Beerenberg Pty Ltd Hahndorf Generating System Connection

Engineering Report

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Issue B

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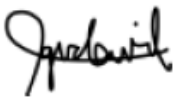
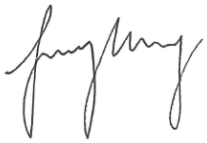
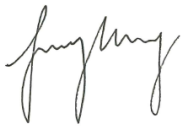
SA Power Networks

Empowering South Australia

Document Control

Issue	Date	Details	Prepared	Checked	Approved
A	11/08/2020	Original Issue	Keilah David 	Victor Ho 	Andrew Lim 
B	4/03/2021	Change of BESS and SLD.	Alan Tran 	Siyuan Wen 	Andrew Lim 

Disclaimer

The findings of this report have been based in part on the results of SA Power Networks steady state system stability studies for this connection. In order to undertake the steady state studies, SA Power Networks has relied on Generating System information and site location details provided by Beerenberg Pty Ltd and Westside Energy Pty Ltd. SA Power Networks accepts no responsibility for the accuracy and completeness of the findings based on information provided.

Where assumptions have needed to be made, they have been made using all reasonable endeavours and been confirmed where possible. SA Power Networks takes no responsibility for its accuracy and/or completeness. Forecast loads and possible future system developments have been based on the best available information at this time.

This Engineering Report is not intended to reduce, vary, or substitute any of the Proponent's obligations to ensure the Proponent's Generating System complies with relevant rules, regulations, codes and legislation.

Please contact Tim Wright (08 8404 5803) if you need any further information in relation to the contents of this report.

Contents

Definition of Terms

AEMO: Australian Energy Market Operator

AS 4777.1:2016: Australian/New Zealand Standard Grid connection of energy systems via inverters Part 1: Installation requirements

AS 4777.2:2015: Australian/New Zealand Standard Grid connection of energy systems via inverters Part 2: Inverter requirements

Business Day: Monday to Friday excluding those days designated as public holidays in South Australia by the South Australian Government.

Connection Point (CP): The agreed point of supply established between SA Power Networks and the Proponent's site to SA Power Networks Distribution Network.

EDC: ESCOSA's Electricity Distribution Code

ESCOSA: Essential Services Commission of South Australia

GDL: Generator Dispatch Limiter

Generating System: All Generating Units and the associated control and protection equipment.

Generating Unit: The actual generator of electricity, including all the related equipment essential to its functioning as a single entity.

MSB: Main Switchboard

NER: National Electricity Rules

Network: Refers to any part of SA Power Networks' Distribution Network.

NOC: SA Power Networks' Network Operations Centre

OTR: The Office of the Technical Regulator

PLC: Programmable Logic Controller

Point of Common Coupling (PCC): The location at which the impact of the Generating System on the Network will be assessed.

Proponent: A person/entity who engages in the activity of owning, controlling, or operating a Generating System that supplies electricity to, or who otherwise supplies electricity to, a transmission or distribution network. For the purposes of this report the Proponent is Beerenberg Pty Ltd.

Power Factor: means the ratio of real power to apparent power.

Retailer: The holder of an electricity retail licence granted under the Electricity Act 1996 who is contracted to sell electricity to the Proponent at the supply address.

ROCOF: Rate of Change of Frequency

RTU: Remote Telemetry Unit

VDRT: Voltage Disturbance Ride Through

1. Scope of Report

The scope of this report is to outline the feasibility of and identify any engineering issues associated with the connection of the Generating System to the Network proposed to be installed at the Proponent's site. Specifically, this report addresses:

- the Generating System requirements;
- the outcomes of the engineering studies undertaken by SA Power Networks;
- any additional plant and equipment that may be required to facilitate the connection of the Generating System to the Network;
- the operating conditions and/or constraints required for connection of the Generating System to the Network; and
- any other potential issues.

This report solely deals with the impact of the proposed Generating System on the Network and does not address the compliance of the Proponent's overall site design with the Service and Installation Rules and suitability for the Proponent's purpose.

SA Power Networks' analysis has been based on and considered the impact of the proposed Generating System on the Network including other existing and approved/committed generating sources on the feeder and upstream zone substation. Other speculative generation connection enquiries on the same feeder or zone substation have not been considered.

The Generating System's connection must comply with the NER, EDC, the requirements of SA Power Networks' Service and Installation Rules and SA Power Networks Technical Standards: TS-130 for Low Voltage EG Connections above 30kVA Technical Requirements or TS-131 for High Voltage EG and Any Size Rotating Generating System Connection Technical Requirements. Unless otherwise stated, if there is any inconsistency between this Engineering Report and TS-130/TS-131 Technical Standard for the proposed connection, the Engineering Report prevails to the extent of the inconsistency.

2. Executive Summary

In June 2020, SA Power Networks was engaged by Beerenberg Pty Ltd, in collaboration with Westside Energy Pty Ltd, to investigate the feasibility of connecting to the Network a Generating System with generation capacity of 550kVA, proposed to be installed at Beerenberg Farm, 2106 Mount Barker Road, Hahndorf SA 5245.

The investigations undertaken by SA Power Networks indicate that provided SA Power Networks' requirements are met, that the Generating System operates within the constraints detailed in Section 4 and that the Network augmentation detailed in Section 6.5 is undertaken, then the connection of the Generating System at the proposed location will not adversely affect the security of the Network or impact on the quality of supply to other Network users.

Prior to connection of the Generating System, the Proponent will conduct commissioning tests to demonstrate compliance of the Generating System and Network connection with the applicable regulations. The Proponent must develop and submit to SA Power Networks a compliance monitoring program, including an agreed method by which the ongoing compliance of the Generating System can be demonstrated against the applicable standards and regulations. The Proponent must arrange for periodic testing of its protection system to ensure it continues to function as designed. This compliance monitoring program must also be submitted to and approved by SA Power Networks prior to final connection. Failure to comply with this compliance monitoring plan may result in SA Power Networks disconnecting or issuing a 'permission denied' signal (if available) to the Generating System until ongoing compliance is demonstrated to SA Power Networks satisfaction.

The following applies as of the 28th of September 2020, as per SA Government's Electricity (General) (Technical Standards) Regulations 2020:

Generating Systems connecting to the SA Power Networks distribution network are required to have the capability for remote disconnection/reconnection functionality by the 31st December 2020. The responsibility is on the installer/manufacturer to ensure systems are compliant with the regulation requirements, and on the system owner to ensure it is functional. SA Power Networks will require all Generating System owners to specify their Relevant Agent and the intended technical solution to be used to achieve remote disconnection/reconnection.

3. General Information

The proposed 550kVA Generating System that has been considered for the purposes of this report consists of the following:

Network Information, Generation Proposal and Connection Point

Proponent	Beerenberg Pty Ltd
Premises	Beerenberg Farm, 2106 Mount Barker Road, Hahndorf
Total Site Generation Capacity	550kVA
Connection Point (CP)	Isolation point on the low voltage side of the existing pad-mounted transformer (TC59748)
Point of Common Coupling (PCC)	High voltage terminals of the pad-mounted transformer (TC59748)
Rotating Generating Units	None
Inverter Generating Units	• 3 × 100kVA solar PV inverters (FIMER-ABB PVS-100-TL) • 1 × 250kVA BESS (PowerTec 250KVA, VACON NXA04605 the inverter/filter assembly)
Solar PV Panels	864 × 405W Trina Solar Tallmax TSM-DE15M(II) roof-mounted fixed with no frame tilt (panel tilt to rely on roofing angles)
Energy Storage System	3 × 91kWh LG Chem BESS (capped to 250kWh due to inverter capacity) • Rack Model: R800 • Cell Model: JH3 • Battery Model: Chem ER3217TDUFNP160DF1
Rate of charge/discharge	110.9kW charge / 110.9kW discharge
Reactive Plant	None
Nominal Supply Voltage (at CP)	0.4kV
Generating Unit voltage	0.4kV

The Generating System is to be connected to Beerenberg Pty Ltd.'s Hybrid Electricity System Board (HESB), which is connected to the Main Switchboard (MSB) through a grid Protection Control Board (GPCB) that contains the Network Protection Unit. The MSB is connected to the Network via the existing 1500kVA padmount transformer (TC59748). The system is comprised of three (3) 100kVA ABB solar PV inverters and one (1) 250kVA BESS (PowerTec 250KVA, VACON NXA04605 the inverter/filter assembly) that are both connected to the HESB. A 560kVA Pramac standby diesel Generating Unit, located adjacent to the BESS, is connected to the MSB.

The proposed connection arrangement and site layout as provided by the Proponent is shown in the Single Line Diagram and Site Layout contained in Appendix A: Beerenberg Pty Ltd Hahndorf Single Line Diagram and **Error! Reference source not found.** respectively.

4. Operating Philosophy

It is SA Power Networks' understanding based on the advice received from Beerenberg Pty Ltd and Westside Energy Pty Ltd and the outcomes of SA Power Networks' engineering studies that the Generating System will operate based on the following operational philosophy.

Agreed maximum demand from the Network	250kVA
NMI	SAAAAAB7837
Power factor when importing MW from the Network (at CP)	Between Unity and 0.85 absorbing VArs from the Network per SA Power Networks' Service & Installation Rules
Primary supply feeder	Hahndorf 11kV Feeder (MTB-21)
Primary substation	Hahndorf 66/11kV Substation
Maximum export output to the Network	199kW
Power factor when exporting MW to the Network (at CP)	0.95 absorbing VArs from the Network at all times
Operating philosophy	Supply onsite load, store surplus solar and export any power generated which is in excess of the Proponent's existing internal demand up to the maximum export output
Action when planned transfer to abnormal feeder[1]	No action
Action for unplanned Network abnormality[1]	No action
Special operating conditions	When load demand is greater than power generated by solar, shortfall is drawn from the grid up to the agreed maximum demand from the Network. If the demand is greater, battery system is turned on for supply. If the load demand is greater than the combination of solar, import from grid and battery capacity, the standby diesel Generating Unit is turned on and import from grid is replaced by the diesel Generating Unit. This transition is via a closed transition transfer switch (CTTS). Solar, battery and diesel Generating Unit to operate in parallel off-grid mode. In the Event Loss of Mains (LOM), the Network Protection Unit will detect this event via ROCOF and open the Main Circuit Breaker (MCB) to isolate Beerenberg Farm from the grid within the parameters approved by SA Power Networks. The solar generating system and BESS will enter off-grid UPS mode and remain online feeding the site load. When grid supply recovers, MCB will close after solar generating system and BESS have synchronised to the grid supply.

Under normal Network conditions, the Generating System is to operate as follows:

- Generated power will contribute towards the supply of the energy requirements on Proponent's site. Any shortfall is drawn from the grid up to the Agreed Maximum Demand from the Network.
- The Battery Energy Storage System will be charged predominantly from the PV system and will also be used to provide reactive support during export of the energy into the Network. In the

[1] Action taken by SA Power Networks

event of the battery being charged from the Network the Agreed Maximum Demand of the site must not be exceeded[2].

- Generating System will export to the Network any power generated which is in excess of the existing Proponent's internal demand up to the maximum export output above.
- In the event that the Proponent's internal demand exceeds the combination of generated power, import from the grid and battery supply, the standby diesel Generating Unit operates and the site disconnects from the grid. This transition happens via a closed transition transfer switch (CTTS) and the site operates in island mode. The site will remain isolated from the Network until the load demand can be met via the combination of solar and import from the Network; or the combination of solar, import from the Network and battery supply.

SA Power Networks has assessed the proposal considering a 199kW export mode of operation for the proposed Generating System. The Proponent will be required to dynamically adjust the power factor of the Generating System to meet the required power factor measured at the Connection Point, accounting for onsite loads and losses.

The Proponent will be required to limit the site's export to the agreed threshold of 199kW using the control system described in Section 9.4. This control system will need to be tested and approved during the commissioning witnessing tests.

If the Proponent proposes to change the site's operating philosophy or future demand characteristic, the Proponent must submit in writing a request for SA Power Networks to assess the feasibility of any such change.

5. Impact Assessment

The investigations undertaken by SA Power Networks indicate that the connection of the 550kVA Generating System at the Hahndorf site should not adversely affect the security of the Network or impact on the quality of supply to other Network users.

5.1 Assumptions

The engineering studies undertaken to assess the impact of the proposed Generating System connection on the existing Network have been based on the following assumptions and information:

- The Generating System's connection will comply with the requirements of the EDC;
- The Generating System's connection will comply with the requirements of SA Power Networks' Service and Installation Rules and relevant technical standards;
- Inverters are compliant with the principle of AS 4777.2:2015, will be installed as per AS 4777.1:2016;
- Details provided by Beerenberg Pty Ltd and Westside Energy Pty Ltd, as listed below:
    - Customer Enquiry Form Rev1 dated 30 March 2020;
    - Westside Energy – Beerenberg 1.1MW Hybrid Electricity System Protection Single Line Diagram, Ref E5000-504, Rev 10, dated 18 January 2021;
    - Beerenberg Pty Ltd Hahndorf Site layout, Rev A, dated 03 June 2020;
    - Beerenberg Pty Ltd Hahndorf Solar & Battery System layout, Rev A, dated 03 June 2020;
    - Beerenberg Pty Ltd Hahndorf Solar Panel layout, Rev A, dated 16 July 2020;
    - FIMER-ABB PVS-100-TL solar PV inverter datasheet, Rev A, dated 03 June 2020;
    - ComAp InteliPro protection relay datasheet, Rev A, dated 03 June 2020;

[2] Extra charges may apply otherwise

- Trina Solar Tallmax TSM-DE15H(II) solar PV modules datasheet, Rev A, dated 14 April 2020;
- LG Chem BESS ER3217TDUFN_P160DF1 battery rack system datasheet, Rev A, dated 03 June 2020;
- ComAp InteliSys Hybrid controller datasheet, Rev A, dated 03 June 2020;
- ComAp InteliMains BaseBox switchgear controller datasheet, Rev A, dated 30 July 2020;
- ComAp InteliGen NTC BaseBox datasheet, Rev A, dated 03 June 2020;
- Pramac GSW560V diesel generator datasheet, Rev A, dated 03 June 2020;
- PT-CP-GU-20-0221PowerCache Catalogue, Rev 21, dated July 2020;
- PT-ST-WE-20-1001 PowerCache 250-270 Technical Specification, Rev 01, dated 7 August 2020
- PowerTec Engineered Solutions, PowerCache 250kVA/270kWh Datasheet, Ref PT-DP-GU-21-022;
- SAA Approvals Certificate of Suitability, Ref 192864/1, dated 08 November 2019;
- Operating Philosophy declaration, Rev 2, dated 30 July 2020;
- Mains Failure Control Logic declaration, dated 03 March 2021; and
- Email correspondence between SA Power Networks, Beerenberg Pty Ltd and Westside Energy Pty Ltd.

5.2 Steady State Voltage

The steady state voltage investigations undertaken have been based on the neutral tap setting being applied to the transformers supplying the Proponent. The investigations undertaken indicate that the steady state voltage rise due to the Generating System is within the permissible limits prescribed by the EDC and detailed in Section 8.1.

The voltage rise under minimum load conditions with varying power factor due to the Generating System is shown in Table 1 below.

STEADY STATE VOLTAGE RISE (%)			
Generation Capacity	**Power Factor at CP**	**Voltage Rise (%)**	
		Substation Bus	**PCC**
550kVA **(199kW net export to the Network)**	0.95 pf absorbing VArs from the Network	0.0 (Reference Voltage)	0.0

Table 1: Steady State Voltage Rise during Minimum Load

5.3 Voltage Fluctuation and Flicker

The investigations undertaken indicate that the voltage step change due to a sudden loss of the Generating System is within the limits prescribed by the EDC. In addition, the expected voltage range that the Generating System will be required to operate is within the range of the Generating System.

The voltage step change due to the loss of the Generating System during the most onerous load conditions is shown in Table 2.

STEP VOLTAGE CHANGE (%)			
Generation Capacity	**Power Factor at CP**	**Scenario**	**Voltage Change (%)**
			PCC
550kVA **(199kW net export to the Network)**	0.95 pf absorbing VArs from the Network	Sudden loss of Generating System	0.45

Table 2: Voltage Step Change Results

The voltage step change due to the potentially rapid changes of the PV system's output contributed by cloud movement and coverage is within limits. SA Power Networks advises that the voltage fluctuation within Beerenberg Pty Ltd's network is the responsibility of the Proponent.

5.4 Fault Current Contribution Investigations

The proposed inverter-based Generating System does not contribute fault current in the same manner as synchronous or induction machines and provides minimal contribution to overall fault levels on the Network. Power electronics within the proposed inverter also provide additional functionality to vary protection constants for quicker response times to fault conditions.

The resultant 3-phase fault level at the Connection Point with the Generating System operating is approximately 28.5kA and the line-ground fault level is 3.20kA.

Based on this, the fault levels at SA Power Networks' equipment, including any additional fault level contribution from the Generating System, will be maintained within the ratings of SA Power Networks' existing equipment.

As the Network fault levels are subject to change, the Network's ultimate fault level as per TS-100 Appendix C at the Connection Point should be used for sizing any new equipment for the proposed installation's plant and switchgear.

5.5 Protection Evaluation

The proposed Generating System is expected to incorporate a form of active anti-islanding protection and passive anti-islanding protection which meets the requirements of the Australian Standards AS 4777.

SA Power Networks' assessment of the proposed protection arrangement is that it is sufficient for the proposed Generating System and it meets the requirements detailed in Section 0.

Protection relay(s)	ComAp InteliPro measuring at 0.4kV
Passive anti-islanding functions available	Yes
Reverse Power Protection	To be implemented under ComAp InteliPro
Stage 1 Pick-up	288A (199kW)
Stage 1 Delay	120 seconds
Stage 2 Pick-up	431A (298.5kW)
Stage 2 Delay	0.4 seconds

The protection settings must be submitted to SA Power Networks for review at least three months prior to the proposed commissioning date of the Generating System and the

proposed protection philosophy is to be demonstrated by the commissioning tests in the presence of SA Power Networks commissioning officers.

The proposed protection arrangement as provided by the Proponent is shown in the Single Line Diagram contained in Appendix A.

6. Network Connection Requirements

SA Power Networks' Network connection requirements for the proposed Generating System are outlined within this section.

6.1 Protection Requirements

PROTECTION SCHEME	SECTION	REQUIREMENT
Over-Current & Earth Fault	7.2	Yes
Inverter Generating System	7.3	Yes
Rotating Generating System	7.4	No
ROCOF	7.5	Yes
Synchronisation	7.6	No
Pole Slip	7.7	No
Load Balance	7.8	No
Directional Power	7.9	Yes
Inter-trip	7.10	No
Feeder/Line Protection	7.11	No

Table 3: Protection Requirements

6.2 Power Quality Requirements

POWER QUALITY REQUIREMENTS	SECTION	REQUIREMENT
Steady State Voltage	8.1	Yes
Reactive Capability	8.2	Yes
Voltage Fluctuation	8.3	Yes
Harmonics	8.4	Yes
Voltage Balance	8.5	Yes
Ramp Rate	8.6	Yes
Energy Storage System	8.7	Yes

Table 4: Power Quality Requirements

6.3 Remote Monitoring and Control Requirements

CONTROL REQUIREMENTS	SECTION	REQUIREMENT
SCADA Load Switch	6.5	No
Runback Scheme	9.3	No
Maximum Export Limiting	9.4	Yes
SCADA Failsafe	9.5	No
Revenue Metering	9.6	Yes

Table 5: Remote Monitoring and Control Requirements

6.4 Compliance, Commissioning and Operation Requirement

OPERATIONAL REQUIREMENTS	SECTION	REQUIREMENT
Code of Compliance	10.1	Yes
Commissioning & Testing	10.3	Yes
Operating Protocols & Procedures	10.4	Yes
Compliance Monitoring & Maintenance	10.5	Yes
Network Connection Agreement	10.6	Yes

Table 6: Compliance, Commissioning and Operation Requirement

6.5 Network Augmentation Requirement

Based on the results of the steady state studies for the proposed inverter-based Generating System at the Hahndorf site, SA Power Networks does not require any additional Network augmentation work to be carried out to facilitate the connection of the proposed Generating System.

7. Protection Requirements

In addition to the protection installed for each Generating Unit, the Generating System must also incorporate a protection system that ensures:

- The Generating System cannot connect to SA Power Networks' Network unless all phases of the Network are energised at the Connection Point. The Generating System must ensure it is synchronised with the Network before connection to the Network. If one or more phases of the Network are lost, then the Generating System must disconnect from the Network.
- The protection equipment is operating within the agreed protection settings;
- If a Network abnormality occurs, resulting in an unacceptable deviation of voltage or frequency at the supply point, the Generating System must disconnect from the Network;
- The Generating System is to automatically disconnect from the Network in the event of the failure of any supplies to the protection equipment that would inhibit the correct operation of the protection equipment (ie fail safe); and
- Each Generating Unit must be equipped with a mechanically lockable means of isolation from the Network.

Where any of these conditions are detected, the Generating System must immediately disconnect from the Network at the agreed circuit breaker within the Proponent's installation that will ensure complete disconnection. The Proponent must ensure that all the Generating Units and any reactive plant is isolated in the event of a protection operation, inter-trip signal or 'permission denied' signal. To detect these conditions, as set out above, the Proponent must install protection that will include the following elements.

7.1 Protection Equipment and Settings

All protection equipment must comply with the relevant IEC 60255 standards. The protection settings report of the final proposed settings must be submitted to SA Power Networks for review and formal approval by SA Power Networks' Protection and Control Planning Manager **three months** prior to project commissioning. The report would include the following:

- For construction protection SLD;
- Incomer overcurrent settings and earth fault (for HV connection);
- Protection installed for each Generating Unit; and
- Back-up relay and anti-islanding settings.

All protection equipment must be suitably tested and commissioned by a competent protection commissioning officer to the agreed settings and a Certificate of Compliance for the complete Generating System installation must be issued by the Proponent to SA Power Networks prior to connection of the Generating System to the Network. Once the agreed settings have been applied to the Generating System, the protection and control settings must be clearly labelled and made secure from tampering in a manner compliant with the requirements specified in section 4.9 of TS-130/TS-131.

The Proponent must keep a written record of all protection settings and of the test results. A copy of this record should be available at the service point or as required by SA Power Networks. A copy of the applied protection settings shall be provided for SA Power Networks' records within the commissioning report.

Inverter System Active Anti-Islanding

Inverter systems are expected to incorporate a form of active anti-islanding protection and also passive anti-islanding protection in the form of under- and over- voltage and under- and over-frequency protection, which shall comply with the requirements of the Australian Standards AS 4777 and SA Power Networks' requirements specified herein.

This is to be tested, proven and demonstrated by the commissioning tests conducted by the Proponent in the presence of SA Power Networks commissioning officers.

Each inverter must be equipped with a lockable means of isolation from the Network.

Protection Failsafe Requirements

The Proponent must ensure that all the protection relays, control circuits and circuit breakers remain operational in the event of circuit breaker failure or a of loss of supply from the Network. The protection and control circuits must be powered and function as intended at all times or be a failsafe design to ensure that the Generating System is completely isolated upon loss of supply from the Network and prior to depletion of any back-up systems (eg DC or UPS supply). Islanded system operation is not considered suitable in the event of a down-stream circuit breaker fail event.

7.2 Over-current and Earth Fault Protection

In accordance with the Service and Installation Rules, the Proponent's incomer circuit breaker must have over-current protection installed, and high voltage connections must also have earth fault protection. This protection is to be set to detect faults within the Proponent's installation and isolate it from the Network. This protection must adequately grade with the Network's protection and requires the use of high-speed protection (ie no intentional delays).

The Proponent is to submit the protection settings to SA Power Networks for review and approval as per section 7.1.

7.3 Inverter System Protection Requirements

Inverter Generating System must incorporate the following grid protection. The Proponent is to submit its final proposed protection settings to SA Power Networks for review and approval as per section 7.1.

Main Passive Anti-Islanding Protection for Inverters

For both low voltage inverters compliant with AS/NZS 4777 and all other inverters, the inverter must be disconnected from the Network for the following settings:

PROTECTION	TYPE	SETTING (e.g. 230/400V)	DELAY (SEC)
Over Voltage 1	V	113% Nominal Voltage (260V)	1
Over Voltage 2	V	115% Nominal Voltage (265V)	0.2
Under Voltage 1	V	78% Nominal Voltage (180V)	1
Sustained over-voltage[3]	V	112% Nominal Voltage (258V)	3
Over Frequency	f	52 Hz	0.2
Under Frequency	f	47 Hz	1

Table 7: LV and HV Connected Inverters Protection Settings

If the frequency exceeds 50.25Hz, the inverter shall reduce the power output linearly with an increase of frequency until the +4% limit is reached.

[3] based on average value over a period of 10min

Inverters must not connect or reconnect to the Network unless the voltage and frequency of the Network has been maintained for at least 60 seconds.

Main Active Anti-Islanding Protection for Inverters
In addition, the inverter must include at least one method of active anti-islanding protection, which will operate the disconnection device within two seconds.

Voltage Ride-Through for Inverters
All inverters must comply with under voltage ride-through performance standards designed to mitigate impacts on the South Australian power system during disturbances. Inverters must remain in continuous operation through a 220ms duration voltage dip to 50V.

Back-Up Passive Anti-Islanding Protection for Inverters
Where the Generating System uses inverter(s) that have internal protection, the inverter(s) can be used as the main protection and a single back-up protection relay be applied as the back-up protection.

The back-up protection when provided at either low voltage or high voltage protection relay(s) shall be set to trip for the following settings:

PROTECTION	TYPE	SETTING (e.g. 230/400V)	DELAY (SEC)
Over Voltage	V	113% Nominal Voltage (260V)	2
Under Voltage	V	78% Nominal Voltage (180V)	2
Sustained over-voltage[4]	V	112% Nominal Voltage (258V)	15
Over Frequency	f	52 Hz	2
Under Frequency	f	47 Hz	2

Table 8: LV or HV Back-up Protection Settings

Back-up protection relays must not connect or reconnect the Generating System to the Network unless the voltage and frequency of the Network has been maintained for at least 60 seconds.

7.4 Rotating Generating System Protection Requirements

The Generating System must incorporate the following grid protection. The Proponent is to submit its final proposed protection settings to SA Power Networks for review and approval as per section 7.1.

Under/Over voltage protection must be installed to monitor the phase to earth voltage on all three phases at the Connection Point. Under and over frequency protection must be installed at the main switchboard. When the protection is provided at low voltage, the Generating System must be disconnected from the Network for the following settings:

PROTECTION	TYPE	SETTING	DELAY (SEC)
Over Voltage	V	110% Nominal Voltage	0.4
Under Voltage	V	94% Nominal Voltage	0.4
Over Frequency	f	52 Hz	0.4
Under Frequency	f	47 Hz	0.4

Table 9: LV Connection Point Rotating Generating Systems Protection Settings

[4] based on average value over a period of 10min

When the protection is provided at high voltage, the rotating Generating System must be disconnected from the Network for the following settings:

PROTECTION	TYPE	SETTING	DELAY (SEC)
Over Voltage	V	110% Nominal Voltage	0.4
Under Voltage	V	90% Nominal Voltage	0.4
Over Frequency	f	52 Hz	0.4
Under Frequency	f	47 Hz	0.4

Table 10: HV Connection Point Rotating Generating Systems Protection Settings

Rotating Generating Systems must not connect or reconnect to the Network unless the voltage and frequency of the Network has been maintained for at least 120 seconds.

7.5 Rate of Change of Frequency (ROCOF)

As the capacity of the Generating System is greater than 30kW, a protection system must be installed that includes ROCOF protection. The Generating System must be capable of continuous uninterrupted operation for one the following rate of change of frequencies:

ROCOF	DURATION
Hz/s	**Sec**
±4	0.25
±3	1

Table 11: ROCOF Protection Settings

The Proponent is to submit its final proposed protection settings to SA Power Networks for review and approval as per section 7.1.

7.6 Synchronising and Synchronising Check Facilities

The Generating Unit control system must include synchronising check facilities at the main switch from which it is proposed to synchronise the Generating System with the Network. These facilities are to include a dead bus check system preventing the Generating Unit connecting to the Proponent's internal network when the Proponent's internal network is de-energised.

7.7 Pole Slip

All rotating Generating Units must include pole slip protection that disconnects the Generating Unit following a loss of synchronism.

7.8 Three-Phase Load Balance

The Generating System must be configured as a 3-phase installation such that no Generating Unit remains connected to the Distribution Network unless all phases of the Network are energised. Likewise, in the event of a fault on a single-phase inverter connected in a 3-phase arrangement, the remaining inverters in the 3-phase arrangement must be automatically isolated from the Network. The maximum unbalance in any phase must be limited to 5kW. Failed inverters must be replaced with an identical make/model inverter. Where this is not possible, an equivalent unit from a different manufacturer approved by SA Power Networks in writing can be installed.

7.9 Directional Power Protection

Directional power protection is required when the export of the Generating System is to be limited to a certain value (including a minimum import) to ensure that the imported/exported power does not breach the agreed limit. The directional protection scheme is in addition to other SA Power Networks' Generating System Network protection requirements. Directional power protection is also required in addition to control systems designed to limit export, e.g. PV cluster controllers.

All inverter Generating Systems with a maximum export limit must include **reverse power protection** to detect and prevent the inadvertent exceeding of the agreed export limit to the Network. Minimum import protection is also acceptable for inverter Generating Systems at sites with net zero export to the Network.

Unless an inter-trip protection scheme is installed, all rotating Generating Systems must include **minimum import protection** to detect an islanding event and to prevent the inadvertent export of electricity into the Network at all times. The minimum import protection is typically set to at least 10% of the Agreed Maximum Demand of the Proponent's installation to ensure a minimum level of demand is continuously supplied by the Network.

The reverse power protection must include 3-phase power monitoring relays installed at the Connection Point, or other agreed location, and electrically disconnect Generating System upon operation. Whenever the power export thresholds outlined in Section 5.5 are breached, the Generation System must be automatically disconnected from the Network using a current-breaking device. The directional power protection circuit must be of fail-safe design.

When the Generation System is transferring back to supply from the Network following a blackout, the Generating Systems must not connect or reconnect to the Network unless the voltage and frequency of the Network has been maintained for at least 60 seconds, and the directional power protection must be enabled in less than 1.5 seconds after closing the main CB.

7.10 Inter-trip Protection

Inter-trip protection is required for any exporting Generating System that does not comply with AS/NZS 4777 or the principles therein (such as rotating Generating Systems).

Inter-trip protection may also be required in cases where the combined generation capacity represents a significant portion of the total area load, implementation of a minimum import protection scheme is not feasible or where deemed necessary by SA Power Networks.

The inter-trip protection scheme shall be installed so that the Generating System is disconnected from the Network when the Network is de-energised via SA Power Networks' Network protection. The inter-trip scheme is in addition to other SA Power Networks' Generating System Network protection requirements.

One (1) set of inter-trip signal is to be sent, to trip the Proponent's upstream protection device for this purpose (see 7.11 for communication requirements). This ensures that both the Generating System and any associated reactive plant are isolated in the event of a fault upstream of the Connection Point.

SA Power Networks will provide, install and commission the required equipment at SA Power Networks' substation(s) and protection device(s) to provide the necessary inter-trip signal. The Proponent is to provide all equipment required for its site to receive and act on this signal to ensure the protection scheme will function as specified. In addition to tripping the Proponent's upstream protection device, a 'permission denied' is to be carried out by the Proponent upon receiving the inter-trip signal.

In the event of a loss of the inter-trip communications to SA Power Networks for more than 30 seconds or failure of the inter-trip protection, a 'permission denied' is to be carried out by the Proponent and a disconnection of the Generating System from the Network is to be initiated by the Proponent's PLC, for which SA Power Networks will not be responsible for any losses (direct or indirect) incurred by the Proponent.

The Proponent is to discuss this inter-trip protection arrangement with SA Power Networks and provided all drawings of the proposed solution to SA Power Networks for review and approval as per section 7.1.

7.11 Feeder/Line Protection

Where a Generating System is required to be connected to the Network via either a dedicated feeder or sub-transmission line, SA Power Networks will require this dedicated asset to be protected by SA Power Networks' protection systems which will be provided by SA Power Networks at the Proponent's expense.

For dedicated distribution feeders, a main / back-up protection system consisting of a main set of differential feeder protection and back-up over-current protection shall be installed. Communications for protection signalling will be via a single set of either optic fibre or radio. The use of mobile phone networks for protection signalling communications will not be accepted.

The final interface requirements will be developed to suit actual final connection arrangements.

Protection for Dedicated 33kV & 66kV Connections

For dedicated sub-transmission connections at 33kV or 66kV, the use of a line differential protection schemes shall be installed. Communications for protection signalling will be via two geographically diverse sets of either optic fibre, radio or a combination thereof. The use of mobile phone networks for protection signalling communications will not be accepted.

The implementation of such protection schemes will require the Proponent to make available suitable space within its control room for SA Power Networks to install its protection panel and any associated telecommunication equipment.

The final interface requirements will be developed to suit actual final connection arrangements.

8. Power Quality Requirements

Generating System must not impact on the quality of supply to SA Power Networks' Network and its Network users/customers. The Generating System must comply with all applicable requirements of the NER, ESCOSA's license conditions, AS/NZS 61000 series and SA Power Networks' Service and Installation Rules, including but not limited to:

1. Network voltage control;
2. Ramp rate;
3. Voltage fluctuations;
4. Harmonics; and
5. Voltage balance.

As part of any application to connect, SA Power Networks has undertaken the required Network studies to determine compliance or otherwise based on assigned power quality of supply limits.

8.1 Steady State Voltage

The following requirements apply when the Proponent is importing MW from the Network.

For low voltage connected Generating Systems, the voltage at the Connection Point should be maintained at 230/400V +10% to -6% as prescribed in SA Power Networks' Service & Installation Rules and Australian Standard AS 60038.

For high voltage connected Generating Systems, the voltage at the Connection Point should be maintained at ±10% nominal connection voltage as prescribed in the NER.

The Proponent must ensure that at all times during the operation of the proposed Generating Unit(s), the voltage levels within the installation are compatible with the installed electrical equipment.

Any inverters must also be equipped with all the power quality response modes as specified in AS 4777.2.

8.2 Reactive Capability

The following requirements apply when the Proponent is exporting MW to the Network.

The power factor compliance of the Proponent and the Generating System must be demonstrated by commissioning tests during all levels of operation.

Whilst generating electricity and connected to the Network, the Proponent must maintain at the Connection Point a power factor as specified in Section 4 which may be varied from time to time by SA Power Networks to suit ongoing Network requirements, taking into consideration the technical and reasonable limitations of the Generating System.

A satisfactory voltage profile must be maintained whilst the Generating System is operated and connected to the Network, with no delay between generation kW change and inverter VAr change to maintain power factor. The Proponent must be able to demonstrate that the proposed Generating System can and will comply with this requirement and the results must be confirmed by commissioning tests and long-term monitoring.

Any capacitive power factor correction units are to be isolated when the Generating System is net exporting unless specifically advised by the Proponent to be utilised as reactive power support and deemed suitable for application by SA Power Networks.

Inverter Power Quality Response Mode

In order to ensure control over real and reactive power contribution to the Network, the Proponent must ensure the South Australian power quality response mode has been set in the inverter(s) as per Table and Table below and must not be changed without written approval from SA Power Networks. These settings should be proven by test by the Proponent's contractor or installer.

Both power quality response mode settings must be enabled for inverters if a fixed power factor is not specified in Section 4. If a fixed power factor is specified in Section 4, only Volt-Watt is required to be enabled.

The South Australian power quality response modes are:

1. Volt-VAr response mode (AS/NZS 4777.2 Table 11) **(Mandatory)**
2. Volt-Watt response mode (AS/NZS 4777.2 Table 10) **(Mandatory)**

REFERENCE	VOLTAGE (eg 230/400V)	VAr % RATED VA
V_1 (Default)	90% Nominal Voltage (207V)	31% leading (sourcing VArs, 2.4%/V)
V_2(Default)	96% Nominal Voltage (220V)	0
V_3	108% Nominal Voltage (248V)	0
V_4	110% Nominal Voltage (253V)	44% lagging (sinking VArs, 8.8%/V)

Table 12: Mandatory Volt-VAr response mode

REFERENCE	VOLTAGE (eg 230/400V)	W % RATED VA
V_1 (Default)	90% Nominal Voltage (207V)	100% (Default)
V_2 (Default)	96% Nominal Voltage (220V)	100% (Default)
V_3 (Default)	109% Nominal Voltage (250V)	100% (Default)
V_4 (Default)	115% Nominal Voltage (265V)	20% (Default, 5.3%/V)

Table 13: Volt-Watt response mode

Note: $V_{nom\text{-}max}$ = 258 Volts

Note: If the Generating System does not operate as required at the specified power factor or if the Network voltage at the Proponent's Connection Point is unable to be managed within the required limits specified by SA Power Networks, then the Proponent may be required to provide additional reactive plant with an associated control system in order to provide a solution that delivers a compliant voltage at the Connection Point under all possible generation scenarios. Where such a condition exists, SA Power Networks reserves the right to limit the export capability of the Generating System via GDL set point control or permissive signalling (if available). The Proponent is to advise SA Power Networks accordingly and provide details of the proposed Generating System operation mode and any required supporting documentation for SA Power Networks review, a minimum of **three months** prior to project commissioning.

Additional Reactive Plant

Appropriately sized reactive plant, such as reactor banks or SVGs, may be required to mitigate any unacceptable voltage issues along the feeder arising from the Generating System. This plant is considered part of the Generating System.

The reactive plant must be set and operate to constant power factor control mode to maintain the specified power factor set point at the connection point.

The Proponent's control system must be capable of disconnecting reactive plant following a loss of mains supply from SA Power Networks. Failure to isolate reactive plant could result in voltages which prevent the Generating System from reconnecting upon restoration of supply from SA Power Networks.

For any protection trips or control commands that either isolate or limit generation output, the reactive plant must respond instantaneously, either by switching off or adjusting reactive load to maintain the specified power factor. This includes instantaneously responding to any constant or passing cloud cover that impacts on PV output.

For any planned or unplanned outages of the reactive plant, the Generating System must not operate until the reactive plant is back in service, unless explicitly detailed in Section 3 or Section 4. This failsafe is to be demonstrated during system commissioning.

The Proponent is to appropriately develop deadbands or hysteresis for the reactive plant operating thresholds to prevent frequent voltage changes due to the combination of generation intermittency.

8.3 Voltage Fluctuation and Flicker

The Proponent must ensure that voltage disturbances caused by the Generating System, the overall electrical installation or by any appliances, do not result in voltage disturbances to other Network users, greater than the limits prescribed in AS/NZS 61000, at the Point of Common Coupling.

8.4 Harmonics

The Proponent must ensure that the permissible harmonic limits associated at the Point of Common Coupling with the electrical installation do not exceed the values stated in Table .

VOLTAGE DISTORTION LIMITS (%) FOR VOLTAGE LEVELS LESS THAN 66KV	
Category	**Limit (%)**
Individual Odd Harmonics	1.33
Individual Even Harmonics	0.67
Total Harmonic Distortion	1.67

Table 14: Harmonic Limit Requirements

If SA Power Networks experiences any issues arising from the harmonic contribution from the existing installation's electrical equipment subsequent of the connection of the Generating System, the Proponent must undertake additional testing and rectify any non-conformance issues identified, to ensure compliance with the Network Connection Agreement, the requirements of this Engineering Report and the EDC.

8.5 Voltage Balance

The voltage unbalance at the Point of Common Coupling caused by the Proponent's electrical installation operate within the limits prescribed by the EDC must not be greater than the values stated in Table 8.

VOLTAGE UNBALANCE FACTOR (%) FOR THREE PHASE SUPPLIES		
Time Period	**Voltage Unbalance Factor (%)**	
	LV Connection Point	**HV Connection Point**
30 minutes average	2.0	1.3
10 minutes average	2.5	2.0
1 minute average	3.0	2.5

Table 8: Voltage Unbalance Requirements

8.6 Ramp Rate

The voltage change from various loading / unloading rates and its resulting impact on the Network voltage control systems forms part of SA Power Networks' feasibility assessment. To ensure that there is no adverse impact on the Network voltage control systems, the maximum allowable rate at which the Generating Units can be loaded and unloaded must not exceed the following limits:

- Any inverter Generating Unit – 16.67% of rated power per minute, as per the principles of AS 4777.2
- Any rotating Generating Unit – a maximum of 1,000kW per minute

In addition, when carrying a controlled shut down of any Generating System, the load on the Generating System should be reduced to a minimum before opening any of the Generating Unit's circuit breakers. The load transfer between the Generating System and the Network must be less than 1,000kW to avoid any impact on SA Power Networks' Network.

Compliance with these requirements must be able to be demonstrated and confirmed by commissioning tests.

8.7 Energy Storage System

An energy storage system (eg battery) which has the ability operate in parallel with the Network, regardless of whether charged directly from the Network or through energy produced from a local generation source is considered part of the Generating System.

When an energy storage system has the ability to charge from the Network, the proposed system may be subject to limits on the time and/or rate at which it may charge, and a constraint may also be applied on the amount and/or rate of energy discharged back into the Network.

Switches to isolate the energy storage system from the main switchboard shall be clearly identified and accessible.

Inverter energy storage system which operate in parallel with the Network shall be compliant with IEEE1547 and the principles of AS4777.2:2015.

9. Remote Monitoring and Control Requirements

Remote monitoring and control will be required in cases where the combined generation capacity represents a significant portion of the total area load (typically export of 200kW or more), a credible Network constraint has been identified or where deemed necessary by SA Power Networks.

To facilitate the remote control and monitoring of the Proponent's Generating System, SA Power Networks will undertake the required modifications to its existing SCADA network to transmit and receive relevant status and monitoring signals from the Generating System.

SCADA control and monitoring of the Proponent's equipment and Generating Units will be achieved through a serial RS232 interface using Modbus RTU protocol between SA Power Networks and the Proponent's proposed Generating System at the facility. The Proponent is to provide a serial interface for the SCADA information, based on the Modbus protocol in order to be compatible with SA Power Networks SCADA.

SA Power Networks will provide SCADA monitoring and communications facilities to allow the connection of the Generating System. It is the Proponent's responsibility to provide all of the SCADA input/output required between the Generating System and SA Power Networks' SCADA interface point unless agreed otherwise.

Prior to beginning SA Power Networks' SCADA works on site, the Proponent's PLC must be brought to SA Power Networks' nominated offices for factory acceptance testing and confirmation that the PLC communicates correctly with SA Power Networks' equipment. The PLC for SA Power Networks to wire to must be located in the Proponent's control room.

Prior to final site commissioning the control system will need to be made available to SA Power Networks for user acceptance testing (UAT).

9.1 Interface Signals

The I/O requirements, shall include, but not necessarily be limited to the following:

Digital Inputs to SA Power Networks

Generating System connection status, which indicates that at least one Generating Unit is connected in parallel to the Network. This signal can also be used as permission to connect/denied feedback, and may require explicit status of all circuit breakers between the Generating Unit(s) and Connection Point(s) to indicate the configuration of the Proponent's internal plant.

All available AC, DC and communication alarms are required. These signals indicate if the DC Supply bus has failed, the secondary system's battery charger station has failed, if a mains AC fail has been detected, if any SCADA or protection communication have failed, or if permission to connect/denied or inter-trip protection has been received.

Digital Outputs from SA Power Networks

In addition to permission to connect/denied, SA Power Networks may send a Heartbeat (a variable which is toggled on/off by SA Power Networks' RTU to indicate active communication with the Proponent's control system.

Analogue Inputs to SA Power Networks

SA Power Networks expects to receive total Generating System metering, including 3-phase volts (at the main bus and Generating System), 3-phase Amps, kW, kVAr of the Generating System (gross output) and Connection Point(s) (net output).

When the site is supplied at high voltage, metering class VTs and CTs are to be used.

Analogue Outputs from SA Power Networks

SA Power Networks may issue a Generator Dispatch Limiter set point, power factor set point at the Connection Point, Net Export Limiter at the Connection Point, and Energy Storage System dis/charge rate limiter set points. The control signals from the Proponent to SA Power Networks are required to feedback the real-time operation of the Generating System in response to these set points.

Generating System gross metering (kW/kVAr) shall be configured as positive while generating and negative while absorbing load. Net metering (where applicable) shall be positive while absorbing load and negative while exporting.

9.2 Explanation of Signals

9.2.1 Generation Dispatch Limiter

A Generation Dispatch Limiter (GDL) control system must be provided to control the proposed Generating System's real power output. The GDL is required in order to enable SA Power Networks to meet our obligations regarding quality of supply for other Network users. The GDL control system required by SA Power Networks will consist of a control signal that will be initiated manually via SA Power Networks' NOC and transmitted to the Generating System via the SCADA Control.

The GDL will provide an analogue signal providing the set point, which will normally be set at the rated capacity of the Network connection. However, subject to Network conditions, the GDL set point may be altered to constrain the Generating System's output between 0MW and the rated capacity of the Generation System to suit the Network or AEMO dispatch requirements.

The final interface requirements will be developed to suit actual final connection arrangements.

9.2.2 Net Export Limiter

The 'Net Export Limiter' control system will be provided to enable SA Power Networks to control the export at the Connection Point of the proposed Generating System's real power output. The Net Export Limiter will consist of a control signal that will be initiated manually via SA Power Networks' NOC and transmitted to the Generating System via the SCADA Control to constrain the net site export at the Connection Point to suit the Network requirements (eg abnormality on the Network).

9.2.3 Permissive Signalling

Permissive signalling provides a method for SA Power Networks to indicate those times when a Generating System may or may not connect to and operate in parallel with the Network. The permissive signalling scheme is in addition to other SA Power Networks' Generating System protection requirements.

Where a permissive signalling scheme has been deemed necessary, SA Power Networks will, at the Proponent's expense, install a communication link between the Generating System and the relevant SA Power Networks' substation. Alternatively, the Proponent may provide this communication link according to SA Power Networks' specification. Under some circumstances, depending on the

location and connection voltage, SA Power Networks may require diversity or duplication of these communications links.

SA Power Networks will provide the permissive signalling signal to an agreed interface panel installed at an agreed location on the Proponent's site. On receipt of a 'permission denied' signal it will be the responsibility of the Proponent to ramp down the Generating Units before tripping the Generating Unit's circuit breakers. The permissive signalling signal from the interface panel to the Generating Unit's circuit breakers, including the communications link, must be of fail-safe design. The Proponent must also include shut down of the Generating System, if DC supply to the scheme is lost.

The minimum accepted operating requirements that the Generating System must achieve when a 'permission denied' is received is as follows.

OPERATION	REQUIREMENT
Ramp down	All Generating Units shall ramp down in accordance with the principles of AS/NZS 4777.2; 0MW output must be achieved in 360 seconds.
Disconnection	All rotating Generating Units must be disconnected from the Network in 360 seconds.
Permission Granted	All Generating Units shall have 'Soft Ramp Up after Connect or Reconnect Mode' in accordance with the principles of AS/NZS 4777.2

Table 9. Permission Denied Operation Requirements

9.2.4 Power Factor Setpoint

In order to suit the Network requirements, SA Power Networks may vary the Generating System's power factor set point, taking into consideration the technical and reasonable limitations of the inverter. The required power factor will be applied automatically via the power factor set point control.

9.2.5 Dis/Charge Rate Limiter

When an energy storage system has the ability to charge from the Network, the proposed energy storage system may be subject to limits on the time and/or rate at which it may charge, and a constraint may also be applied on the amount and/or rate of energy discharged back into the Network.

9.3 ADMS Runback Scheme

Where a credible Network constraint has been identified, SA Power Networks will undertake the required modifications to automatically runback the export of the Generating System until the Network constraint has been lifted.

9.4 Maximum Export Capacity Control System

When the maximum export output to the Network is less than the nameplate capacity of the Generating System, the Proponent must use the 'Energy Meter' and Controller to limit the export output for each Connection Point if a minimum import protection scheme is not specified.

The **ComAp InteliMains switchgear** will take readings of incoming grid supply on site, standby diesel Generating Unit and bus bar. It will send signals to BESS controller and gen-

set controller for syncing. The ComAp InteliMains switchgear controller will also control the mains and generator circuit breaker.

The **ComAp Intelisys microgrid controller** (located within the Hybrid System Board) monitors the power import/export from/to grid via the ComAp InteliMains switchgear controller. It is connected to all inverters on site and controls their power output dynamically based on the grid reading.

The **ComAp InteliPro protection relay** will take readings from the ComAp InteliSys microgrid controller.

The system will utilise IEC 104 Ethernet communication lines.

SA Power Networks is open to any other methods that can control the maximum export output. The proposed protection design settings must be submitted to SA Power Networks for review and approval **three months** prior to project commissioning.

9.5 SCADA Communication Failsafe Operation

SA Power Networks proposes to have two modes of communications failsafe operation:

	COMMUNICATIONS FAILURE	OPERATION
1	Failure of the SCADA communication link between the SA Power Networks' RTU and upstream Master Station communication link.	SA Power Networks' RTU will send a failsafe signal to the Proponent RTU upon waiting a pre-configured time interval (15–45 minutes) for communications to return (to prevent nuisance fail safe activation).
2	Failure of the SCADA communications link between the SAPN RTU and the Proponent's controller for more than 60 seconds (the Modbus communication link).	Proponent's site controller must ramp to a GDL of 0kW and rotating Generating Units must disconnect from the Network, for which SA Power Networks will not be responsible for any losses (direct or indirect) incurred by the Proponent.

Table 10: Communication Failsafe Operation

The failsafe signal will be the action when planned transfer to abnormal feeder in section 4. When this is not specified, inverter-only Generating Systems will be issued a GDL 0, and Generating Systems with rotating Generating Units will be issued a 'permission denied'.

9.6 Revenue Metering

The installation of revenue metering must comply with the requirements of the NER, SA Power Networks' Service and Installation Rules and any other specific requirements of the Proponent's Retailer.

10. Compliance, Commissioning and Operation Requirement

10.1 Code Compliance

The general installation must comply with the relevant Australian Standards, including AS 3000, AS 3010.1 (Diesel Generating Units/internal combustion engines), AS 4777, EDC and SA Power Networks' Service and Installation Rules. All other relevant government and statutory requirements must be adhered to, such as the Technical Regulations under the Electricity Act 1996, Electricity (General) Regulations 2012 and WHS Regulations 2012.

The proposed installation at the Proponents site must comply with the following Standards, Codes, Regulations and SA Power Networks' Guidelines:

- Essential Services Commission of South Australia (ESCOSA) EDC;
- SA Power Networks' Service and Installation Rules;
- SA Power Networks' Proponent Guide to Large Embedded Generation Network Connections;
- SA Power Networks Technical Standards: TS-130 for Low Voltage EG Connections above 30kVA Technical Requirements or TS-131 for High Voltage EG and Any Size Rotating Generating System Connection Technical Requirements;
- SA Power Networks' NICC 270 Proponent Guide for Connecting Large Embedded Generation;
- National Electricity Rules (NER), where applicable;
- Applicable Australian Standards; and
- This Engineering Report.

As the Generating System has a nameplate capacity greater than 100kVA, an Essential Services Commission of South Australia (ESCOSA) Electricity Generation License (or Exemption) must be obtained from ESCOSA. Please note that ESCOSA and the Office of the Technical Regulator (OTR) have implemented significant new changes to licence conditions and Development Application Commission approval conditions respectively, applying to electricity generators in South Australia. The changes are based on technical advice provided by the Australian Energy Market Operator (AEMO) and these are aimed at promoting the resilience and security of the South Australian power system. The onus is on the Proponent to obtain this license or exemption prior to connection of the Generating System to SA Power Networks' Network. Any plant required to comply with the OTR's development approval requirements are unknown to SA Power Networks and should be specified by the Proponent prior to connection and will require revision of this Engineering Report.

10.2 Commissioning Plan

The Proponent must submit a commissioning plan to SA Power Networks at least **20 Business Days** prior to the commencement of commissioning. This is required to allow for a review of the proposed commissioning plan and to support the scheduling of resources required to attend and witness the commissioning tests.

SA Power Networks will review the nature and relative timing of the proposed Generating System's commissioning tests with respect to the impact on other Proponents and coordination with other Network outages and will advise accordingly.

The commissioning plan is to be divided into 'Part A: Pre-connection off-line testing', 'Part B: Compliance testing' and 'Part C: On-line commissioning'.

The Proponent's commissioning plan is to be of sufficient detail to allow SA Power Networks to understand the following:

- Those elements of the Generating System proposed to be tested;
- For each element of the Generating System to be tested, the specific steps that the Proponent proposes to test this element;
- The proposed timeframe for testing and commissioning; and
- Pass/ Fail criteria for each test, including any settings/values that are to be verified.

10.3 Commissioning and Testing of the Generating System

Prior to the connection of the Generating System to the Network, an SA Power Networks connection officer will be required to attend site to verify and sign off the installation's compliance with the Service and Installation Rules.

Once the installation is verified to be compliant with the Service and Installation Rules, an SA Power Networks representative will attend site to witness commission the Generating System to verify operation of the protection and control schemes are compliant with the requirements of this Engineering Report, applicable standards and regulations.

As part of the site witnessing of commissioning, the Proponent will conduct commissioning tests to demonstrate compliance of the Generating System and Network connection with the requirements of this Engineering Report and the submitted protection and control systems. The Proponent's commissioning program and tests shall include all relevant tests to confirm the Generating System's compliance with the quality of supply requirements as specified by the Electricity Distribution Code and any issues identified within this Report.

The Generating System will not be permitted to connect to the Network until SA Power Networks' representatives have signed off the installation to be compliant with the requirements of this Engineering Report, applicable standards, regulations and the Service and Installation Rules.

The Proponent will provide a copy of the commissioning test results including a report stating the compliance or otherwise with the requirements of this Engineering Report, to SA Power Networks for review within **20 Business Days** of undertaking the commissioning tests.

10.3.1 Part A: Pre-Connection Off-Line Testing

This part is to ensure the Generating System is tested to prove that the equipment that has been installed is operating correctly under test conditions. For new high voltage supply (greenfield) sites, the injection testing for incoming circuit breakers and the earth grid testing will be managed by SA Power Networks' connection officers and our Project Manager. It is not anticipated that any other pre-connection off-line generator control element testing will be required.

The Proponent is to submit the following documents to SA Power Networks at least **five Business Days** prior to the date of SA Power Networks' compliance witnessing:

- A copy of Electrical Certificate of Compliance for the Generating System;
- Any other applicable off-line testing records as per Section 10.1.1;
- Protection test results for the protection relays, from a suitably qualified protection commissioning officer;
- Written statement from a competent protection technician certifying that the Generating System is installed and will operate as per the requirements of this Engineering Report; and

- Serial numbers of all Generating Units, protection and control devices.

10.3.2 Part B: Compliance Testing

These tests are to demonstrate that the Generating System meets the requirements of this Engineering Report before connection to SA Power Networks' Network. The extent of compliance testing will vary depending on the generation capacity and connection configuration, but may include:

1. **Injection testing:** Simulation of system events by applying test signals to the Proponent's protection and control systems and confirming the correct response of the Generating System's control system; or

2. **Controlled testing**: Controlled testing of the protection and control systems by manipulating relevant settings and confirming the correct response of the Generating System's relevant circuit breakers or isolation facilities.

Table provides an indication of the compliance tests that may be required for given protection and control elements. Where tests are nominated as required by both injection testing and controlled testing, compliance can be undertaken based on either test method or a combination of both.

Compliance Requirements	Injection Test	Controlled Test
Directional Power (if applicable)	Yes	Yes
Inhibits/Interlocks	No	Yes
Under/Over Frequency	Yes	Yes
Under/Over Voltage	Yes	Yes
ROCOF	Yes	No
Earth Fault	Yes	No
Voltage Unbalance	Yes	No
Synchronisation	Yes	Yes
Inter-tripping (if applicable)	No	Yes
Circuit Breaker Fail (if applicable)	No	Yes

Table 18: Compliance Requirements

10.3.3 Part C: On-Line Commissioning

These tests are to demonstrate that the Generating System meets the requirements of this Engineering Report after connection to SA Power Networks' Network.

Table provides indication of the post connection online tests that may be required for given performance standards.

Post Connection	Test
Reactive Power Capability	Yes
Export Limiting	Yes
Quality of Supply	Yes
SCADA Reading	Yes
Synchronisation	Yes
Generation Dispatch Limiter	Yes
Ramp Rate	Yes

Table 19: Post Connection Requirements

Commissioning of the Generating System whilst connected to the Network must not commence until the protection scheme has been fully tested by a competent protection technician.

The Proponent is to demonstrate that the settings within the Generating System and the associated protection device cannot be changed without agreement by SA Power Networks. The Proponent is to arrange for the installation of appropriate warning signage on the switchboard(s) to clearly indicate the actual type of generation source installed, and other details if applicable (eg multiple supplies, circuits affected by these supplies) and a warning stating all settings are not to be adjusted without approval by SA Power Networks.

Upon the post connection online tests being successfully witnessed by SA Power Networks, power quality measurement data (voltage level, harmonics, flicker and voltage balance at a 10-min average) for a minimum of 7 days, with at least 2 of those 7 days of logging undertaken while the Generating System is not operating. The Proponent's power quality log is to be provided in a format suitable to SA Power Networks (ie Excel with corresponding graphs) as an attachment to the commissioning report. Data logging must be undertaken as close as possible to the Proponent's Connection Point(s).

If the most practical location for undertaking the commissioning tests is the low voltage main switchboard, the results at the high voltage Point of Common Coupling may be inferred from the low voltage test results.

10.4 Operating Protocols and Procedures

The Proponent must ensure that an authorised person is available at all times whilst generating to receive communications from SA Power Networks' NOC, so that emergencies requiring urgent attention can be addressed adequately.

The onus of ensuring the operating conditions are up to date rests with Proponent. If SA Power Networks attempts to contact the nominated contacts contained within the job and it is unable to do so, SA Power Networks reserves the right to issue A 'permission denied' signal without notice, to manage the Network at any time.

Additional Operating Protocol Requirements (When inter-trip Interface Signals are Required)

When inter-trip interface signals are a requirement, SA Power Networks in consultation with Proponent will develop and agree on the proposed operating protocols prior to commissioning of the Generating System.
The operating protocols will generally address the following:

- SA Power Networks / Proponent's asset interface definition;
- SA Power Networks / Proponent's liaison responsibility and communication;
- Both parties' obligations & operations under emergency and fault conditions;
- High voltage switching procedures;
- Maintenance and access arrangements; and
- Plant capability and limitations.

SA Power Networks will provide to the Proponent its model operating protocols document for export Generating Systems for modification and submission by the Proponent.

The Proponent must develop its internal operating procedures to cover the initial connection to the Network, pre-commissioning and commissioning of the Generating System as well as its ongoing operation and maintenance activities associated with the connection.

Prior to final connection of Generating System, the normal operational procedures must have been developed and adopted for the day to day operation. The procedures must complement the operating protocols to be developed by SA Power Networks. Similarly, visibility of the Generating System must be available to SA Power Networks' NOC via SCADA.

The requirement for operating protocols and procedures are to ensure that the Generating System does not introduce safety hazards to SA Power Networks' personnel or Network.

The protocols and procedures shall set out the operating interfaces between SA Power Networks' NOC and the Proponent, having regard to the safe and efficient operation of the Network in compliance with the NER and ESCOSA's Electricity Distribution Code.

The operating procedures are to be designed to protect the Network and to maximise the Proponent's access to and use of the Network within the agreed limits. The operating procedures and protocols will need to include, amongst other things:

- details of the operating procedures and nomenclature standards to be adopted in relation to the interface between SA Power Networks' NOC and the Proponent;
- details of the procedures to be adopted by both parties in relation to the NOC oversight, monitoring, control and operation of the Network and Generating System access to said Network;
- contact details for both parties' authorised persons available on a 24 hour, 7 days a week basis;
- Permission to Connect / Denied procedures; and
- High voltage and Isolation switching procedures.

The agreed operating procedures once developed, will need to consider the existing operating procedures used by SA Power Networks' NOC for the operation of the entire Network.

The operating procedures must be considered as an active document in so far as the procedures may need to be reviewed and revised from time to time as both technology and circumstances require.

10.5 Compliance Monitoring and Maintenance

The Proponent must develop and submit to SA Power Networks a compliance monitoring program, including an agreed method by which the Generating System's ongoing compliance with the requirements in this Engineering Report, applicable standards and regulations and continued operation are in accordance with good engineering practice and can be demonstrated. This must be submitted to SA Power Networks for review **five Business Days** prior to the date of commissioning and connection of the Generating System to the Network.

Where SA Power Networks requires alteration to the provided compliance monitoring program, SA Power Networks reserves the right to deny Network connection or apply a 'permission denied' signal to the Generating System until an appropriate program is in

place. SA Power Networks will not be liable for any losses (direct or indirect) incurred by the Proponent in issuing any such permissive signalling.

The compliance monitoring program must include:

- Proposed methods and test procedures by which the Proponent can demonstrate ongoing compliance of the Generating System with this Engineering Report; and
- Proposed periodic testing times to confirm ongoing compliance with each applicable requirement in this Engineering Report. The frequency of testing shall be once every three years, or after any internal disturbance event and any plant change at the Proponent's site. This is subject to change upon review by SA Power Networks.

In respect of the ongoing operation of the Generating System, the Proponent must maintain the Generating System protection and control systems as well as any other service provided by the Proponent regarding the Generating System that impacts on the Generating System, its safety or operation, or the safety and operation of the Network.

In accordance to the agreed compliance monitoring program, the Proponent must arrange for periodic testing of the protection system to ensure it continues to function as designed. The Proponent will make available a copy of the agreed compliance monitoring program to SA Power Networks and resultant test results as and when required.

The cost of such compliance testing and maintenance shall be borne by the Proponent.

Where such compliance testing is not conducted by the Proponent in accordance with the agreed compliance monitoring program, SA Power Networks reserves the right to issue a 'permission denied' signal preventing operation of the Generating System until the relevant testing is conducted and the performance of the relevant system(s) are proven to the satisfaction of SA Power Networks. Where SA Power Networks exercises such rights, the Proponent shall have no right of claim against SA Power Networks for any loss of revenue.

10.6 Network Connection Agreement

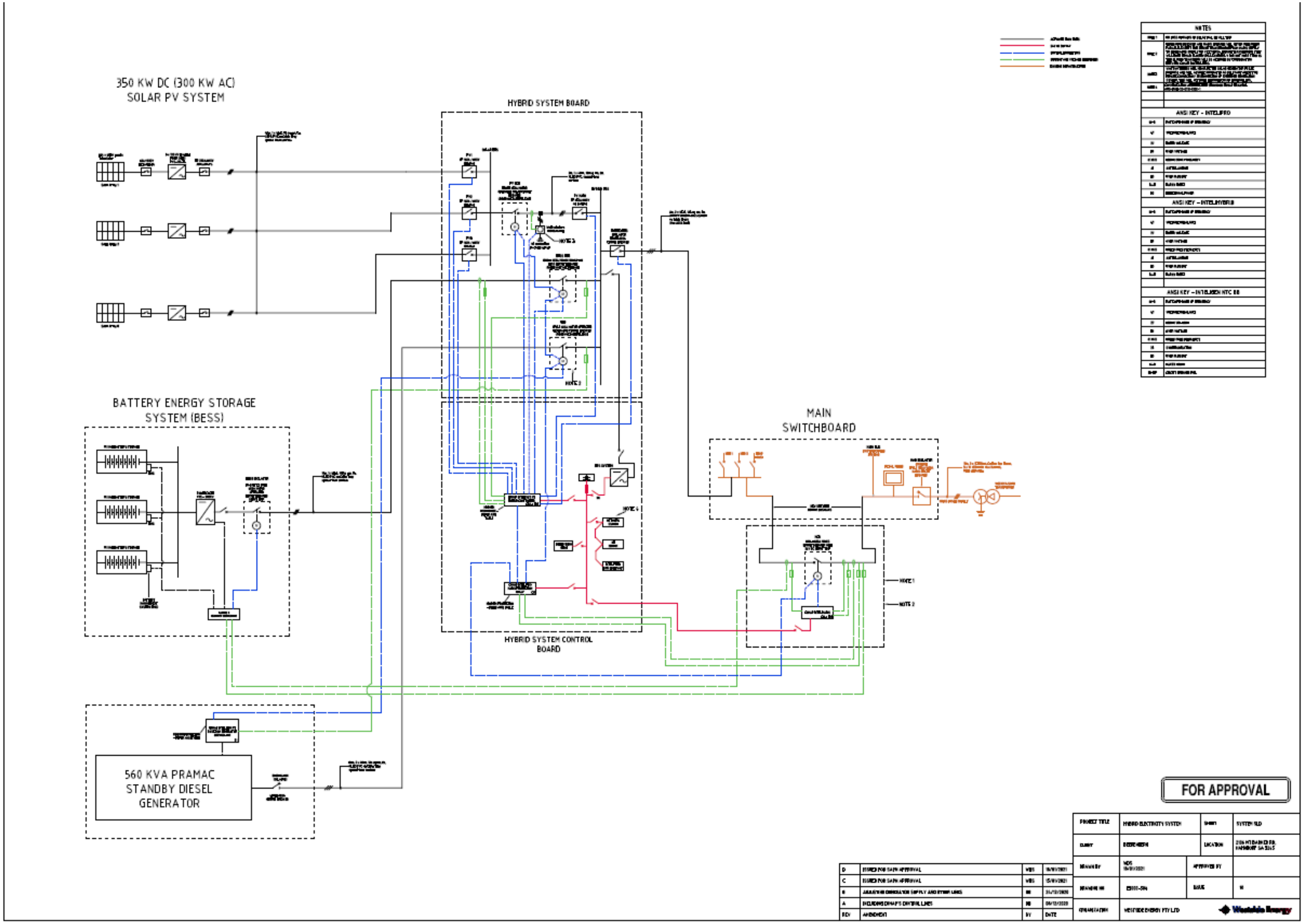
The Proponent must enter into an individual Network Connection Agreement with SA Power Networks. The Connection Agreement will encompass both the technical and commercial aspects of the connection, address the Standards and minimum technical requirements and specify the terms, conditions and quality of supply requirements in accordance with the relevant Codes and this report.

The agreement also requires the Proponent to indemnify SA Power Networks against any liability resulting from its use of the Network in a manner prejudicial to the safety and efficiency of the Network.

11. Appendices

Appendix A: Beerenberg Pty Ltd Hahndorf Single Line Diagram
Appendix B: Beerenberg Pty Ltd Hahndorf Site Layout

Appendix A: Beerenberg Pty Ltd Hahndorf Single Line Diagram



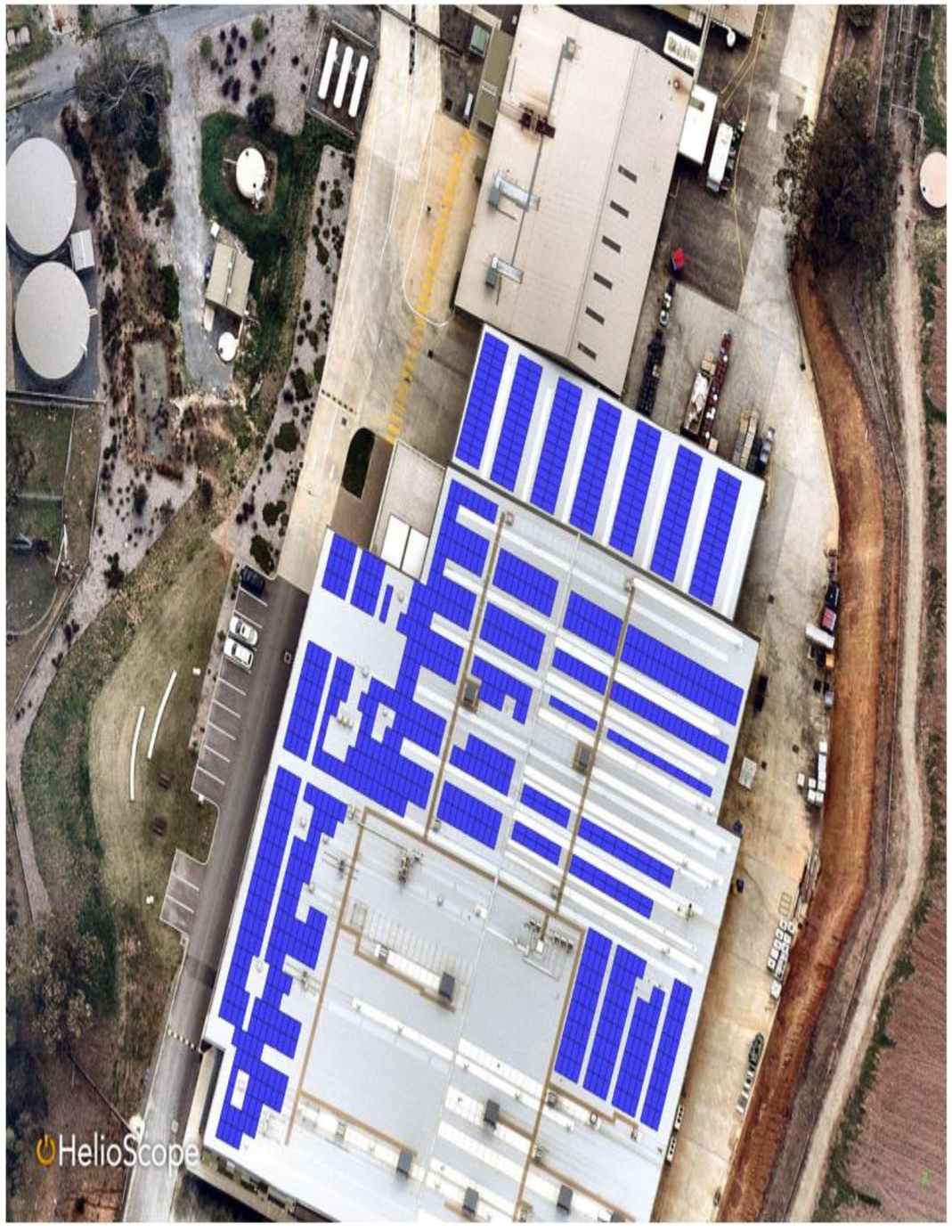
ISSUE:B

Appendix B: Beerenberg Pty Ltd Hahndorf Site Layout

SITE LAYOUT

- Site Boundary
- SAPN Transformer
- Site Main Switchboard
- Battery Inverter Location
- PV Inverter Location

SOLAR SYSTEM LAYOUT



Electrical infrastructure plan

- Battery Energy Storage System Location
- Diesel Generator (with integrated fuel tank) Location
- Inverters Location on southern wall of Factory 2
- Standby/Network Board in Old Air Compressor room