insignificant

Hazardous material	Management approach	Potential residual consequence	
		Onsite	Offsite
	Compliance with Safety Data Sheet.		
Transformer oils	Use of personal protective equipment. Compliance with Safety Data Sheet.	Minor	Insignificant
MCPA	Use of personal protective equipment. Compliance with Safety Data Sheet.	Moderate	Insignificant

Other hazards and risks

The detailed outcome of the hazard identification process in **Appendix 1** presents the consequence rating of the potential hazard events. These ratings are based on the consequence definitions in **Appendix 1**.

<u>Likelihood analysis</u>

The detailed outcome of the hazard identification process in **Appendix 1** presents the likelihood rating of the potential hazard events. These ratings are based on the consequence definitions in **Appendix 1**.

<u>Risk level</u>

Table 4-3 presents a summary of the key hazards from those detailed and assessed in **Appendix 1** and the associated risk levels. The highest Risk Level associated with the project is medium. Medium level risks can be managed with the measures inherent to the project (refer to **Section 2**), the controls described in **Appendix 1** and the additional measures described in **Section 5**.

Table 4-3: Hazard and risk analysis summary

Hazard	Event	Consequence (to People)	Likelihood	Risk
Electrical	Exposure to voltage	Major	Very Unlikely	Medium
Arc flash	Arc flash	Major	Very Unlikely	Medium
EMF	Exposure to EMF	Insignificant	Extremely Unlikely	Low
Fire	Fire – Transformers	Major	Very Unlikely	Medium
	Fire – Switch rooms	Major	Extremely Unlikely	Medium
	Fire – Construction compound	Major	Very Unlikely	Medium
	Bushfire	Moderate	Likely	High
Reaction	Thermal runaway in battery	Major	Very Unlikely	Medium
Chemical	Release of electrolyte from the battery cell (liquid/vented gas)	Major	Very Unlikely	Medium

	resulting in fire and/or explosion			
	Battery coolant leak	Minor	Very Unlikely	Low
	Refrigerant leak (BESS and refrigeration/chiller units)	Minor	Very Unlikely	Low
	Exposure to hazardous material (herbicide/pesticide)	Minor	Very Unlikely	Low
	Release of LPG from storage vessel or filling point resulting in fire and/or explosion	Major	Very Unlikely	Medium
	Release of gasoline from storage tank or filling point resulting in fire	Major	Very Unlikely	Medium
External factors	Water ingress resulting in fire (BESS or Switch rooms)	Major	Extremely Unlikely	Medium
	Vandalism due to unauthorised personnel access	Moderate	Unlikely	Medium
	Lightning strike	Major	Very Unlikely	Medium

4.1.4 Electromagnetic risks

Simulation by DNV (2022) of the EMF produced by the medium voltage underground cabling network has shown that the maximum magnetic field strength is at ground level immediately above the underground cable. Since magnetic field strength decreases as the distance from the source increases, the field strength at all other locations would be within the exposure limits recommended for the protection of the public (DNV, 2022). The maximum magnetic field associated with the underground transmission cables for the project is 20

The detailed result of the modelling is detailed in **Appendix J** of the EIS.

The magnetic field strengths associated with the medium voltage cabling at all locations across the wind farm site are expected to be within the limits recommended by the International Commission on Non-Ionizing Radiation Projection (ICNIRP) at ground level.

The project includes the following key elements designed to limit exposure to EMF to below the general public and occupational exposure limits:

- the design, selection and procurement of electrical equipment for the project would comply with relevant international and Australian standards for generation of and exposure to EMF
- selection of suitable locations for EMF-generating project infrastructure (through provision of separation distance to surrounding land uses including neighbouring properties and agricultural operations) and fencing along the project boundary would limit the exposure to EMF for the general public
- The two closest dwellings are located approximately 55 metres and 70 metres away from the underground cabling network. All other dwellings are located more than 1,000 metres

from the underground cabling at which the EMF from the project would be negligible exposure to EMF (specifically magnetic fields) from electrical equipment would be localised and the strength of the field attenuates rapidly with distance

- fencing around key EMF generating infrastructure (substations, inverters and transformers) within the project to limit occupational exposures
- the design and the installation height of high voltage transmission lines (330-500 kilovolt) would mitigate risks for people at ground level
- duration of exposure to EMF for personnel onsite would be transient. Where personnel need to undertake maintenance activities on infrastructure with higher EMF emissions, work would be undertaken in accordance with Safe Work Method Statements describing the required safety procedures and personal protective equipment.

4.1.5 Fire risk

The main potential sources of ignition of, and fuel for, unplanned fires caused by construction and operation of the project are:

- vehicle and machine movement over long, dry grass
- human error, such as non-compliance with hot works procedures (and associated generation of sparks) or incorrect disposal of cigarette butts
- diesel (stored and used in generators)
- flammable liquids (stored and used in machinery).

Other potential sources outside of the project include escaped back burning; lightning strikes; incorrect disposal of cigarette butts and litter; arson; and arcing, sagging or damaged to the adjacent transmission lines.

Several bushfire protection measures would be inherent to the project design and layout, and would also be incorporated into the construction and operating procedures:

- vegetation control along and around access roads, parking areas and temporary assets (such as site offices) during construction and for permanent assets during operation
- minimising vehicle movements off access roads and through long grasses
- the construction induction would highlight the bushfire risks and the importance of compliance with construction procedures, in particular hot works procedures, vehicle movement restrictions, material storage requirements and the bushfire emergency response procedures.
- the construction induction would also discuss the importance for the correct disposal of cigarette butts. In times of high fire risk, restrictions on where and when smoking can occur may be implemented
- establishment and maintenance of one of the following Asset Protection Zones (APZ) strategies:
    - a minimum 10 metre APZ established and maintained for the life of the project for the structures and associated buildings and infrastructure (excluding road access to the site and power or other services to the site and associated fencing). The APZ will be to the standard of an Inner Protection Areas (IPA) as outlined in Appendix 5 of PBP and the NSW RFS document Standard for Asset Protection Zones
    - a minimum 11 metre APZ for all buildings associated with the construction workforce accommodation component of the project. The APZ must be installed and maintained for the life of the development to the standard of an Inner Protection Areas (IPA) as outlined in Appendix 5 of Planning for Bushfire 2019 (PBP) and the NSW RFS document Standard for asset protection zones.

  - all habitable buildings in the workers accommodation will be constructed to BAL-29 construction in accordance with Section 7 of AS3959-2018 Construction of Building in Bushfire Prone Areas
  - the design of the project provides for 40 metre X 80 metre concrete hardstands around the base of the turbines for the life of the project. This exceeds the minimum APZ requirement for these assets.
- no combustible fencing would be installed within 10 metres of any structure
- wind turbine components will be manufactured and certified to current best practice Australian and international (IEC 61400-23) safety standards and equipped with sensors that can react to any imbalance in the rotor blades and shut down the turbine if necessary Internal access ways will be maintained through the life of the project and will support access for Cat-1 fire vehicles consistent with the NSW RFS Fire Trail Standards a dedicated static water supply (approximately 50- 80kL) would be provided in strategic locations throughout the project infrastructure, and in accordance with the requirements of *Planning for Bushfire Protection 2019*
- wherever possible electricity supply and distribution within the study area would be underground and so not contribute to fire risk
- any fuels and chemicals stored as part of the project would be stored in accordance with their Safety Data Sheet and *Planning for Bushfire Protection 2019*
- The BESS sub-units would be spaced at a suitable distance to ensure that any fires from a sub-unit do not propagate to neighboring sub-units or to other onsite and offsite infrastructure. This would be determined during detailed design of the project and considered in the Fire Safety Study, both of which would be prepared by UPC\AC or its contractors and submitted to the Department prior to construction (refer to mitigation measures in **Table 5-1** below.

5. MANAGEMENT AND MITIGATION MEASURES

Proposed measures to manage and/or mitigate hazards and risks (in addition to those controls identified in **Appendix 1**) are detailed in **Table 5-1**.

Table 5-1: Management and mitigation measures – hazards and risks

ID	Management/mitigation measure	Timing
H1	The operator will contact Warrumbungle Local Emergency Management Committee (LEMC) to discuss how the site will be considered under the *Warrumbungle Shire Adverse Event Plan* (2022).	Prior to operation
H2	UPC\AC will prepare a Fire Safety Study (FSS) for the finalised design of the battery energy storage system in consultation with Fire and Rescue NSW as required under the development consent for the project. The FSS would be prepared prior to construction of the battery energy storage system.	Prior to construction
H3	The principles from NFPA 855, AS 5139, IEC 62897, UL 9540, UL 9540A and the FM Global's *Development of Sprinkler Protection Guidance for Lithium Ion Based Energy Storage Systems* will be considered during final design of the BESS, where they are appropriate for the project and feasible.	During detailed design/ prior to construction
H4	The BESS would be operated and managed in accordance with the safety requirements for the selected battery technology. Safe handling and operation of battery technology will include storage in a cool (preferably below 30°C) and ventilated area; away from moisture, sources of heat, open flames, food and drink. Appropriate personal protective equipment will be used when handling battery technology.	Operation
H5	The transformer oil would be handled and managed in accordance with the Safety Data Sheet, including use of required personal protective equipment when handling.	Operation
H6	The refrigerant would be handled and managed in accordance with the Safety Data Sheet, which includes: protection from sunlight and storage in a cool, well-ventilated place; and use of required personal protective equipment when handling.	Operation

6. REFERENCES

Department of Planning. (2011a). *Hazardous Industry Planning Advisory Paper No 4 - Risk Criteria for Land Use Safety Planning.*

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APPENDIX 1
PRELIMINARY HAZARD ASSESSMENT

Likelihood definitions

Likelihood	Description
Very likely	The event is expected to occur in most circumstances
Likely	The event will probably occur in most circumstances
Unlikely	The event could occur
Very Unlikely	The event could occur but not expected
Extremely unlikely	The event occurs only in exceptional circumstances

Consequence definitions

Consequence	Description
Catastrophic	One or more fatalities or permanent disabilities.
Major	Minor injury or illness to between 100 and 1000 individuals/ Major injury or illness to between 10 and 100 individuals.
Moderate	Minor injury or illness to 10 to 100 individuals/ Major injury or illness to between 1 and 10 individuals.
Minor	Minor injury or illness to less than 10 individuals/ Major injury or illness to one individual.
Insignificant	No injury or illness associated with the Project

Risk Level Definitions

Risk Level	Definition
Negligible	Will have minimal impact, which requires no or minimal implementation of standard management measures
Low	Will have low impacts, which can be managed by standard management measures.
Medium	May have moderate impacts that can be mitigated by the application of standard management measures.
High	May have moderate to high impacts. Detailed assessment necessary to determine the level of potential impact and to develop appropriate measures to mitigate and manage the impacts.
Extreme	May have significant impacts. Detailed assessment necessary to determine the level of potential impact and to develop appropriate measures to mitigate and manage the impacts.

Risk assessment matrix

Likelihood	Consequence				
	Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Very likely	Low	Medium	High	Extreme	Extreme
Likely	Low	Medium	High	High	Extreme
Unlikely	Negligible	Low	Medium	High	High
Very Unlikely	Negligible	Low	Medium	Medium	High
Extremely unlikely	Negligible	Negligible	Low	Medium	Medium

Hazard Identification and Analysis

ID	Hazard	Infrastructure/Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
1	Electrical	Electrical reticulation network Substation BESS Transformers Overhead transmission lines	Exposure to voltage	Short circuit/ electrical connection failure - Faulty equipment - Incorrect installation - Incorrect maintenance - Human error during maintenance - Safety device/circuit compromised - Battery casing/enclosure damage	- Electrocution - Injury and/or fatality - Fire	Major	- Equipment and systems will be designed and tested to comply with international standards and guidelines - Engagement of reputable contractors - Independent certifiers/owner's engineers - Installation and maintenance will be done by trained personnel - Electrical switch-in and switch-out protocol (pad lock) - BESS BMS fault detection and safety shut-off - BESS fire protection system (enclosure/building) - Warning signs (electrical hazards, arc flash) - Emergency Response Plan - External assistance for firefighting (FRNSW and RFS) - Use of appropriate PPE - Rescue kits (i.e., insulated hooks)		Very Unlikely
2	Arc flash	Electrical reticulation network Substation BESS Transformers Overhead transmission lines	Arc flash	- Incorrect procedure (i.e., installation/ maintenance) - Faulty equipment (e.g., corrosion on conductors) - Faulty design (e.g., equipment too close to each other) - Insulation damage - Human error during maintenance	- Burns - Injury and/or fatality - Exposure to intense light and noise - Arc blasts and resulting heat, may result in fires and pressure waves	Major	- Equipment and systems will be designed and tested to comply with international standards and guidelines - Engagement of reputable contractors - Independent certifiers/owner's engineers - Site induction/substation training (i.e., high voltage areas) - Installation and maintenance will be done by trained personnel - Maintenance procedure (e.g., deenergize equipment) - Preventative maintenance (insulation) - Emergency Response Plan - External assistance for firefighting (FRNSW and RFS) - Warning signs (arc flash boundary) - Use of appropriate PPE for flash hazard - Distance between BESS sub-units and the BESS infrastructure and other internal and external infrastructure	An arc is produced by flow of electrical current through ionized air after an initial flashover or short circuit, resulting in a flash that can cause significant heating and burn injuries to occur. Arc flash may result in rapid rise in temperature and pressure in the air between electrical conductors, causing an explosion known as an arc blast.	Very Unlikely

ID	Hazard	Infrastructure/Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
3	EMF	Electrical reticulation network Substation BESS Transformers Overhead transmission lines	Exposure to electric and magnetic fields	Operations of power generation equipment	- High level exposure (i.e., exceeding the reference limits) may affect function of the nervous system (i.e., direct stimulation of nerve and muscle tissue and the induction of retinal phosphenes) - Personnel injury	Insignificant	- Location siting and selection (incl. separation distance) - Optimising equipment layout and orientation - Reducing conductor spacing - Balancing phases and minimising residual current - Incidental shielding (i.e., BESS building/enclosure, switch room) - Equipment and systems will be designed and tested to comply with international standards and guidelines - Exposure to personnel is short duration in nature (transient) - Warning signs -	Adverse health effects from EMF have not been established based on findings of science reviews conducted by credible authorities (ENA, 2016). No established evidence that ELF EMF is associated with long term health effects (ARPANSA).	Extremely Unlikely
4	Fire	Wind turbines	Fire (wind turbines)	- Transformer oil leak - Faulty equipment - Arc flash - External fire (e.g., bushfire, adjacent infrastructure)	- Fire in switchyard and escalation to switch room - Release of toxic combustion products - Injury/fatality - Asset damage - Interruption in power supply	Major	- Equipment and systems will be designed and tested to comply with the relevant international standards and guidelines - Equipment will be procured from reputable supplier - Independent certifiers/owner's engineers - All relevant Transgrid's requirements will be met - Transformers are located in designated area - Installation, operations and maintenance by trained personnel (e.g., reputable third party) in accordance with relevant procedures - Preventative maintenance (e.g., insulation, replacement of faulty equipment) - Activation of emergency shutdown (ESD button) - Fire Management Plan - Emergency Response Plan - External assistance for firefighting (FRNSW and RFS)	-	Very Unlikely
5	Fire	Collector substation	Switch room fire	- Equipment failure - Arc flash - Vandalism - External fire (e.g., bushfire, adjacent infrastructure)	- Fire in substation and escalation to switchyard - Release of toxic combustion products - Injury/fatality - Asset damage - Interruption in power supply	Major	- Equipment and systems will be designed and tested to comply with the relevant international standards and guidelines - Equipment will be procured from reputable supplier - Independent certifiers/owner's engineers - All relevant Transgrid's requirements will be met - Transformers are located in designated area - Installation, operations and maintenance by trained personnel	-	Extremely Unlikely

ID	Hazard	Infrastructure/Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
							(e.g., reputable third party) in accordance with relevant procedures - Preventative maintenance (e.g., insulation, replacement of faulty equipment) - Electrical switch-in and switch-out protocol (pad lock) - Circuit breakers - Substation is locked and located in designated area - Security fence and controlled access - Activation of emergency shutdown (ESD button) - Fire Management Plan - Emergency Response Plan - External assistance for firefighting (FRNSW and RFS)		
6	Fire	Construction Compound	Fire in compound	- Kitchen fire - Paper fire - Smoking	- Injury/fatality - Asset damage	Major	- Fire Management Plan - Cooling water supply onsite - Defendable boundary for firefighting will be established - Dedicated smoking area - Fire protection system in the CAV - Emergency Response Plan - External assistance for firefighting (FRNSW and RFS) - Use of appropriate PPE	-	Very Unlikely
7	Fire	All infrastructure	Bushfire	- Encroachment of offsite bushfire - Escalated event from NESF fire	- Injury/fatality - Asset damage	Major	- Fire Management Plan - Cooling water supply onsite - Defendable boundary for firefighting will be established - Emergency Response Plan - External assistance for firefighting (FRNSW and RFS) - Use of appropriate PPE - Establishment and maintenance of Asset Protection Zone	-	Very Unlikely

ID	Hazard	Infrastructure/Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
8	Reaction	Battery	Thermal runaway in battery	<u>Elevated temperature</u> - Bushfire - External fire (e.g., substation, transformer) <u>Electrical failure</u> - Short circuit - Excessive current/voltage - Imbalance charge across cells <u>Mechanical failure</u> - Internal cell defect - Damage (crush/penetration/puncture) <u>Systems failure</u> - BMS failure - HVAC failure	- Fire in the battery cell - Injury/fatality - Escalation to the enclosure/ building - Escalation to the entire BESS	Major	- Equipment and systems will be designed and tested to comply with the relevant international standards and guidelines - Equipment will be procured from reputable supplier - Independent certifiers/owner's engineers - Battery Management System (BMS) * Voltage control * Charge-discharge current control * Temperature monitoring * Safety shut-off function - HVAC system - Cell chemistry selection (minimise runaway) - Battery cell/pack design - BESS is housed in dedicated enclosure /building - BESS is located in designated area - BESS will be equipped with fire walls (this is applicable for building option only) - BESS fire protection system (enclosure/building) - Distance between BESS sub-units and the BESS infrastructure and other internal and external infrastructure - Activation of emergency shutdown (ESD button; outside of BESS or remotely from the OandM building) - Fire Management Plan - Emergency Response Plan - External assistance for firefighting (FRNSW and RFS) - Establishment and maintenance of Asset Protection Zone	Thermal runaway refers to a cycle in which excessive heat, initiated from inside/outside the cell, keeps generating more heat. Chemical reactions inside the cell in turn generate additional heat until there are no reactive agents left in the cell.	Very Unlikely
9	Chemical	Battery	Release of electrolyte (liquid/ vented gas) from the battery cell	<u>Mechanical failure/damage</u> - Dropped impact (installation/maintenance) - Damage (crush/penetration/puncture) <u>Abnormal heating/elevated temperature</u> - Thermal runaway - Bushfire - External fire	- Release of flammable liquid electrolyte - Vapourisation of liquid electrolyte - Release of vented gas from cells - Fire and/or explosion in battery enclosure/building - Release of toxic combustion products - Injury/fatality	Major	- Equipment and systems will be designed and tested to comply with the relevant international standards and guidelines - Equipment will be procured from reputable supplier - Independent certifiers/owner's engineers - Engagement of reputable contractors - Installation and maintenance will be done by trained personnel - Layers of battery case (pod and external casing) - Spill cleanup using dry absorbent material - BMS fault detection and shut-off function	Vented gases are early indicator of a thermal runaway reaction	Very Unlikely

ID	Hazard	Infrastructure/Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
				(e.g., substation, transformer)			- HVAC system (regulate air flow) - BESS fire protection system (enclosure/building) - Distance between BESS sub-units and the BESS infrastructure and other internal and external infrastructure		
10	Chemical	Battery	Coolant leak	- Mechanical failure/damage - Incorrect maintenance	Irritation/injury for personnel on exposure (inhalation)	Minor	- Equipment and systems will be designed and tested to comply with the relevant international standards and guidelines - Equipment will be procured from reputable supplier - Independent certifiers/owner's engineers - Engagement of reputable contractors - Maintenance will be done by trained personnel - Layers of battery case (pod and external casing) - Spill cleanup using dry absorbent material - BMS fault detection and shut-off function - PPE	Typically, coolant is 50/50 mixture of ethylene glycol and water. A typical system includes about 37 L of coolant but this can vary depending on the detail design and configuration. The fluid does not emit a strong odour.	Very Unlikely
11	Chemical	BESS refrigeration Chiller units	Refrigerant leak	- Mechanical failure/damage - Incorrect maintenance	Irritation/injury for personnel on exposure (skin contact)	Minor	- Equipment and systems will be designed and tested to comply with the relevant international standards and guidelines - Equipment will be procured from reputable supplier - Independent certifiers/owner's engineers - Engagement of reputable contractors - Maintenance will be done by trained personnel - (BESS) Layers of battery case (pod and external casing) - (BESS) BMS fault detection and shut-off function - (Chiller Unit) Separation distance to other equipment - PPE	The thermal management system typically includes 400g of R134a refrigerant in a sealed system. Mechanical damage of could result in a release of the refrigerant. Such a release would appear similar to the emission of smoke.	Very Unlikely
12	Chemical	Vegetation management and landscaping	Exposure to hazardous material	Inappropriate storage use and handling of pesticides/herbicides for vegetation management and landscaping	Irritation/injury for personnel on exposure	Minor	- Product will be stored in dedicated storage area - Quantity kept in work area will be minimised - No spraying will be done during high wind conditions - Limited usage prior to and during rain events - PPE (as required by Safety Data Sheet)	Herbicide/pesticide will likely be MCPA (widely used phenoxy herbicide). Other types of herbicides/pesticides may used for more targeted weed treatment.	Very Unlikely

ID	Hazard	Infrastructure/Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
13	LPG	Construction compound	Release of LPG from storage vessel or filling point	- Mechanical failure - Human error during transfer	- Fire and/or explosion - Boiling Liquid Expanding Vapour Explosion (BLEVE) – escalated event - Injury/fatality	Major	- Equipment and systems will be designed and tested to comply with Australian standards and guidelines (e.g., AS 1596) - Engagement of reputable contractors - Independent certifiers/owner's engineers - Installation and maintenance will be done by trained personnel - Warning signs (flammable material) - Fire Management Plan - Defendable boundary for firefighting will be established - Emergency Response Plan - External assistance for firefighting (FRNSW and RFS) - Use of appropriate PPE	LPG may be provided for utility purposes during construction for use in the construction compound and workers accommodation	Very Unlikely
14	Gasoline	Supporting infrastructure (Gasoline tank and filling system)	Release of gasoline from storage tank or filling point	- Mechanical failure - Human error during transfer	- Fire - Injury/fatality	Major	- Equipment and systems will be designed and tested to comply with Australian standards and guidelines (e.g., AS 1940) - Engagement of reputable contractors - Independent certifiers/owner's engineers - Installation and maintenance will be done by trained personnel - Secondary containment (i.e., bunding) - Warning signs (flammable material) - Fire Management Plan - Defendable boundary for firefighting will be established - Emergency Response Plan - External assistance for firefighting (FRNSW and RFS) - Use of appropriate PPE	Gasoline may be provided onsite for refuelling of vehicles.	Very Unlikely
15	External factors	BESS Substation	Fire (BESS, Substation Switch rooms)	Water ingress (e.g., rain, flood)	- Electrical fault/short circuit - Fire - Injury/fatality	Major	- Location siting (i.e., outside of flood prone area) - Switch rooms and BESS are housed in dedicated enclosure/building. which will be constructed in accordance with relevant standards - Drainage system - Preventative maintenance (check for leaks)	-	Extremely Unlikely
16	External factors	Substation BESS	Vandalism	Unauthorised personnel access	- Asset damage - Potential hazard to unauthorised person (e.g., electrocution)	Moderate	- Project infrastructures are located in secure fenced area - Onsite security protocol - Warning signs - During construction, the area will be manned, and fence will be installed	-	Unlikely

ID	Hazard	Infrastructure/Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
17	External factors	All project infrastructure	Lightning strike	Lightning storm	- Injury/fatality - Fire - Asset damage	Major	- Earthing - Lightning protection mast (Substations) - PPE	-	Very Unlikely