

## **APPENDIX J 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	PV modules PCUs MV cable reticulation network Substation BESS Transformers Overhead transmission lines	Exposure to voltage	<u>Short circuit/ electrical connection failure</u> - Faulty equipment - Incorrect installation - Incorrect maintenance - Human error during maintenance - Safety device/circuit compromised - Battery casing/enclosure damage	- Electrocutation - 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 & RFS) - Use of appropriate PPE - Rescue kits (i.e. insulated hooks)		Very Unlikely

ID	Hazard	Infrastructure/ Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
2	Arc flash	PV modules PCUs MV cable reticulation network Substation BESS Transformers Overhead transmission lines	Arc flash	<ul style="list-style-type: none"> <li>- Incorrect procedure (i.e. installation/maintenance)</li> <li>- Faulty equipment (e.g. corrosion on conductors)</li> <li>- Faulty design (e.g. equipment too close to each other)</li> <li>- Insulation damage</li> <li>- Human error during maintenance</li> </ul>	<ul style="list-style-type: none"> <li>- Burns</li> <li>- Injury and/or fatality</li> <li>- Exposure to intense light and noise</li> <li>- Arc blasts and resulting heat, may result in fires and pressure waves</li> </ul>	Major	<ul style="list-style-type: none"> <li>- Equipment and systems will be designed and tested to comply with international standards and guidelines</li> <li>- Engagement of reputable contractors</li> <li>- Independent certifiers/owner's engineers</li> <li>- Site induction/substation training (i.e. high voltage areas)</li> <li>- Installation and maintenance will be done by trained personnel</li> <li>- Maintenance procedure (e.g. deenergize equipment)</li> <li>- Preventative maintenance (insulation)</li> <li>- Emergency Response Plan</li> <li>- External assistance for firefighting (FRNSW &amp; RFS)</li> <li>- Warning signs (arc flash boundary)</li> <li>- Use of appropriate PPE for flash hazard</li> </ul>	<p>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.</p> <p>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.</p>	Very Unlikely
3	EMF	PV modules PCUs MV cable reticulation network Substation BESS Transformers Overhead transmission lines	Exposure to electric and magnetic fields	Operations of power generation equipment	<ul style="list-style-type: none"> <li>- 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)</li> <li>- Personnel injury</li> </ul>	Insignificant	<ul style="list-style-type: none"> <li>- Location siting and selection (incl. separation distance)</li> <li>- Optimising equipment layout and orientation</li> <li>- Reducing conductor spacing</li> <li>- Balancing phases and minimising residual current</li> <li>- Incidental shielding (i.e. BESS building/enclosure, switchroom)</li> <li>- Equipment and systems will be designed and tested to comply with international standards and guidelines</li> <li>- Exposure to personnel is short duration in nature (transient)</li> <li>- Warning signs</li> <li>- Studies found that the EMF for commercial solar power</li> </ul>	<p>Adverse health effects from EMF have not been established based on findings of science reviews conducted by credible authorities (ENA, 2016).</p> <p>No established evidence that ELF EMF is associated with long term health effects (ARPANSA).</p>	Extremely Unlikely

ID	Hazard	Infrastructure/ Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
							generation facilities comply with ICNIRP occupational exposure limits		
4	Fire	PCUs Transformers	Fire (Transformers, PCUs)	<ul style="list-style-type: none"> <li>- Transformer oil leak</li> <li>- Faulty equipment</li> <li>- Arc flash</li> <li>- External fire (e.g. bushfire, adjacent infrastructure)</li> </ul>	<ul style="list-style-type: none"> <li>- Fire in switchyard and escalation to switchroom</li> <li>- Release of toxic combustion products</li> <li>- Injury/fatality</li> <li>- Asset damage</li> <li>- Interruption in power supply</li> </ul>	Major	<ul style="list-style-type: none"> <li>- Equipment and systems will be designed and tested to comply with the relevant international standards and guidelines</li> <li>- Equipment will be procured from reputable supplier</li> <li>- Independent certifiers/owner's engineers</li> <li>- All relevant Transgrid's requirements will be met</li> <li>- PCUs and transformers are located in designated area</li> <li>- Installation, operations and maintenance by trained personnel (e.g. reputable third party) in accordance with relevant procedures</li> <li>- Preventative maintenance (e.g. insulation, replacement of faulty equipment)</li> <li>- Activation of emergency shutdown (ESD button)</li> <li>- Fire Management Plan</li> <li>- Emergency Response Plan</li> </ul>	-	Very Unlikely

ID	Hazard	Infrastructure/ Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
							- External assistance for firefighting (FRNSW & RFS)		
5	Fire	Collector substation	Switchroom fire	<ul style="list-style-type: none"> <li>- Equipment failure</li> <li>- Arc flash</li> <li>- Vandalism</li> <li>- External fire (e.g. bushfire, adjacent infrastructure)</li> </ul>	<ul style="list-style-type: none"> <li>- Fire in substation and escalation to switchyard</li> <li>- Release of toxic combustion products</li> <li>- Injury/fatality</li> <li>- Asset damage</li> <li>- Interruption in power supply</li> </ul>	Major	<ul style="list-style-type: none"> <li>- Equipment and systems will be designed and tested to comply with the relevant international standards and guidelines</li> <li>- Equipment will be procured from reputable supplier</li> <li>- Independent certifiers/owner's engineers</li> <li>- All relevant Transgrid's requirements will be met</li> <li>- PCUs and transformers are located in designated area</li> <li>- Installation, operations and maintenance by trained personnel (e.g. reputable third party) in accordance with relevant procedures</li> <li>- Preventative maintenance (e.g. insulation, replacement of faulty equipment)</li> <li>- Electrical switch-in &amp; switch-out protocol (pad lock)</li> <li>- Circuit breakers</li> </ul>	-	Extremely Unlikely

ID	Hazard	Infrastructure/ Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
							<ul style="list-style-type: none"> <li>- Substation is locked and located in designated area</li> <li>- Security fence and controlled access</li> <li>- Activation of emergency shutdown (ESD button)</li> <li>- Fire Management Plan</li> <li>- Emergency Response Plan</li> <li>- External assistance for firefighting (FRNSW &amp; RFS)</li> </ul>		
6	Fire	Construction Compound	Fire in compound	<ul style="list-style-type: none"> <li>- Kitchen fire</li> <li>- Paper fire</li> <li>- Smoking</li> </ul>	<ul style="list-style-type: none"> <li>- Injury/fatality</li> <li>- Asset damage</li> </ul>	Major	<ul style="list-style-type: none"> <li>- Fire Management Plan</li> <li>- Cooling water supply onsite</li> <li>- Defendable boundary for firefighting will be established</li> <li>- Dedicated smoking area</li> <li>- Fire protection system in the CAV</li> <li>- Emergency Response Plan</li> <li>- External assistance for firefighting (FRNSW &amp; RFS)</li> <li>- Use of appropriate PPE</li> </ul>	-	Very Unlikely
7	Fire	All infrastructure	Bushfire	<ul style="list-style-type: none"> <li>- Encroachment of offsite bushfire</li> <li>- Escalated event from NESF fire</li> </ul>	<ul style="list-style-type: none"> <li>- Injury/fatality</li> <li>- Asset damage</li> </ul>	Major	<ul style="list-style-type: none"> <li>- Fire Management Plan</li> <li>- Cooling water supply onsite</li> <li>- Defendable boundary for firefighting will be established</li> <li>- Emergency Response Plan</li> <li>- External assistance for firefighting (FRNSW &amp; RFS)</li> <li>- Use of appropriate PPE</li> </ul>	-	Very Unlikely

ID	Hazard	Infrastructure/ Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
8	Reaction	Battery	Thermal runaway in battery	<p><u>Elevated temperature</u></p> <ul style="list-style-type: none"> <li>- Bushfire</li> <li>- External fire (e.g. substation, transformer)</li> </ul> <p><u>Electrical failure</u></p> <ul style="list-style-type: none"> <li>- Short circuit</li> <li>- Excessive current/voltage</li> <li>- Imbalance charge across cells</li> </ul> <p><u>Mechanical failure</u></p> <ul style="list-style-type: none"> <li>- Internal cell defect</li> <li>- Damage (crush/penetration/puncture)</li> </ul> <p><u>Systems failure</u></p> <ul style="list-style-type: none"> <li>- BMS failure</li> <li>- HVAC failure</li> </ul>	<ul style="list-style-type: none"> <li>- Fire in the battery cell</li> <li>- Injury/fatality</li> <li>- Escalation to the enclosure/building</li> <li>- Escalation to the entire BESS</li> </ul>	Major	<ul style="list-style-type: none"> <li>- Equipment and systems will be designed and tested to comply with the relevant international standards and guidelines</li> <li>- Equipment will be procured from reputable supplier</li> <li>- Independent certifiers/owner's engineers</li> <li>- Battery Management System (BMS) <ul style="list-style-type: none"> <li>* Voltage control</li> <li>* Charge-discharge current control</li> <li>* Temperature monitoring</li> <li>* Safety shut-off function</li> </ul> </li> <li>- HVAC system</li> <li>- Cell chemistry selection (minimise runaway)</li> <li>- Battery cell/pack design</li> <li>- BESS is housed in dedicated enclosure /building</li> <li>- BESS is located in designated area</li> <li>- BESS will be equipped with fire walls (this is applicable for building option only)</li> <li>- BESS fire protection system (enclosure/building)</li> <li>- Activation of emergency shutdown (ESD button; outside of BESS or remotely from the O&amp;M building)</li> <li>- Fire Management Plan</li> <li>- Emergency Response Plan</li> <li>- External assistance for firefighting (FRNSW &amp; RFS)</li> </ul>	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

ID	Hazard	Infrastructure/ Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
9	Chemical	Battery	Release of electrolyte (liquid/vented gas) from the battery cell	<p><u>Mechanical failure/damage</u></p> <ul style="list-style-type: none"> <li>- Dropped impact (installation/maintenance)</li> <li>- Damage (crush/penetration/puncture)</li> </ul> <p><u>Abnormal heating/elevated temperature</u></p> <ul style="list-style-type: none"> <li>- Thermal runaway</li> <li>- Bushfire</li> <li>- External fire (e.g. substation, transformer)</li> </ul>	<ul style="list-style-type: none"> <li>- Release of flammable liquid electrolyte</li> <li>- Vapourisation of liquid electrolyte</li> <li>- Release of vented gas from cells</li> <li>- Fire and/or explosion in battery enclosure/building</li> <li>- Release of toxic combustion products</li> <li>- Injury/fatality</li> </ul>	Major	<ul style="list-style-type: none"> <li>- Equipment and systems will be designed and tested to comply with the relevant international standards and guidelines</li> <li>- Equipment will be procured from reputable supplier</li> <li>- Independent certifiers/owner's engineers</li> <li>- Engagement of reputable contractors</li> <li>- Installation and maintenance will be done by trained personnel</li> <li>- Layers of battery case (pod and external casing)</li> <li>- Spill cleanup using dry absorbent material</li> <li>- BMS fault detection and shut-off function</li> <li>- HVAC system (regulate air flow)</li> <li>- BESS fire protection system (enclosure/building)</li> </ul>	Vented gases are early indicator of a thermal runaway reaction	Very Unlikely
10	Chemical	Battery	Coolant leak	<ul style="list-style-type: none"> <li>- Mechanical failure/damage</li> <li>- Incorrect maintenance</li> </ul>	Irritation/injury for personnel on exposure (inhalation)	Minor	<ul style="list-style-type: none"> <li>- Equipment and systems will be designed and tested to comply with the relevant international standards and guidelines</li> <li>- Equipment will be procured from reputable supplier</li> <li>- Independent certifiers/owner's engineers</li> <li>- Engagement of reputable contractors</li> <li>- Maintenance will be done by trained personnel</li> <li>- Layers of battery case (pod and external casing)</li> <li>- Spill cleanup using dry absorbent material</li> <li>- BMS fault detection and shut-off function</li> <li>- PPE</li> </ul>	<u>Typically</u> 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 odor.	Very Unlikely

ID	Hazard	Infrastructure/ Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
11	Chemical	BESS refrigeration Chiller units	Refrigerant leak	<ul style="list-style-type: none"> <li>- Mechanical failure/damage</li> <li>- Incorrect maintenance</li> </ul>	Irritation/injury for personnel on exposure (skin contact)	Minor	<ul style="list-style-type: none"> <li>- Equipment and systems will be designed and tested to comply with the relevant international standards and guidelines</li> <li>- Equipment will be procured from reputable supplier</li> <li>- Independent certifiers/owner's engineers</li> <li>- Engagement of reputable contractors</li> <li>- Maintenance will be done by trained personnel</li> <li>- (BESS) Layers of battery case (pod and external casing)</li> <li>- (BESS) BMS fault detection and shut-off function</li> <li>- (Chiller Unit) Separation distance to other equipment</li> <li>- PPE</li> </ul>	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	<ul style="list-style-type: none"> <li>- Product will be stored in dedicated storage area</li> <li>- Quantity kept in work area will be minimised</li> <li>- No spraying will be done during high wind conditions</li> <li>- Limited usage prior to and during rain events</li> <li>- PPE (as required by Safety Data Sheet)</li> </ul>	Herbicide/pesticide will likely be MCPA (widely used phenoxy herbicide). Other types of herbicides/pesticides may be 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	<ul style="list-style-type: none"> <li>- Mechanical failure</li> <li>- Human error during transfer</li> </ul>	<ul style="list-style-type: none"> <li>- Fire and/or explosion</li> <li>- Boiling Liquid Expanding Vapour Explosion (BLEVE) – escalated event</li> <li>- Injury/fatality</li> </ul>	Major	<ul style="list-style-type: none"> <li>- Equipment and systems will be designed and tested to comply with Australian standards &amp; guidelines (e.g. AS 1596)</li> <li>- Engagement of reputable contractors</li> <li>- Independent certifiers/owner's engineers</li> <li>- Installation and maintenance will be done by trained personnel</li> <li>- Warning signs (flammable material)</li> <li>- Fire Management Plan</li> <li>- Defendable boundary for firefighting will be established</li> <li>- Emergency Response Plan</li> <li>- External assistance for firefighting (FRNSW &amp; RFS)</li> <li>- Use of appropriate PPE</li> </ul>	LPG may be provided for utility purposes during construction for use in the construction compound	Very Unlikely
14	Gasoline	Supporting infrastructure (Gasoline tank and filling system)	Release of gasoline from storage tank or filling point	<ul style="list-style-type: none"> <li>- Mechanical failure</li> <li>- Human error during transfer</li> </ul>	<ul style="list-style-type: none"> <li>- Fire</li> <li>- Injury/fatality</li> </ul>	Major	<ul style="list-style-type: none"> <li>- Equipment and systems will be designed and tested to comply with Australian standards &amp; guidelines (e.g. AS 1940)</li> <li>- Engagement of reputable contractors</li> <li>- Independent certifiers/owner's engineers</li> <li>- Installation and maintenance will be done by trained personnel</li> <li>- Secondary containment (i.e. bunding)</li> <li>- Warning signs (flammable material)</li> <li>- Fire Management Plan</li> <li>- Defendable boundary for firefighting will be established</li> <li>- Emergency Response Plan</li> <li>- External assistance for firefighting (FRNSW &amp; RFS)</li> <li>- Use of appropriate PPE</li> </ul>	Gasoline may be provided onsite for refuelling of vehicles.	Very Unlikely

ID	Hazard	Infrastructure/ Area	Event	Cause	Consequence	Consequence Rating	Controls	Other Comments	Likelihood Rating
15	External factors	BESS PCUs Substation	Fire (BESS, PCUs, Substation Switchrooms)	Water ingress (e.g. rain, flood)	<ul style="list-style-type: none"> <li>- Electrical fault/short circuit</li> <li>- Fire</li> <li>- Injury/fatality</li> </ul>	Major	<ul style="list-style-type: none"> <li>- Location siting (i.e. outside of flood prone area)</li> <li>- Switchrooms and BESS are housed in dedicated enclosure/building. which will be constructed in accordance to relevant standards</li> <li>- Drainage system</li> <li>- Preventative maintenance (check for leaks)</li> </ul>	-	Extremely Unlikely
16	External factors	PV modules PCUs Substation BESS	Vandalism	Unauthorised personnel access	<ul style="list-style-type: none"> <li>- Asset damage</li> <li>- Potential hazard to unauthorised person (e.g. electrocution)</li> </ul>	Moderate	<ul style="list-style-type: none"> <li>- Project infrastructures are located in secure fenced area</li> <li>- Onsite security protocol</li> <li>- Warning signs</li> <li>- During construction, the area will be manned and fence will be installed</li> </ul>	-	Unlikely
17	External factors	All project infrastructure	Lightning strike	Lightning storm	<ul style="list-style-type: none"> <li>- Injury/fatality</li> <li>- Fire</li> <li>- Asset damage</li> </ul>	Major	<ul style="list-style-type: none"> <li>- Earthing</li> <li>- Lightning protection mast (Substations)</li> <li>- PPE</li> </ul>	-	Very Unlikely