APPENDIX K PRELIMINARY HAZARDS ASSESSMENT

Neoen Australia Pty Ltd
Proposed Solar Farm & BESS

PRELIMINARY HAZARD ANALYSIS

NEOEN PTY LTD

PRELIMINARY HAZARD ANALYSIS

IDENTIFICATION TABLE	
Client/Project owner	Neoen Australia Pty Ltd
Project	Culcairn Solar Farm
Study	Preliminary Hazard Analysis (PHA)
Type of document	Report
Date	7 / 11 / 2019
File name	
Reference number	LG20190913
Confidentiality	
Language	English
Number of pages	42

APPROVAL

Version	Name		Position	Date	Signature	Modifications
DRAFT Rev A	L J Gawecki		Author	1/10/2019		For NGH Environmental review
	S Meiers		Reviewer	1/10/2019		
	S Clements		Approver	1/10/2019		
DRAFT Rev B	L J Gawecki		Author	25/10/2019		For Neoen review
	S Meiers		Reviewer	25/10/2019		
	S Clements		Approver	25/10/2019		
Final Rev 1	L J Gawecki		Author	7/11/2019		For Final Issue
	S Meiers		Reviewer	7/11/2019		
	S Clements		Approver	7/11/2019		

Abbreviations

ALARP	As Low as Reasonably Practicable
BESS	Battery Energy Storage System
BMS	Battery Management System
DA	Development Application
DC	Direct current
DCC	Design or Construction Contractor
DG	Dangerous Goods
DP	Deposited Plan
DPIE	(NSW) Department of Planning , Industry and Environment
EIS	Environmental Impact Statement
EP&A	Environmental Planning and Assessment
ESD	Emergency Shut Down
FRNSW	Fire and Rescue NSW
HAZID	Hazard Identification
HIPAP	Hazardous Industry Planning Advisory Paper
HV	High Voltage
HVAC	Heating Ventilation Air Conditioning
Hz	Hertz
ISO	International Standards Organization
km	Kilometres
LEP	Local Environmental Plan
LGA	Local Government Area
LPG	Liquefied Petroleum Gas
LV	Low Voltage
MW	Megawatt
MWh	Megawatt hours
Neoen	Neoen Australia Pty Ltd (The client)
O&M	Operations & Maintenance
OH&S	Occupational Health & Safety
PCU	Power Control Unit

PLC	Programmable Logic Control
PG	Packing Group
PHA	Preliminary Hazard Analysis
PPE	Personal Protective Equipment
PV	Photovoltaic
SDS	Safety Data Sheet
SCADA	Supervisory Control and Data Acquisition
SEARs	Secretary's Environmental Assessment Requirements
SEPP	State Environmental Planning Policy
SFARP	So Far as Reasonably Practicable
SRD	State and Regional Development
SSD	State Significant Development

Contents

1. Introduction

1.1. Background

The Culcairn Solar Farm proposed by Neoen Australia Pty Ltd (referred to hereafter as “Neoen”) includes the construction and operation of a solar photovoltaic (PV) energy generation facility with an installed capacity of 350 MW. The proposal includes a Battery Energy Storage System with a maximum rating of 100MW/200 MWh.

The Solar farm site is located about 5km south- east of Culcairn, and about 50km north of Albury, on a remote rural property, in south-western NSW.

Schedule 3, item 18 of the *Environmental Planning and Assessment Regulation 2000* (EP&A Reg) refers to Electricity Generating Station, including a reference to a delivery capacity above 30MW, as Designated Development:

18 Electricity generating stations

(1) Electricity generating stations, including associated water storage, ash or waste management facilities, that supply or are capable of supplying—

(c) more than 30 megawatts of electrical power from other energy sources (including coal, gas, wind, bio-material or solar powered generators, hydroelectric stations on existing dams or co-generation).

Battery Energy Storage Systems (BESS) are a new and rapidly growing industry based on emerging technologies. There is lack of reliable information about the extent of the environmental impacts of such development and lack of operational experience. There may be hazards that arise from factors other than the presence of dangerous goods that are covered in the risk screen method. Fire and Rescue NSW (FRNSW) have also raised submissions concerning the potential fire hazards of large-scale BESS in their previous reviews on development proposals. As such, the Department has adopted the approach to consider developments (or modifications) incorporating a BESS which can deliver or supply more than 30 MW of electrical power to be potentially hazardous under the State environmental Planning Policy No. 33 (SEPP 33). Further details can be found in Appendix 3 of the Department’s *Applying SEPP 33.*

Based on the above proposal by Neoen, a Solar project with a BESS development proposal above 30MW is considered as a designated development, and its EIS is expected to include a PHA in accordance with the Department’s *Hazardous Industry Planning Advisory Paper No. 6, ‘Hazard Analysis’* (HIPAP 6) and *Multi-level Risk Assessment* (MLRA). A recent example of an SSD incorporating a BESS above 30 MW is New England Solar Farm SSD 9255. The Environmental Impact Statement (EIS) included a PHA in accordance with HIPAP 6 and MLRA guidelines.

Notwithstanding the BESS threshold of 30 MW, any development incorporating a BESS (any capacity) must include (and not be limited to) the following information to enable an assessment:

1. location of the BESS and any sub-systems associated with the BESS;
2. description of the BESS technology to be used (modular or containerised system, hazards specifically related to battery chemistry);
3. standards to which the BESS will be designed upon and operated; and
4. description of safeguards (whether is inherent to the battery design, or additional measures which are part of the facility) to prevent a significant fire incident of the batteries, in considering items 1, 2 and 3 above.

The Preliminary Hazard Analysis (PHA) details the potential hazards and controls to mitigate such hazards. To ensure the fire prevention and protection systems are adequate to protect the new battery recycling facility. A SEPP 33 screening analysis is also undertaken to address any other Dangerous Goods stored or transported to the site.

The NSW Department of Planning, Industry and Environment (NSW DPIE) requires a Preliminary Hazard Analysis Study (PHA) to be conducted as part of a suite of safety documentation (as listed in Figure 1 – Assessment Process for Potentially Hazardous Facilities).

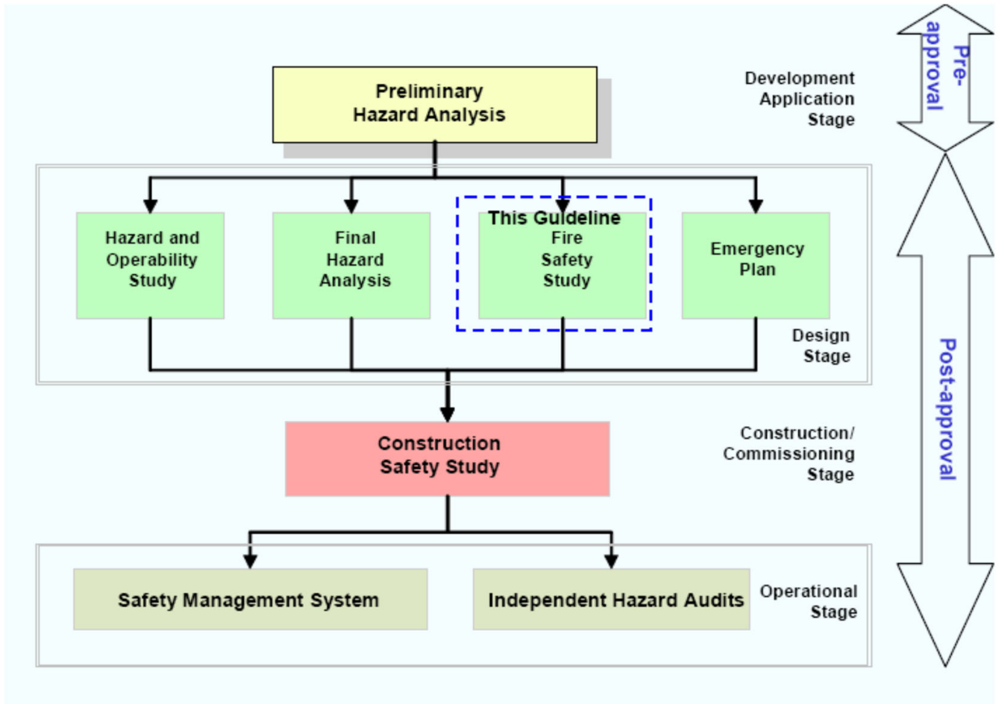


Figure 1 – Assessment Process for Potentially Hazardous Facilities

Systra Scott Lister (SSL) has been commissioned by NGH on behalf of Neoen to prepare the PHA for submission to the NSW DPIE and the Minister for approval and prior to issue of the construction certificate.

This document details the PHA, including the study objectives, scope of work, methodology, results, conclusions and recommendations for the proposed solar farm and battery storage facility.

This PHA will form an appendix of the EIS, and hence for completeness should be read in the context of the entire EIS.

1.2. Objectives

The objectives of this study are to:

- Prepare and document a Preliminary Hazard Analysis (PHA) for the proposed solar fam and battery storage facility at Culcairn, NSW, in accordance with Hazardous Industry Planning Advisory Paper (HIPAP) No. 4 – Risk Criteria for Land Use Safety Planning (Reference 4) and HIPAP No.6 – Hazard Analysis Guidelines (Reference 1); and

- Provide a report on the results of the PHA study for submission to the NSW DPIE.

1.3. Scope

The scope of work is to be limited to the Neoen Solar farm and proposed battery storage facility at Culcairn, NSW as depicted in Figure 2 - Location Plan, and Figure 4 – Solar Array Footprint.

The PHA will be prepared in accordance with the NSW DPI&E HIPAP series of documents, and the land use safety planning requirements contained in SEPP 33.

The aim of the PHA is to analyse and assess the hazards and resultant residual risk associated with the solar facility, particularly the HV systems, including the PV Skids, HVAC and BESS at the Development Application (DA) stage.

The risks or events considered are those events that could have off-site effects on either surrounding land, the public or the environment., i.e. those events that may have consequences outside of the plant or site boundary

2. Site Location and Description

2.1. Site Location

The project site is located around 5km south-east of the Culcairn town centre and around 50km north of Albury, within the Greater Hume Shire Council Local Government Area (LGA).

The development site is bounded by Walbundrie Road (north), Weeamera Road (east), Cummings Road (west), and Benambra Road (south), and intersected by Cummings Road, Schoff's Lane, and an unnamed lane crossing the site north/south in the south-west corner. Proposed transmission lines would connect to an existing TransGrid 330 kV line crossing the site.

The site covers an area of around 1,351 hectares of mostly cleared agricultural land (grazing and cropping). There are 20 farm dams within or near the proposal site, and 2 ephemeral waterways that run through the site, and hence the site is prone to flood in certain areas, particularly around creeks and rivers.

The location of the proposal site is illustrated in Figure 2.

2.2. Surrounds

The surrounding land within a five-kilometre radius of the proposal site is predominantly agricultural farmland (grazing and cropping).

2.3. Sensitive receptors

There are approximately 31 potentially sensitive receivers and 4 industries within 3 km of the subject land (see Figure 3). The flat terrain and intermittent tree cover limits long range views in the locality. The closest receptor is 1.5 km away from the proposed Sub-station and battery storage location.

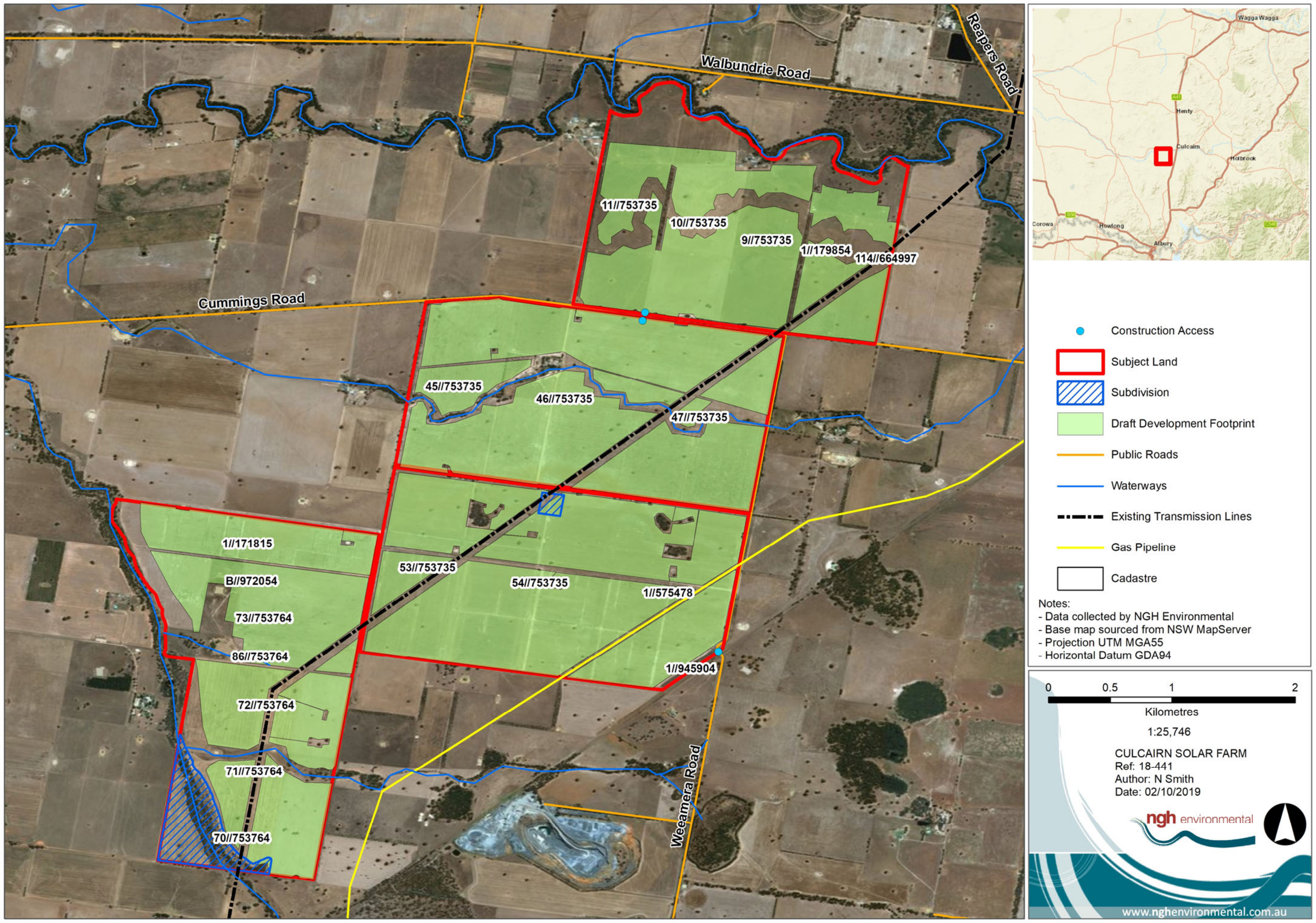


Figure 2 – Location of Proposed Solar farm footprint & surrounds

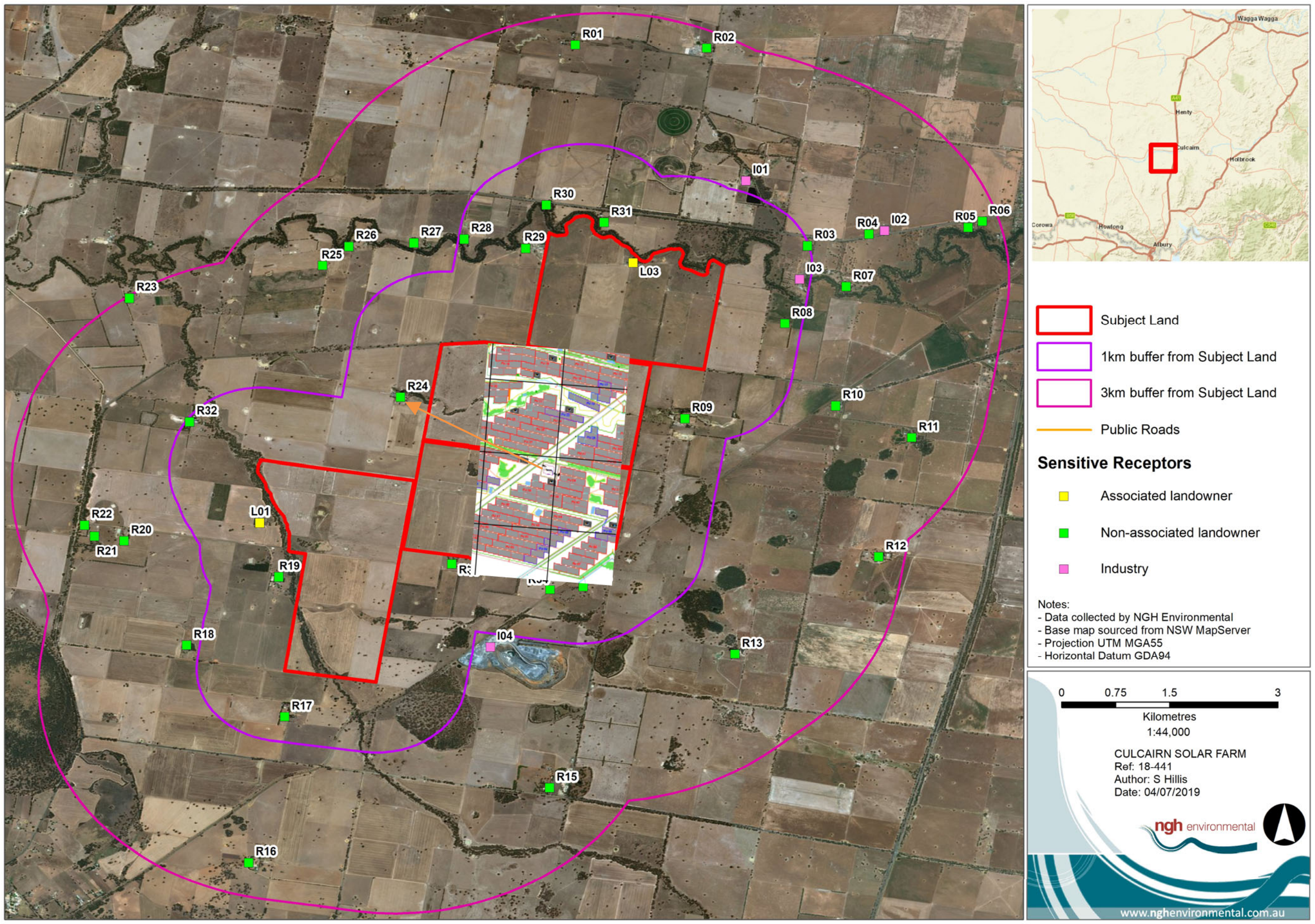


Figure 3 – Sensitive receivers within 3km of the proposed site (showing closest receptor R24).

3. Project Description

3.1. The Proposal

The proposal by Neoen includes an integrated 350 MW solar array coupled to a 100MW/200 MWhr BESS

The solar farm proposal by Neoen includes the following ;

- Single axis tracking system units (north- south oriented fixed-tilt units, east-west facing fixed-tilt units or a combination of these technologies) over most of the site.
- Battery storage to store energy (100MW/200MWh capacity).
- Underground and overground electrical conduits and cabling to connect the arrays and to the inverters and transformers.
- Systems of invertor units and voltage step-up throughout the arrays.
- On site substation, connecting to existing 330 kV TransGrid transmission line.
- Site office and maintenance building, vehicle parking areas, internal access tracks and perimeter security fencing.
- A Site access track from Cummings Road and unnamed Crown and local roads that cross the site.
- Road crossing and easement electrical crossing through underground and/or overhead lines.

The main features of the PV plant are summarised in Table 1 – PV Plant Specifications and depicted in Figure 4.

The existing site is around 1,351 ha.

The construction phase of the project would be approximately 18 months and is scheduled to be completed by mid-2021, depending on DA approval. The proposal is expected to have a 30-year operating life.

PV PLANT MAIN FEATURES

Total Peak Power:	398.7036 MWp
Total Inverters Power:	402 MVA@35 ºC
Total AC Power:	350 MWac @POI
PV Modules:	1,049,220 bifacial PV modules JOLYWOOD JW-D72N-380 of 380 Wp (or similar) 36,180 strings of 29 PV modules in series per string
Inverters:	134 inverters SMA Sunny Central 3000-EV (1,500 Vdc)
Structure:	ARRAY DuraTrack HZ Single Axis Tracker Pitch distance: 6.0 m

73 PV fields. Main features:

61 PV Fields:

- 2 x inverters SMA Sunny Central 3000-EV (1,500 Vdc)
- 2 x 270 strings = 540 strings
- 2 x 7,830 PV modules = 15,660 PV modules
- 2 x 2,975,400 Wp = 5,950,800 Wp

12 PV Fields:

- 1 x inverter SMA Sunny Central 3000-EV (1,500 Vdc)
- 270 strings
- 7,830 PV modules
- 2,975,400 Wp

Table 1- PV Plant Specifications

3.2. Solar Arrays

The solar arrays proposed comprise approximately 1,049,220 solar panels. The panels are installed on single-axis trackers (approximately 36,180 tracker units), The panel structures are around 2-3m high. The solar arrays are then connected by cable to the PV field units .

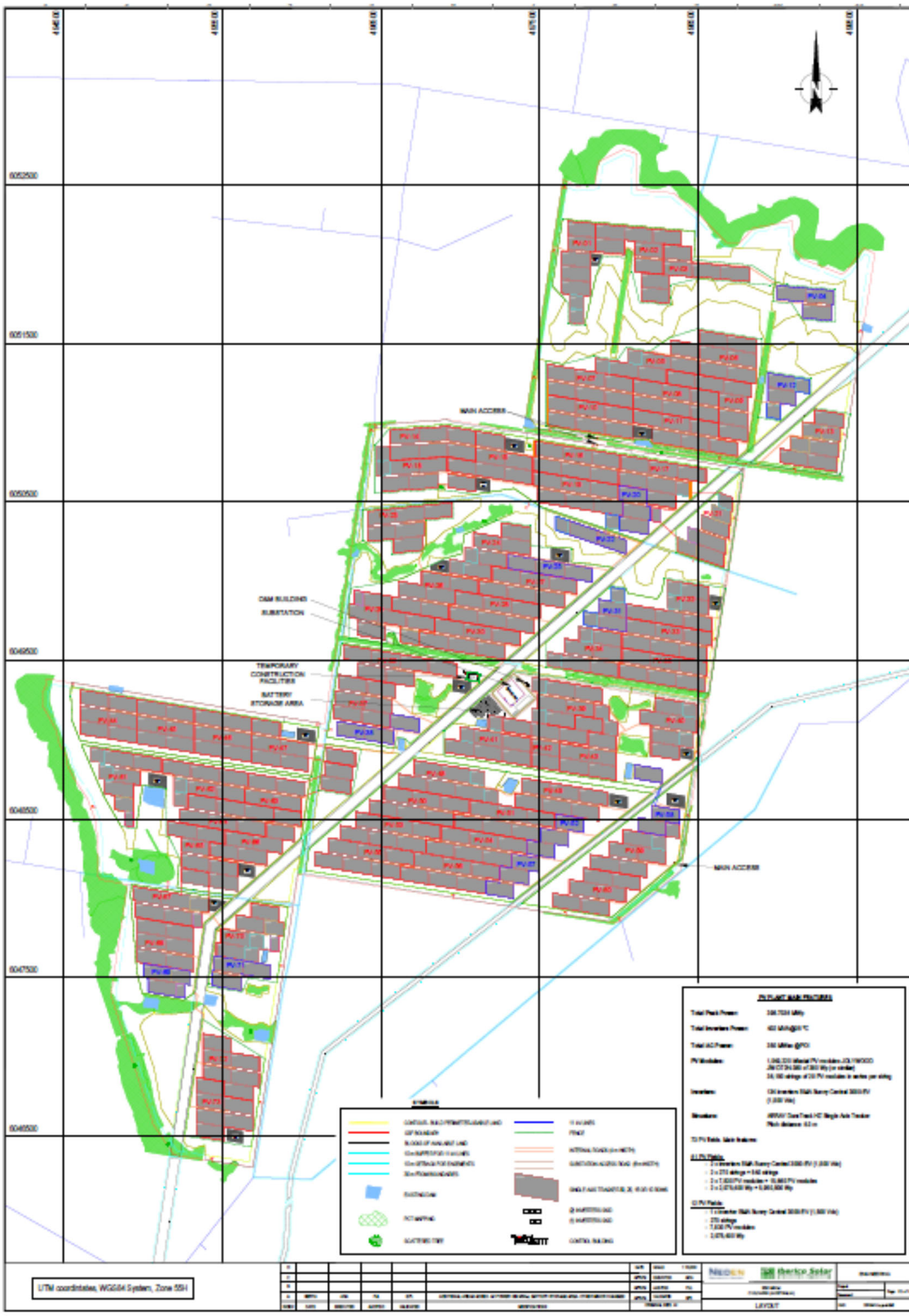


Figure 4 – Solar Array Footprint

3.3. PV Field Units

Approximately 73 PV field units would be installed and spread across the site. 61 of them would contain 2 invertors and a transformer, and 12 would contain a single each of them inverter and transformer.

The PV fields would be an inverter and transformer installed on a platform and would be similar to that illustrated in Figure 5.

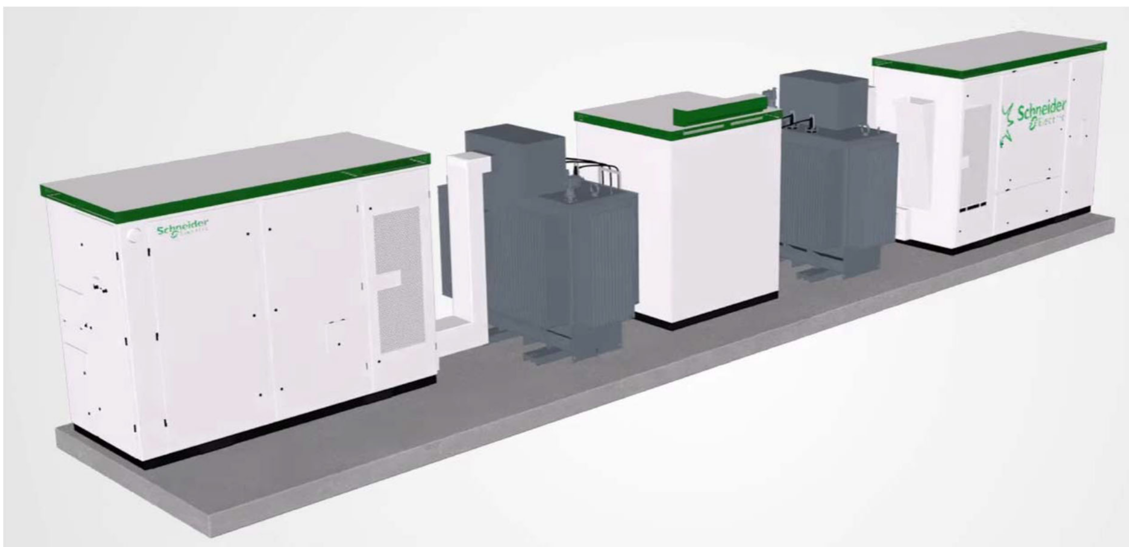


Figure 5 – Typical PV Field – containing the invertor and transformer units

3.4. Battery Energy Storage System (BESS)

The purpose of the BESS would be to support the network, introduce a dispatchable capability to the project's energy generation profile and allow for revenue generation. The maximum design rating for the BESS will be up to 100MW/200 MWhrs.

The specific battery provider has not yet been selected but will comprise one of the common or standard lithium battery types currently offered on the Australian Market, either

- Lithium iron phosphate ('LFP'),
- Lithium Nickel Manganese Cobalt Oxide ('NMC'), or
- Lithium Manganese Oxide ('LMO').

As the chemistry, battery density, operating and failure characteristics are similar for each lithium battery type, then the hazards are also similar and the strategies to mitigate such incidents are also similar. The hazards associated with the BESS are explored in detail in the Hazards section of this PHA.

The BESS units typically comprise either modular Lithium battery cells, located between 2 HVAC cooling units, at either end of each module. Such modular units can be located strategically around the site (such as the Tesla Powerpack arrangement) . Or containerised and located at a central battery store or location (Such as the Tesla MegaPack)

Whichever arrangement is selected , modular or containerised , It is anticipated that the battery modules will have secondary containment , to ensure that any one battery module failure (e.g. any battery fires or thermal runaway event) is contained. This is the case with Tesla Battery Safety technology and the safety systems are outlined in Section 6.2 – BESS - Safety Management Systems.

4. SEPP 33 Screening Analysis

In NSW any industrial proposal that includes the storage or transport of dangerous goods must be viewed against the requirements of State Environment Planning Policy 33 (SEPP 33). SEPP 33 requires the applicant to first undertake a screening analysis, to determine whether an industrial activity is potentially hazardous , and hence whether a PHA is required to accompany the DA or not.

In this case a PHA is required automatically as the proposed battery storage units exceed 30 MW.

However, the SEPP 33 also advises the NSW DPIE or Council whether other storages of dangerous goods are significant or not and if threshold quantities are exceeded that these are included in assessment. Neoen has identified which dangerous goods would be stored on or transported to the site and their quantities or frequency of movements (see Tables 2 and 3, respectively). These have been reviewed against the SEPP33 threshold quantities (also listed in the tables) and it can be concluded that;

1. The SEPP 33 storage thresholds are not exceeded, and
2. The SEPP33 transport of dangerous goods are not exceeded.

Hence the solar farm and battery storage facility is not considered potentially hazardous with regards to the storage and transport of dangerous goods to / from the site during construction or operations.

The screening analysis also confirms that the PHA will be focus on HV systems, including the transformers, invertors, and the battery systems (BESS).

Note also that Lithium batteries are deemed Class 9 – Miscellaneous dangerous goods, and also exceed the NSW WorkCover Notification threshold quantity for Class 9 Dangerous goods (10,000 kg). Meaning that Neoen will need to notify NSW Workcover in respect of Class 9 battery storage and provide a detailed emergency plan for the site.

4.1. Dangerous Goods Storage

Table 2 lists the updated quantity of dangerous goods which would be used or stored on the site, as advised by Neoen.

Class	Proposed Quantity Stored (kg) by DG class.	SEPP33 General Thresholds (kg)	Conclusion/ Determination
Class 2.2 Inert Gases – Such as Carbon Dioxide, used for the gas flooding/ fire suppression system.	400 litres/ battery module	No Limit	Exempt - NA
Class 3 Pg II & III flammable liquids including fuel (ULP)	1,000 kg	5 ,000 kg	ULP will be stored in a dedicated tank to AS1940, some 20m from the site boundary. Not exceeded.
Class 6 – Poisons such as weedicides and herbicides	1,000 kg	2,500 kgs	Secure Operations and Maintenance Building, Not exceeded.
Class 9 Pg III – Miscellaneous , includes BESS battery	100 MW/200MWh	30 MW	Exceeded and subject to PHA and NSW DPIE risk assessment requirements

Table 2- List of Dangerous Goods Stored or Handled

Note 1. - If Diesel is stored with other flammables then it is to be treated as Class 3 Pg III. (this is not the case at Neoen) Skid Diesel Tank assumed for Construction team – up to 2000 litres.

4.2. Dangerous Goods Transport

Table 3 lists the updated quantity of dangerous goods which would be transported to and from the site, as advised by Neoen. It is anticipated that Construction Activities will see Dangerous Goods, such as Welding gases, Diesel Fuel, and LP Gas, delivered to the site as part of construction activities, however these will typically be in minor quantities and subject to Australian Design Standards as listed in Appendix A.. An estimate for battery and TX unit deliveries is made on the basis that each module requires 1 truck movement to site.

Table 3 – Dangerous Goods Transported

Product Name/ Description	Typical Products	Proposed DG Vehicle Max Movements/ Annum	NSW DOP Threshold	Conclusion / Determination
Class 2.2 Exempt, hence no storage limits for argon, nitrogen or rare/inert gases - however must consider sub-classes also – hence need to cover compressed Carbon Dioxide	Generally, Not applicable	0	NA	NA
Class 3 – PG II or III paints, thinners, and liquid fuels , such as petrol (ULP)	Flammable Liquids such as Kerosene, Methylated Spirits. Solvent based Paints, Class 3 PG II or III	12	750 - 1000	Threshold not exceeded. Deliveries are generally made weekly or fortnightly, or as required. Estimate 1 / week for construction period duration , over 3 months , hence 12 deliveries / annum.
Class 6.1 – Poisons, Biocides etc. Or weedicides	Agricultural products, weedicides, herbicides, pesticides. Round Up and other brands	122	500	Threshold not exceeded. Deliveries are generally made weekly or fortnightly, or as required. Estimate 1 / week for construction period duration , over 3 months , hence 12 deliveries / annum.
Class 9 – Miscellaneous, including delivery of the BESS battery modules	BESS modules delivered to site	100	1000	Threshold not exceeded.
Class C1 and C2 combustible oils – which are deemed non-hazardous by NSW DOP	Transformer oils, motor oils are all examples of Class C1 and C2 combustible liquids.	100	NA	Threshold not exceeded.
	TOTAL Predicted Annual Dangerous Goods Delivery Movements	**334**		**No transportation thresholds exceeded.**

5. Preliminary Hazard Analysis

5.1. PHA Approach

The NSW DPIE Multi-Level Risk Assessment (Reference 3) approach was used for this Preliminary hazard analysis. The Multi-Level Risk Assessment Guidelines are intended to assist industry, consultants and the consent authorities to carry out and evaluate risk assessments at an appropriate level for the facility being studied.

The approach considered the proposed development in the context of;

1. its location – the proposed BESS is located in a remote area, some 5km south of the centre of the nearest township of Culcairn and over 1.5km from the nearest residence (R24), and there were no potential events or accidents with significant off-site consequences,
2. the hazardous nature of battery systems, which can overheat or rupture and result in fires or acid gas release. However, these release events are designed out, or are typically contained within the modular units, and essentially on-site. (Reference 9)
3. The technical and safety management controls incorporated within each battery module under the BMS provides protection against thermal overload, heating ,and thermal runaway events.

In this case, the PHA team concluded that the main hazards of fire, or thermal runaway associated with BESS storage systems and operations, and their effects, are localised, and unlikely to impact residences located over 1 km away. Hence, a fully qualitative approach was selected, i.e. a Level 1 assessment, for this analysis.

The land use safety and risk assessment process is outlined in HIPAP 10 and is illustrated in Figure 6, and as we have demonstrated a PHA is required, and the appropriate level of detail is a Level 1 – or qualitative risk assessment .

Four major steps are involved in the qualitative risk analysis, namely;

1. Incident identification,
2. Consequence analysis,
3. Likelihood estimation, and
4. Risk assessment and control.

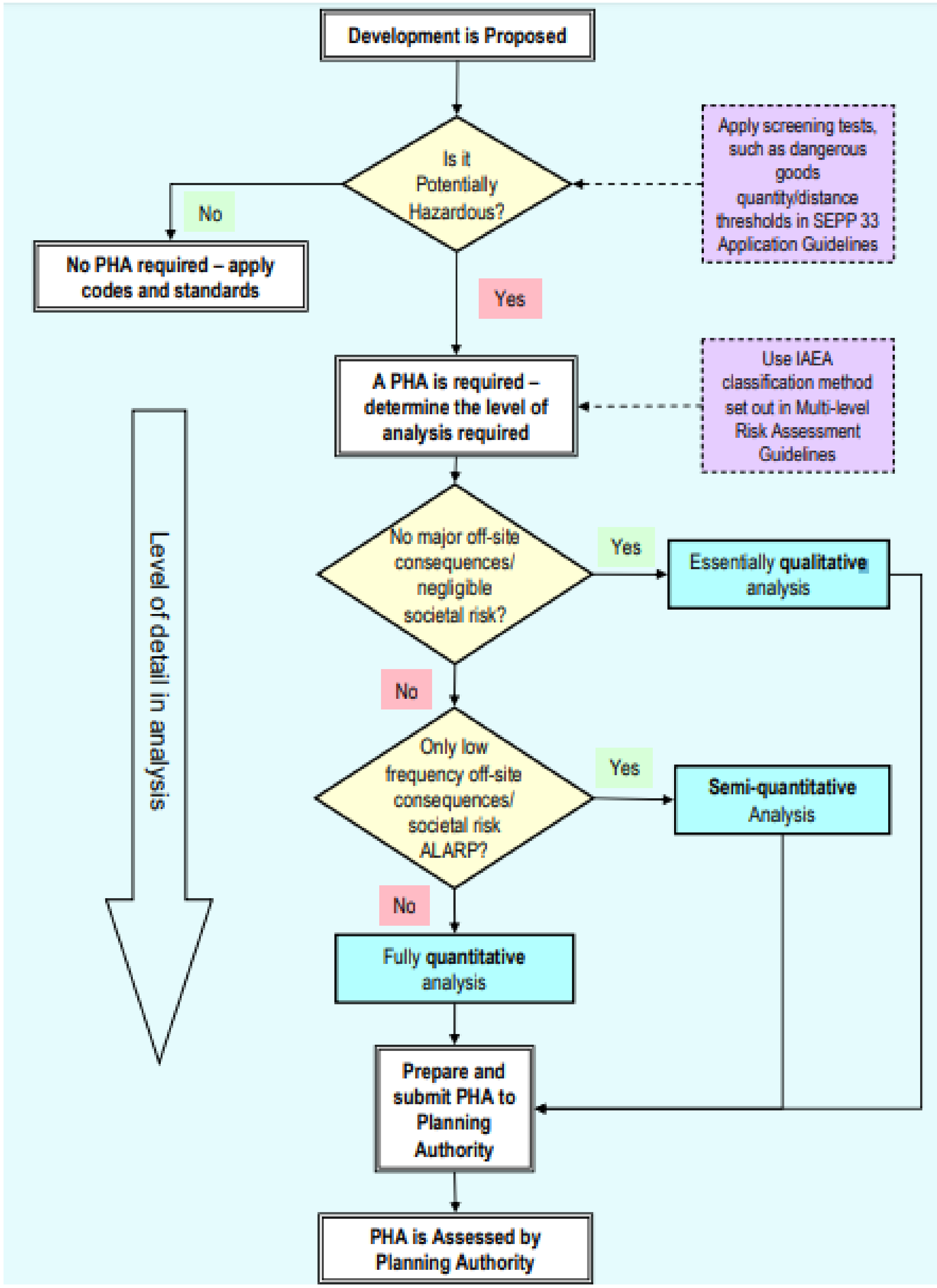


Figure 6 – Risk Management Process

5.2. Hazard Identification

The following sections summarises the hazards form the solar HV systems and battery storage facilities. In preparation for the HAZID, Systra have undertaken;

1. A literature survey of similar BESS systems
2. Design advice from Neoen,
3. A review of Solar battery equipment failures and outcomes.

The identified hazards and outcomes are listed in Table 6 and are used as inputs into the risk worksheet presented in Appendix D. Events considered in this risk review are listed in Table 6, for all Solar battery activities on the proposed modification site. The risk review also includes the controls and mitigation measures Neoen will implement as part of the project.

A total of 9 risk events associated with the BESS were considered. Each event was then rated as Low, medium or high risk, based on the consequence and likelihood scales provided in Tables 4 and 5 respectively.

5.3. Consequence Analysis

The consequence scales used in this risk analysis are derived for project risk for project values in the range $100 - $500 M CAPEX range. Consequence ratings are also provided for H&S and Environmental issues.

Consequence	Rank	Minor	Moderate	Serious	Major	Severe
	Scale	5	4	3	2	1
Financial AUS$	FIN	<$100,000	$100k to $1m	$1m to $10m	$10m to $80m	>$80m
Recurring Financial	Rec $	<$10k per annum	$10k to $100k per annum	$100k to $1m per annum	$1m to $30m per annum	>$30m per annum
Health and Safety	H&S	Local treatment with short recovery - minor short term health effects.	Medical treatment required or short term acute health effects.	Lost Time Injury (off work recovery required) or short / medium term health issues.	Extensive injuries or chronic health issues including disease pandemic.	Single fatality or permanent disability.
Environment	ENV	Onsite release, containable with minimal damage. Localised impact on energy usage.	Onsite release with some damage, no offsite damage. Remediation in terms of days. Numerous and or wide spread small scale impacts on energy and waste.	Offsite release, no significant environmental damage. Remediation in terms of weeks.	Major off-site release, short to medium term environmental damage. Remediation in terms of months.	Major off-site release, long term environmental damage. Remediation in terms of years.
Reputation	REP	Workforce concern	Local client loss of business demand and alienation of key stakeholders. Local community concern.	Regional loss of business demand and alienation of key stakeholders. Regional community concern.	Widespread loss of business demand and alienation of key stakeholders. Single business unit affected. Widespread community outcry.	Widespread loss of major clients and alienation of key stakeholders. All business units affected. Extreme community outcry nationally.

Table 4 – Consequence Scales

Consequence events considered by the Neoen and Systra Team included;

1. **Bush or Scrub Fire** - Given the fire load is to be kept low, and a Bushfire Control Plan will be documented in consultation with the local fire authority. Such risks are qualitatively assessed as low.
2. **Battery Leakage** – As secondary containment is provided this incident will not have off-site effects
3. **Battery failure / fire & potential acid gas release** – Fire testing completed by DNVGL in June 2019 demonstrated that a powerpack cell fire will nor propagate to adjacent packs or cells, even after complete burn-out of the cell. (Reference 9). The battery units also have deflagration vents to allow for combustion gas venting at controlled rates. As the fire and acid gas releases are controlled, the effects of the event are localised.
4. **Transformer Failure - incident statistics confirm that fire event is localised.**

In summary, there are no postulated incidents that pose significant off-site risks.

Overall the assumptions used in this assessment are very conservative, and the data used was that from the upper range of the data sets (i.e. the conservative end, with the exception of flange leaks) and the results of the analysis would be at the upper end of the risk scale. It is considered that a more detailed analysis would yield lower risks in all cases.

5.4. Likelihood Matrix

The likelihood scales are provided on a project life and frequency basis.

	Likelihood	**Description**	**Frequency**	Rank
Second Determine the Likelihood (L)	Almost certain	Event may recur during the lifetime of the operation / project.	May occur more than once per year.	**A**
	Probable	Event that could probably occur during the life-time of the operation / project.	May occur once per year.	**B**
	Possible	Event that may possibly occur during the life-time of the operation / project.	May occur in 1-10 years.	**C**
	Unlikely	Event that is unlikely to occur during the life-time of the operation / project.	May occur in 10 -100 years.	**D**
	Very unlikely	Event that is very unlikely to occur during the life-time of the operation / project.	Less often than 100 year event.	**E**

Table 5 – Likelihood Scales

5.5. Risk Assessment Matrix

The risk matrix used in this qualitative risk analysis, along with the Risk Acceptance and Tolerability criteria is provided in Appendix C. Generally, risks assessed as low – medium are considered broadly acceptable.

Then team identified nine (9) key risks around solar PV array and BESS infrastructure. Of which 7 are considered medium risks, and will require monitoring, and 2 low risk event.

The risk findings are discussed in Section 8. Risk Assessment Findings.

Table 6 – Inherent Hazards of Solar Equipment, HV equipment and BESS

	Solar Equipment					
		HV Electricity	Arcing / Short	Fire	Explosion	Gas release
Battery (BESS) Components						
1	Lithium Cells	✓	✓	✓	✓	✓
2	Battery Racks	✓	✓	✓	✓	✓
3	HVAC systems	✓	-	-	-	-
Power Conversion Units						
4	Invertors	✓	✓	✓	✓	✓
5	Transformers	✓	✓	✓	✓	✓
Associated Systems						
6	HV Switchgear in collector sub-station	✓	✓	-		-
7	Overhead Transmission Lines	✓	✓	-	-	-
8	Oil Filled Power transformers	✓	✓			
9	Fuel Storage	-	-	✓	✓	-

Note1: Work, Health and Safety risks will be covered in detail in the Health and Safety Plan / SWMS and other work safe related documents.

6. Safety Management Systems

In addition to the PHA, SSL has also reviewed the status of safety documentation, and the efficacy of safety management systems employed on-site. The review findings are presented below.

6.1. PLC and SCADA systems

The Design and/or Construction Contractor (DCC) will incorporate comprehensive process safety systems and PLC systems for BESS control and supporting systems would be incorporated during construction and operation.

Any installed battery system will generally comply with the standards listed in Appendix A. And specifically, for those standards around battery energy storage systems (BESS) which include, but not limited to, with the following standards :

- IEC 62933 (parts 1-5) Electrical energy storage (EES) systems
- IEC 62619:2016 Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications with the exception of the SIL 2 requirement
- IEC 62485-1:2015 Safety requirements for secondary batteries and battery installations - Part 1: General safety information, and
- IEC 62485-2:2010 Safety requirements for secondary batteries and battery installations - Part 2: Stationary batteries

PLC systems will ensure that in case of temperature rise in the battery cabinet, for e.g. due to HVAC failure, that the battery module will trip on high temperature, and shut down the module or BESS or both.

6.2. BESS Safety Management Systems

A containerised BESS solution is designed with multiple automated and manual safety protection systems within each container. An example of this is the Tesla MegaPack., and the safety systems incorporated in this arrangement follow.

Cell Safety

Tesla conduct and test each battery module assembly independently, and flawed cells are discarded and relegated to further testing and drive further cell manufacturing improvements.

Battery Module Safety

Each Megapack battery module includes individually fused cells and dedicated power electronics that electrically and galvanically isolate the batteries from the common DC bus, similar to the Pod architecture in Powerpack. Unlike racked battery systems, the battery modules arrive pre-installed without the need to connect live high voltage DC elements on site. Each battery module includes a built-in isolated DC- DC converter and an active fuse that provides an added layer of protection in case of hazardous conditions, allowing for multiple levels of isolation. All of these features are controlled by the module's dedicated Battery Management System (BMS), which ensures that the cells are operated within approved limits.

System Level Safety

A parallel battery module architecture (up to 17 per Megapack) provides optimized performance and redundant safety control, reducing the risk of cascading failures. Combined with the isolated DC-DC architecture in each module, this parallel design greatly reduces the risk of events such as electrical fault propagation, arc flash, or cascading thermal runaway. Battery modules are sealed to prevent touch access to the battery cells, power electronics, and terminals.

Dedicated deflagration vents in the enclosure's roof are designed to mitigate the impact of thermal runaway on surrounding exposures and personnel. These pressure-sensitive vents direct all gases, smoke, and flame out of the top of the Megapack in the unlikely event of thermal runaway and fire.

The Customer Interface Bay is a touch-safe bay located at the centre of the enclosure. It is designed to be the only interface required for installation, operation, and maintenance. Megapack's pre-assembled and pre-tested nature ensures that minimal installation and commissioning scope is required on site, minimizing risk of hazards to all personnel interfacing with the equipment.

Megapack's weatherproof steel enclosure is rated to IP66 (NEMA 4) and provides robust protection against extreme environmental, chemical, and physical exposures. It cannot be entered by personnel, further limiting the possible interaction between maintenance personnel and internal components.

Fire testing completed by DNVGL in June 2019 demonstrated that a powerpack cell fire will nor propagate to adjacent packs or cells, even after complete burn-out of the cell. (Reference 9).

Fire Suppression Systems

The fire suppression systems may be added to the BESS, but it is unlikely as Tesla certify that a runaway event will be contained to any one module(Reference 9). However, should a gas suppression system be installed, then the flooding agent will be either CO2 or Novec 1230 or possibly water spray systems. This aspect will be covered under Detailed Design by Neoen and / or the DCC.

6.3. Other site Safety Controls

Other site safety systems and mitigation measures to reduce fire risk, particularly fire risk between battery units or modules, and bush fire risk, include;

- gravel hardstands
- APZ/fire break
- separation between the units
- regular / routine maintenance of the BESS, notably the HVAC systems
- SCADA controls and monitoring systems, including CCTV (surveillance)

These technical, organisational and management safety controls will ensure that fire risks associated with the proposed BESS are managed appropriately and minimise risks to the surrounding land uses, people and the environment.

The northern and western sections of the property have been identified as bushfire prone land on NSW Rural Fire Service mapping, and it is anticipated that Neoen or the Operator will prepare a Bushfire Hazard Management Plan in consultation with the local NSW Rural Fire Service.

6.4. Safety Management Systems (describe)

It is also anticipated that Neoen's Solar plant will have a detailed quality assurance program that incorporates an Occupational Health and Safety Management Plan, an Environmental System and a Quality Assurance System, including;

- Quality Assurance System to ISO 9001 – Quality Management Systems;
- Occupational health and safety management plan, supported by an electronic OHS management system for the entire site, generally to AS 4801;
- Environmental Management systems and plans to ISO 14001 – Environmental Management Systems; and

- A Site Emergency Response Plan – A detailed site Emergency Response Plan will be drafted for the facility prior to commencement of operations, and
- A Bushfire Management Plan

7. Risk Assessment Results

The team identified 9 key risks around solar BESS infrastructure, of which 7 are considered medium risks which would require monitoring, and 2 low risk events, as summarised in Table 7.

The worst-case consequence for the identified events is a fire event which may result from overheating or a thermal runaway of the Lithium battery. These fires are localised and only have the potential to shut down a battery module.

Based on the risk acceptance criteria used for the study, the risk profile for the proposed modification is considered to be low – medium.

The majority of the Medium risk events relate to fire events resulting from a variety of causes (e.g. release of acid gases during fire, battery thermal runaway, transformer fire, switch room, etc).

The mitigation and control measures afforded by the proponent (Neoen) and the DCC would reduce the likelihood of these events to manageable risk levels and contain the effects on-site.

In summary, there are no postulated incidents that pose significant off-site risks.

Table 7 – Summary Risk Assessment Findings

#	Hazard	Event	Consequence	Likelihood	Risk
1	General Electrical	Exposure to high voltage	Major (2)	Unlikely(D)	Medium
2	Arcing / short Circuit	Short Circuit or Equipment Failure	Major (2)	Unlikely(D)	Medium
3	Fire	BESS due overheating	Major (2)	Unlikely(D)	Medium
4	Thermal runaway / explosion	BESS – failure of HVAC cooling system or overheating leading to runaway reaction	Major (2)	Unlikely(D)	Medium
5	Acid gas release	BESS - failure of HVAC cooling system or overheating leading to runaway reaction and failure , and release of electrolyte / acid gases	Major (2)	Unlikely(D)	Medium
6	TX arcing and Fire	Oil fill transformer failure and pool fire	Major (2)	Unlikely(D)	Medium
7	Fuel storage Fire	ULP storage tank – leakage and fire	Major (2)	Unlikely(D)	Medium
8	Malicious Damage	Vandalism or unauthorized access to site	Insignificant (5)	Possible (3)	Low
9	Bush or scrub fire	Exposure to fire, and potential equipment damage	Insignificant (5)	Possible (3)	Low

8. Qualitative Risk Criteria

The Qualitative Risk Criteria is provided by the NSW DPIE Major Hazards Unit, and covered in the Hazard Industry Advisory paper number 4 (HIPAP 4), (Reference 4), as follows;

The following qualitative criteria are appropriate whether making zoning decisions, assessing the risk implications of a development project of a potentially hazardous nature or the locational safety suitability of a development in the vicinity of a potentially hazardous installation: The criteria was utilised whilst considering the consequence and likelihood of all risk identified for the proposal, and includes;

> (a) All ‘avoidable’ risks should be avoided. This necessitates the investigation of alternative locations and alternative technologies, wherever applicable, to ensure that risks are not introduced in an area where feasible alternatives are possible and justified.
>
> (b) The risk from a major hazard should be reduced wherever practicable, irrespective of the numerical value of the cumulative risk level from the whole installation. In all cases, if the consequences (effects) of an identified hazardous incident are significant to people and the environment, then all feasible measures (including alternative locations) should be adopted so that the likelihood of such an incident occurring is made very low. This necessitates the identification of all contributors to the resultant risk and the consequences of each potentially hazardous incident. The assessment process should address the adequacy and relevancy of safeguards (both technical and locational) as they relate to each risk contributor.
>
> (c) The consequences (effects) of the more likely hazardous events (i.e. those of high probability of occurrence) should, wherever possible, be contained within the boundaries of the installation.
>
> (d) Where there is an existing high risk from a hazardous installation, additional hazardous developments should not be allowed if they add significantly to that existing risk.

The risks considered were assessed to be low- medium risks, and hence are deemed acceptable under the NSW DPIE risk tolerability criteria. (See Appendix D for risk worksheet).

9. Conclusions and Recommendations

SSL has identified 9 potential incidents, all of which are considered manageable.

As a results of the risk assessment, SSL concludes that there is insignificant potential for offsite fatality or injury identified and therefore the Culcairn project meets the NSW DPIE land use planning criteria outline in HIPAP 4.

In summary, the risk events from the BESS would have onsite impacts only and residual risks are assessed as medium to low risk. Further, these risks are considered tolerable or as low as reasonably practicable (ALARP).

SSL consider the recommendations following are made in the interests of risk reduction, including;

1. Provide a High temperature trip on each battery module for HVAC failure, or overheating (if not already included in the BMS) , and
2. Provide an emergency response plan and bushfire control plan for the site.

Copies of any of the Neoen safety reviews studies referred to in this report can be made available on request from the NSW DPIE.

10. References

1. Hazardous Industry Planning Advisory Paper No.6 – Guidelines for Hazard Analysis, Department of Planning, NSW, 1992.
2. State Environmental Planning Policy No.33 – Hazardous and Offensive Development Application Guidelines (1994), “Applying SEPP 33”, Department of Planning NSW.
3. Multi-Level Risk Assessment, Department of Infrastructure, Planning and Natural Resources – 1997.
4. Hazardous Industry Planning Advisory paper No.4, “Risk Criteria for Land Use Safety Planning”, NSW Department of Infrastructure, Planning and Natural Resources (1992)
5. SAFETI Version 7.2.1
6. Culcairn Solar Farm – Scoping report prepared by NGH Environmental , dated February 2019
7. UK HSE Data - Failure Rate and Event Data for use within Risk Assessments (dated 28/06/2012)
8. Mudan, 1990 – Probit equations for acid gases.
9. DNVGL Energy, Live Fire Test of Tesla PowerPacks, Document # 100118434-HOU-R-02-E, dated 4th June, 2019

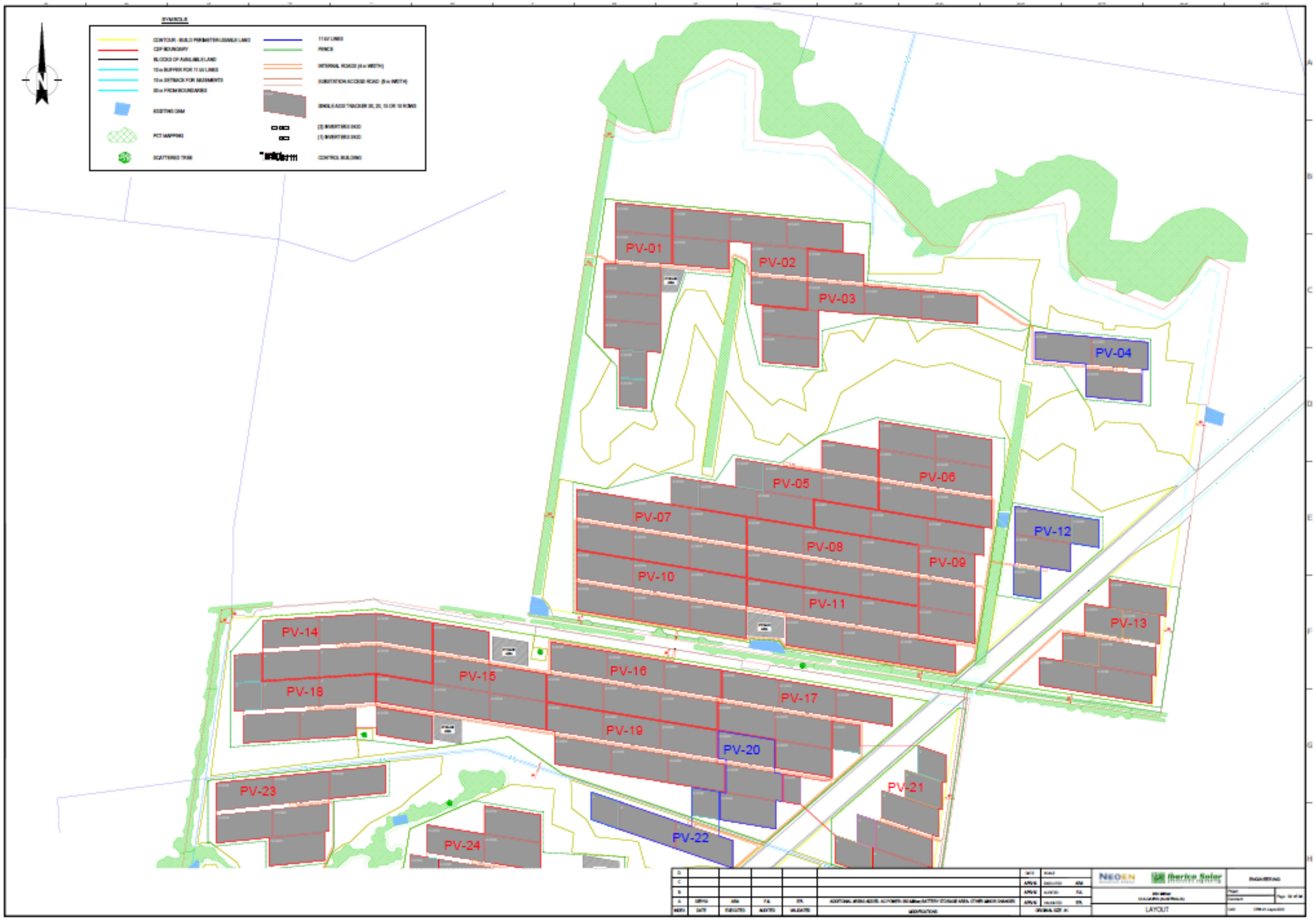
Appendix A – Design Standards

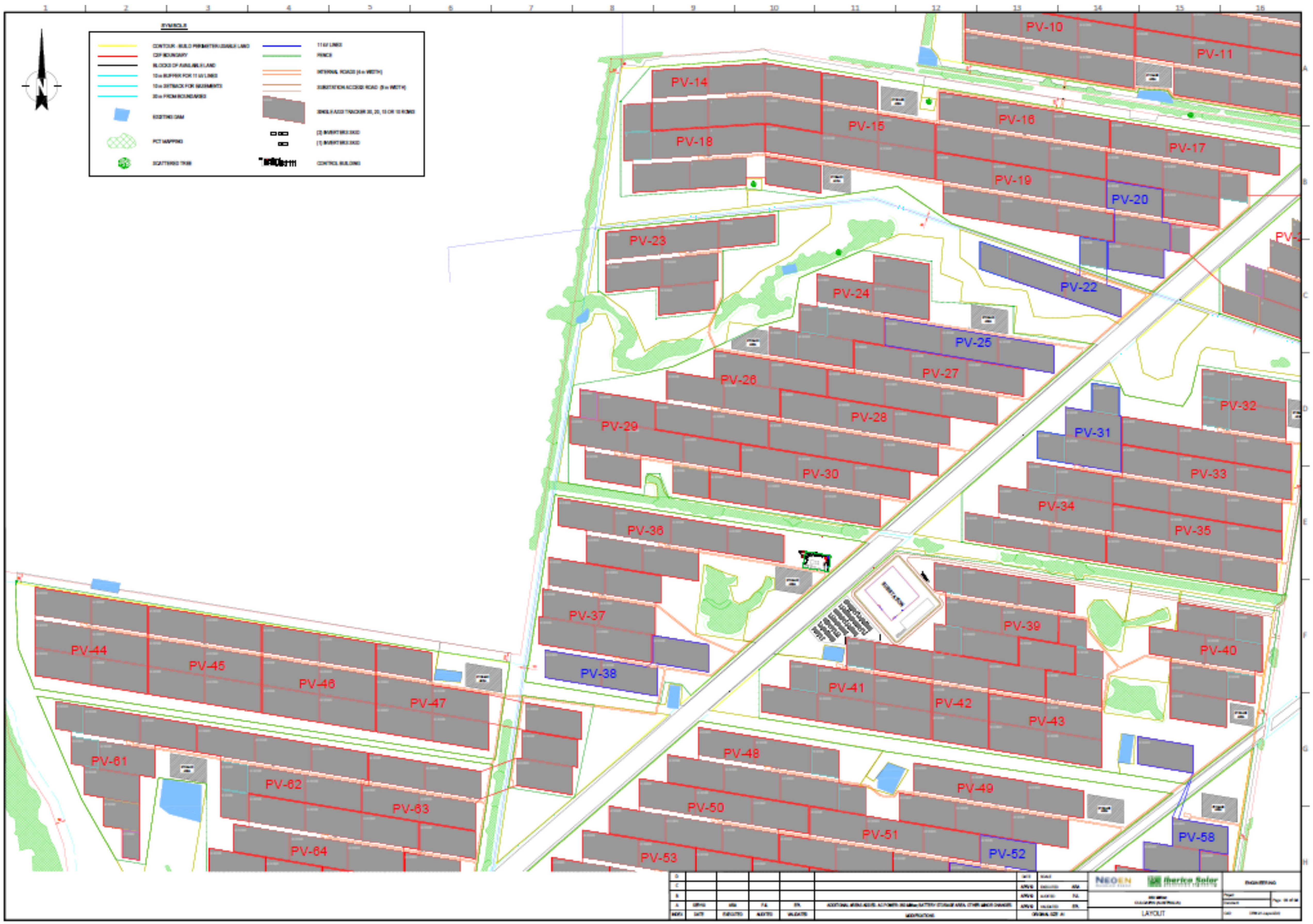
Standard No.	Standard Title
AS 1000	The international system of units (SI) and its applications
AS 1046	Letter symbols for use in electrotechnology
AS 1100	Technical drawing
AS 1101	Graphical symbols for general engineering
AS 1102	Graphical symbols for electrotechnology
AS 1102.8	Symbols for location diagrams
AS 1170	Structural design actions
AS 1170.1	Structural design actions – Permanent, imposed and other actions
AS 1170.2	Structural design actions – Wind actions
AS 1170.4	Structural design actions – Earthquake actions in Australia
AS 1307.2	Surge arresters - Metal-oxide surge arresters without gaps for a.c. systems
AS 1379	Specification and supply of concrete
AS 1418	Cranes (including hoists and winches)
AS 1603	Automatic fire detection and alarm systems
AS 1670	Fire detection, warning control and intercom systems – System design, installation and commissioning
AS 1670.4	Fire detection, warning control and intercom systems- System design, installation and commissioning- Sound systems and intercom systems for emergency purposes
AS 1680	Interior lighting
AS 1768	Lightning protection
AS 1851	Maintenance of Fire Protection systems and Equipment
AS 1940	The storage and handling of flammable and combustible liquids
AS 2067	Switchgear assemblies and ancillary equipment for alternating voltages above 1 kV
AS 2293.1	Emergency escape lighting and exit signs for buildings – System design, installation and operation
AS 2293.3	Emergency escape lighting and exit signs for buildings – Emergency escape luminaires and exit signs
AS 2374	Power transformers
AS 2444	Portable fire extinguishers and fire blankets Selection and location
AS 2700	Colour standards for general purposes
AS 2758.1	Aggregates and rock for engineering purposes – Concrete aggregates
AS 3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS 3008	Electrical installations – Selection of cables
AS 3011	Secondary batteries installed in buildings
AS 3439.1	Low-voltage switchgear and controlgear assemblies – Type-tested and partially type-tested assemblies

Standard No.	Standard Title
AS 3600	Concrete structures
AS 3610	Formwork for concrete
AS 3780	The storage and handling of corrosive substances
AS 3835	Earth potential rise - Protection of telecommunications network
AS 3990	Mechanical equipment – Steelwork
AS 4044	Battery chargers for stationary batteries
AS 4360	Risk management
AS 4428	Fire detection, warning, control and intercom systems Control and indicating equipment
AS 4777	Grid connection of energy systems via inverters
AS 4801	Occupational health and safety management systems
AS 4853	Electrical Hazards on Metallic Pipelines
AS 5577	Electricity network safety management systems
AS 7000	Overhead line design - Detailed procedures
AS/ISO 9001	Quality management systems - Requirements
AS/ISO 14520	Gaseous Fire extinguishing Systems
AS 60044.1	Instrument transformers – Part 1: Current transformers
AS 60044.2	Instrument transformers – Part 2 : Inductive voltage transformers
AS 60529	Degrees of protection provided by enclosures (IP Code)
AS 60947	Low-voltage switchgear and control gear
AS 61558.1	Safety of Power Transformers, Power Supplies, Reactors and Similar Products - General requirements and test
AS 62040	Uninterruptible power systems (UPS)
AS 62271.1	High-voltage switchgear and controlgear - Common specifications
AS 62271.201	High-voltage switchgear and controlgear – AC insulation-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV
BCA	Building Code of Australia
BS 142	Specification for electrical protective relays
EN 300012-1	Quality assurance requirements for measuring equipment
FCC Part 15	Electronic Code of Federal Regulations – Radio Frequency Devices
IEC 255	Electrical relays
IEC 297	Dimensions of panels and racks
IEC 50178	Electronic Equipment For Use In Power Installations
IEC 60076	Power transformers
IEC 60079	Explosive atmospheres
IEC 61508	Functional safety of electrical/electronic/programmable electronic safety-related systems (Parts 1-7)

Standard No.	Standard Title
IEC 62477	Safety Requirements for Power Electronic Converter Systems and Equipment
IEEE 80	IEEE Guide for safety in AC substation grounding
IEEE C37.013	AC High-voltage circuit breakers rated on A symmetrical current basis
IEEE C37.90.1	IEEE Standard Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus
IEEE C37.90.2	IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers
ISO 1000	The international system of units (SI) and its applications
ISO 14617	Graphical symbols for diagrams
NEC	National Electrical Code
NFPA 850	Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations
UL 1741	Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use With Distributed Energy Resources
UL 9540	Energy Storage Systems and Equipment

Appendix B – PV Solar Farm - Preliminary Layout

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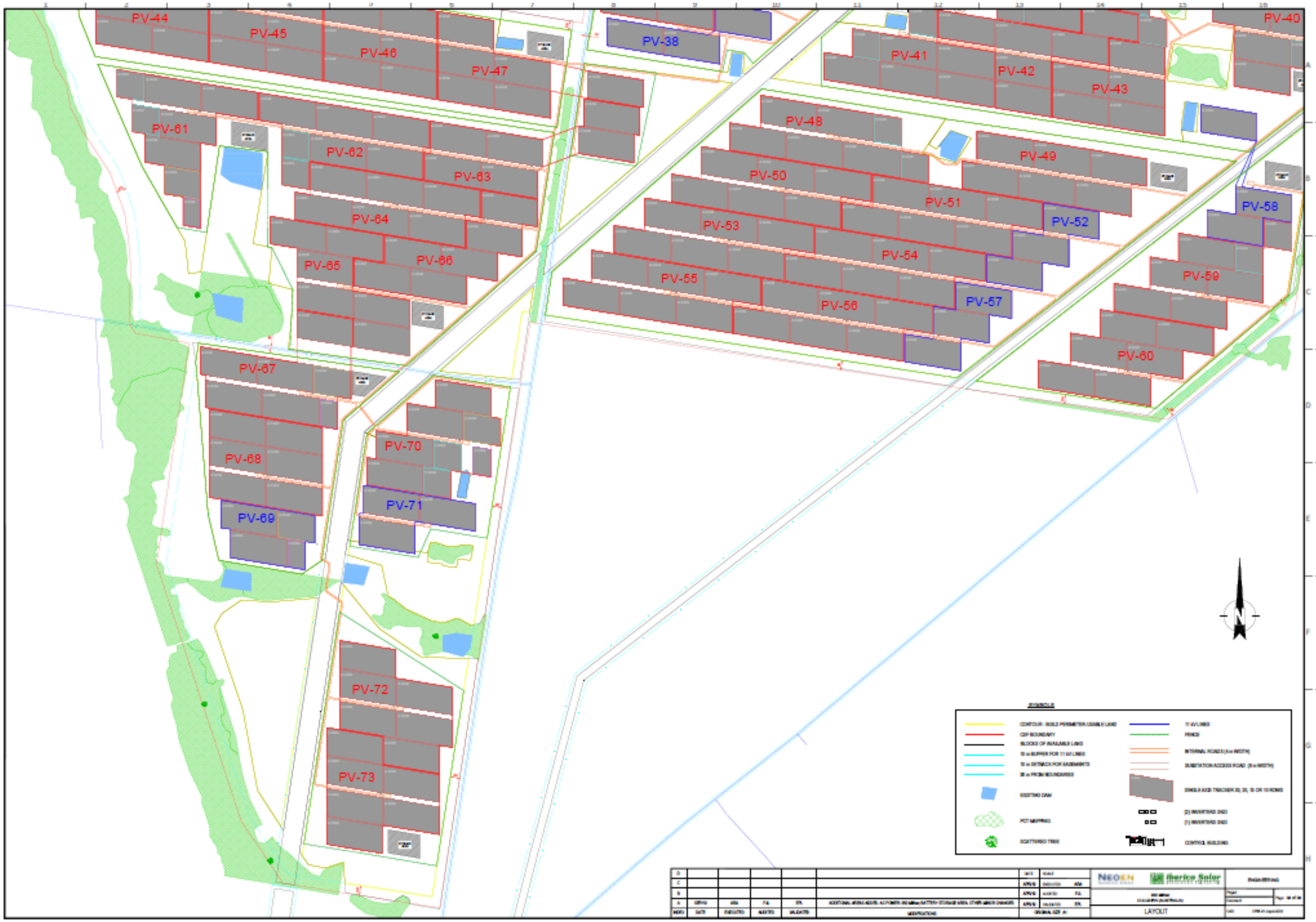
LAYOUT

SYSTRA SCOTTLISTER



Appendix C – Risk Assessment Matrices

NEOEN Risk MAtrix

Type	Code	First Determine the Consequence (C)				
Consequence	Rank	Minor	Moderate	Serious	Major	Severe
	Scale	5	4	3	2	1
Financial AUS$	FIN	<$100,000	$100k to $1m	$1m to $10m	$10m to $80m	>$80m
Recurring Financial	Rec $	<$10k per annum	$10k to $100k per annum	$100k to $1m per annum	$1m to $30m per annum	>$30m per annum
Health and Safety	H&S	Local treatment with short recovery - minor short term health effects.	Medical treatment required or short term acute health effects.	Lost Time Injury (off work recovery required) or short / medium term health issues.	Extensive injuries or chronic health issues including disease pandemic.	Single fatality or permanent disability.
Environment	ENV	Onsite release, containable with minimal damage. Localised impact on energy usage.	Onsite release with some damage, no offsite damage. Remediation in terms of days. Numerous and or wide spread small scale impacts on energy and waste.	Offsite release, no significant environmental damage. Remediation in terms of weeks.	Major off-site release, short to medium term environmental damage. Remediation in terms of months.	Major off-site release, long term environmental damage. Remediation in terms of years.
Reputation	REP	Workforce concern	Local client loss of business demand and alienation of key stakeholders. Local community concern.	Regional loss of business demand and alienation of key stakeholders. Regional community concern.	Widespread loss of business demand and alienation of key stakeholders. Single business unit affected. Widespread community outcry.	Widespread loss of major clients and alienation of key stakeholders. All business units affected. Extreme community outcry nationally.

Second Determine the Likelihood (L)	Likelihood	Description	Frequency	Rank	5	4	3	2	1
	Almost certain	Event may recur during the lifetime of the operation / project.	May occur more than once per year.	A	Medium	High	Very High	Very High	Very High
	Probable	Event that could probably occur during the life-time of the operation / project.	May occur once per year.	B	Medium	Medium	High	Very High	Very High
	Possible	Event that may possibly occur during the life-time of the operation / project.	May occur in 1-10 years.	C	Low	Medium	Medium	High	Very High
	Unlikely	Event that is unlikely to occur during the life-time of the operation / project.	May occur in 10 -100 years.	D	Low	Low	Medium	Medium	High
	Very unlikely	Event that is very unlikely to occur during the life-time of the operation / project.	Less often than 100 year event.	E	Low	Low	Low	Medium	Medium

Risk Level	Required Actions
Very High	Risks that significantly exceed the risk acceptance threshold and need urgent and immediate attention.
High	Risks that exceed the risk acceptance threshold and require proactive management. Includes risks for which proactive actions have been taken but further risk reduction is impracticable. Active monitoring and sign-off from business unit senior management is required.
Medium	Risks that lie on the risk acceptance threshold and require active monitoring. The implementation of additional measures could be used to reduce the risk further.
Low	Risks that are below the risk acceptance threshold and do not require active management. Certain risks could require additional monitoring.

Look up lists			
	Consequence	Likelihood	Control effectiveness
	1 2 3 4 5	A B C D E	Effective Adequate Marginal Ineffective

Appendix D – Preliminary Risk Register

Ref. No:	Hazard	Risk Area	Event	Causes	Consequences	Existing Controls	Control Effectiveness	Residual Risk (with existing controls)				Recommendations
								Type	C	L	Risk Level	
1	General Electrical hazards	Lithium Cells Battery Racks HVAC systems (cooling systems) Invertors Transformers HV Switchgear Overhead Transmission Lines	Exposure to high voltage	Short circuit/ or equipment failure	Electrocution / Injury/ fatality	Equipment and systems will be designed and tested to comply with international and/ or Australian standards and guidelines, mainly As 3000 for wiring. BESS BMS fault detection and safety shut-off systems provided Emergency Response Plan to cover all site hazards External assistance for firefighting (FRNSW & RFS) Use of appropriate PPE	Effective	H&S	2	D	Medium	
2	Arcing / Short Circuit	BESS	Arcing / Short Circuit	Cable or equipment fault	Electrocution / Injury/ fatality	AS above	Effective	H&S	2	D	Medium	
3	Fire	BESS	Fire in 1 x battery pack	Overcharging / or overheating due to HVAC cooling unit failure	Loss of battery module	Battery modules to be fire separated, so that the loss of one module to fire does not affect any other. Fire test by DNVGL show that effects are localised and controlled for a complete burn-out of 1 battery module unit.	Effective	FIN	4	C	Medium	
4	Explosion / thermal runaway reaction	BESS	Explosion / thermal runaway reaction	Overcharging / or overheating due to HVAC cooling unit failure	Loss of battery module and release of electrolyte	Equipment and systems will be designed and tested to comply with international and/ or Australian standards and guidelines, mainly As 3000 for wiring. BESS BMS fault detection and safety shut-off systems provided Emergency Response Plan to cover all site hazards External assistance for firefighting (FRNSW & RFS)	Effective	FIN	4	C	Medium	
5	Gas / vapour release	BESS	release of thermal decomposition product or electrolyte	Explosion / thermal runaway reaction	Loss of battery module / release of acid gases or HF. Module shut down	Equipment and systems will be designed and tested to comply with international and/ or Australian standards and guidelines, mainly As 3000 for wiring. BESS BMS fault detection and safety shut-off sytems provided. The battery units also have deflagration vents to allow for combustion gas venting at controlled rates. Emergency Response Plan to cover all site hazards External assistance for firefighting (FRNSW & RFS)	Effective	FIN	4	C	Medium	
6	Transformer arcing and fire	Transformers	transformer fire event / or pool fire	winding arc fault, or overheating, poor oil maintenance	Pool fire event	transformer subject to routine maintenance including oil sampling PCUs and transformers are located in designated area / adequate separation distance to not involve adjacent plant & equipment - 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 & RFS)	Adequate	H&S	2	D	Medium	
7	Fire	Fuel Storage (ULP)	Leakage / fire	equipment failure, flex hose failure	pool fire or flash fire	Site to be fenced. Fuel storage and handling to AS 1940 - Storage and Handling of Flammable liquids - Onsite security protocol Emergency and Bushfire Plans to be documented and implemented - Warning signs	Adequate	H&S	2	D	Medium	
8	Security / Unmanned Site	solar PV modules PCUs Invertors MV cable reticulation Transgird Substation BESS Transformers Overhead transmission lines	Vandalism	Unauthorised access	Asset damage / or stolen PV panels	Site to be fenced. 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	Adequate	FIN	5	C	Low	
9	Bush fire or scrub fire	Site and surrounding bush/ scrublands	Bushfire or Scrub fire	Arson, lighting strike, HV systems arcing or secondary fire causing bushfire.	Personnel injury or burns, asset or equipment damage.	Site to be fenced. gravel hardstands to be provided APZ/fire break to be provided SCADA controls and monitoring systems, including CCTV (surveillance) to be provided Bushfire Hazard management Plan to be documented and implemented in consultation with local NSW Rural Fire Service	Adequate	H&S	5	C	Low	