Beerenberg Pty Ltd
Hybrid Energy System –
SAPN Witnessing Plan

Westside Energy (SA) Pty Ltd
ABN 15 617 819 271

13 October 2021

Document No: 5000-PLN-001 Revision No: 5

Westside Group

Contents

Purpose

The purpose of this document is to outline the SAPN Witnessing that is required to connect the Beerenberg Hybrid Energy System to the SAPN grid. This document has been compiled in accordance with the following documents:

- Beerenberg Pty Ltd Generating System Connection - Engineering Report (NC-015175) Issue B
- SAPN Customer Settings Approval – NC15175 REV B - dated 23rd September, 2021
- Beerenberg Hybrid Energy System – Operating Philosophy (ComAp) - AUS-ENG-OP-20-0110-0001 Rev C
- SLD Drawing: AUS-DWG-20-0110-0301 RevD Protection SLD - dated 17 September-2021

Document Control

Revision	Date	Description	Issued by	Approved
1	2021-04-08	First issue as DRAFT	S. Moules	J. Goldsworthy
2	2021-04-30	Issued to SAPN for Witnessing	S. Moules	J. Goldsworthy
3	2021-05-24	Final SAPN Comments	S. Moules	J. Goldsworthy
4	2021-09-10	Revised based on SAPN Witnessing comments	P. Smith	J. Goldsworthy
5	2021-10-13	Revised based on SAPN Review 24-09-21	P. Smith	J. Goldsworthy

Abbreviations & Definitions

- AI Analogue Input
- AO Analogue Output
- ACB Air Circuit Breaker
- BESS Battery Energy Storage System
- BHES Beerenberg Hybrid Energy System
- BI Binary Input
- BO Binary Output
- BOC Breaker Open and Cool Down (Alarm type)
- BTB Bus Tie Breaker
- CAN1 CANBUS for ComAp extension modules and genset ECUs
- CAN2 CANBUS communications between ComAp controllers
- CHEMS ComAp Hybrid Energy Management System
- Del Delay timer in seconds (s)
- EXP Export (to mains)
- FCAS Frequency Control Ancillary Services
- FPA Fraser's Property Australia
- GCB Generator Circuit Breaker
- GA General Arrangement
- GCP Generator Control Panel

- GPCB Grid Protection Control Board
- GPD Grid Protection Device
- HESB Hybrid Energy System Board
- HMI Human Machine Interface
- HLI High Level Interface
- HSCB Hybrid System Control Board
- IMP Import (from mains)
- IV12T ComAp InteliVision 12” Touchscreen HMI
- IP Internet Protocol
- LCB Load Control Breaker
- LOM Loss of Mains
- MCB Mains Circuit Breaker
- MCCB Moulded Case Circuit Breaker
- MGCB Master Generator Circuit Breaker
- MOC Motor Operator Open Coil
- MPPT Maximum Power Point Tracker
- MSB Main Switch Board
- NEM National Electricity Market
- P Real power in kilo-watt (kW)
- PELS Pre-Emptive Load Shedding
- PV Photovoltaics (in context of solar power system)
- Q Reactive power in kilo-volt-ampere-reactive (kVAr)
- RTU Remote Terminal Unit
- RU Real Utilities
- SD Shut Down (Alarm type - engine stops immediately)
- SCADA Supervisory Control And Data Acquisition
- SHT Shunt Trip Coil
- SLD Single Line Diagram
- SP Setpoint (user defined)
- SPD Service Protection Device
- TBC To Be Confirmed
- TCP Transmission Control Protocol
- UFLS Under-Frequency Load Shedding
- UVT Undervoltage Release Trip Coil
- VF Voltage-Frequency

Project Information

Stakeholders

Owner	Beerenberg Pty Ltd
Owner's Representative	Louis Mavropoulos
Owner's Engineer	2XE Pty Ltd
Owner's Engineering Representative	Anna Pfarr
Main Contractor	Westside Energy (SA) Pty Ltd
Main Contractor's Representative	Peter Smith
Controls Contractor	ComAp Controls Pty Ltd
Controls Contractor's Representative	Barnaby Simpson

General

Engineering -Report Number	NC-015175
Engineering Report Revision	Rev B
Site Address	2106 Mount Barker Road, Hahndorf, SA, 5245
Total Solar PV Approved Capacity	300 kVA (AC), 350 kVA (DC)
Total Battery Approved Capacity	250 kVA (AC)
Total Combined Synchronous Approved Capacity	550 kVA (AC)
Connection Point Power Factor	0.95
Operating Philosophy	Import Control/Export Control
Maximum Export	199 kW (AC)
Minimum Import	-
Nominal Voltage	240 V
Responsible Qualified Person	Corey Evans PGE 289810
Installer Accreditation Number	ELECTRICAL (PGE): 291719 SOLAR (CEC): A9548718
Installed Date	30/08/2021
Witnessing Date	30 / 10 /2021
Site Contact Name	Peter Smith (Westside)
Site Contact Mobile Phone Number	0457 733 140

NMI 1	SAAAAAB7837
Solar PV Approved Capacity	300 kVA (AC), 350 kVA (DC)
Battery Approved Capacity	250 kVA (AC)
Synchronous Approved Capacity	0 kVA (AC)
NMI1 Power Factor	0.95
Maximum Export	199 kW (AC)
Minimum Import	-

SAPN Site Information

Logger Number	
Logger IP Address	
Order Number	
Transformer Number(s)	
Commissioning Officer	
Site Number	

The Beerenberg Hybrid Energy System (the System) consists of the following components:

- Roof mounted solar PV system connected to the system via 3 x string inverters;
- Battery Energy Storage System (BESS) consisting of two cabinets (1 for the battery modules, 1 for the inverters and control systems);
- Diesel genset; and,
- Electrical and control switchboards including an extension to the Main Switchboard (MSB) and a new Hybrid Switchboard (HSB).

The system is connected to the grid via a SAPN pad-mounted transformer located on-site. All components of the hybrid energy system (including the connection point) are behind Beerenberg security meaning that access is only granted to authorized visitors to the site.

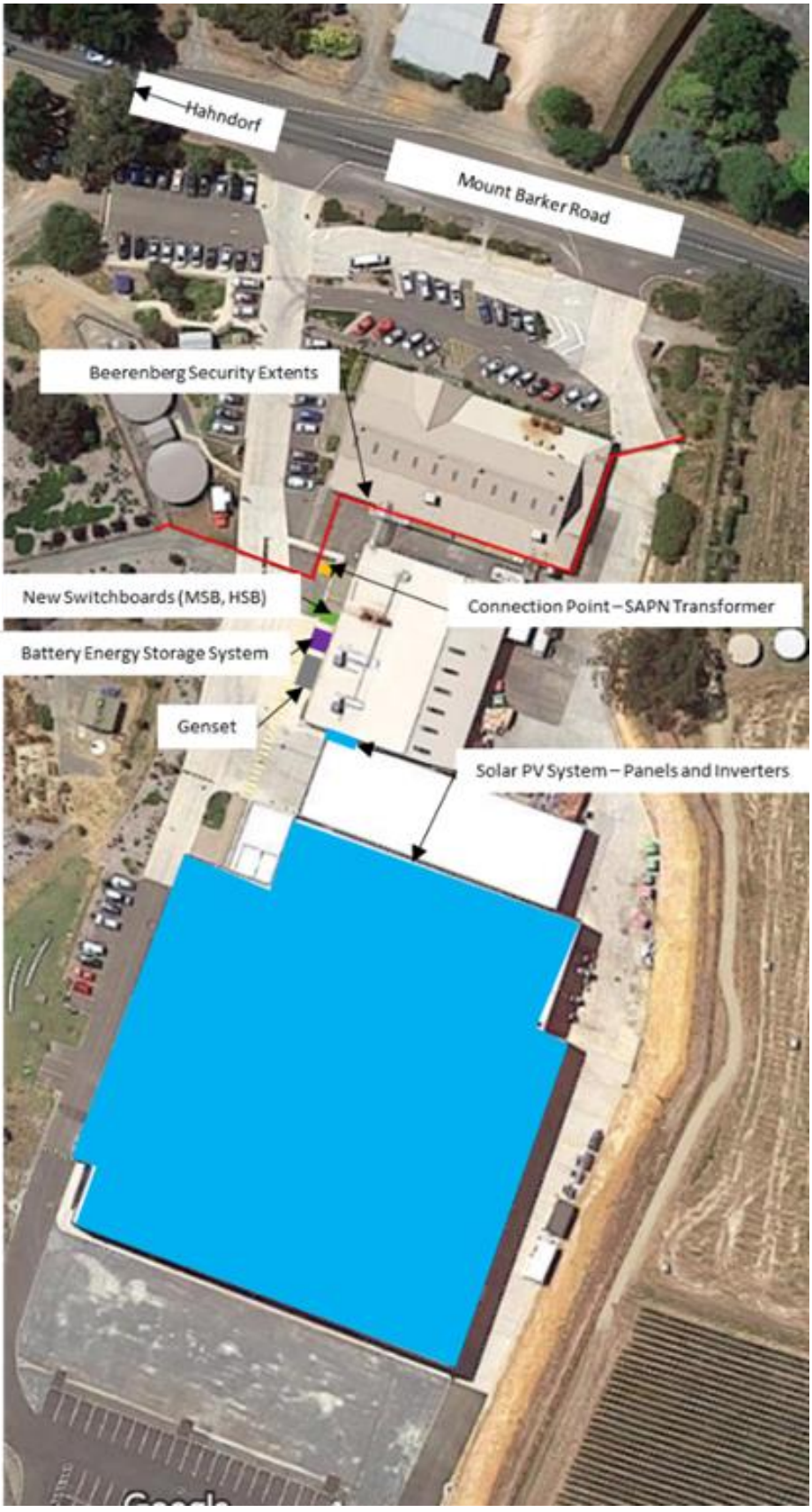
The generation capacity of the system is as follows:

- Solar PV System – PV
    - 349.92 kW DC: 864 x 405 w Trina Tallmax TSM-DE15M(II) roof-mounted solar panels
    - 300 kW AC: 3 x 100 kVa FIMER-ABB PVS-100-TL Solar PV Inverters
- Battery Energy Storage System – BESS
    - 273 kWh storage: 3 x 91 kWh LG-Chem battery cabinets (Rak Model R800, cell model JH3)
    - 250 kVa capacity: 1 x PowerTech 250 kVA VACON NXA04605 inverter)
- Diesel Genset – GEN
    - 560 kVa Pramac standby diesel generator

Key components of the system are described as follows:

- Main Switchboard - **MSB**
- Grid Protection Control Board - **GPCB**
- Hybrid Energy System Board – **HESB**
- Hybrid System Control Board – **HSCB** (Controls Section of the HESB)

Site Layout


Hahndorf
Mount Barker Road
Beerenberg Security Extents
New Switchboards (MSB, HSB)
Connection Point – SAPN Transformer
Battery Energy Storage System
Genset
Solar PV System – Panels and Inverters

Functional Description

The system is designed to operate in the following manner:

- **During Normal Grid Conditions (Grid Parallel Operation)**
  Demand is met by a combination of the solar PV system and the grid to a maximum grid demand. If site requirements exceed the maximum grid demand, the additional demand is absorbed by discharging the BESS. If the site demand is greater than the solar + BESS + maximum grid demand, the site is islanded and the site demand will be met a combination of the Solar PV, BESS and genset. The BESS will be charged by a combination of excess Solar PV and from the grid during off-peak energy times.

- **Grid Outage (Island Operation)**
  The system will sense a grid outage and site demand will be initially by the solar PV and the BESS (acting as a UPS). The site will be islanded and the genset will start. Once the genset is running, the site demand will be met by the Solar PV, BESS and genset. Once the grid returns, the genset will stop and operation will return to the Normal Grid Operations.

Additional details on the function of the system are outlined in the Operating Philosophy. The primary controllers of the system are characterized in the following table.

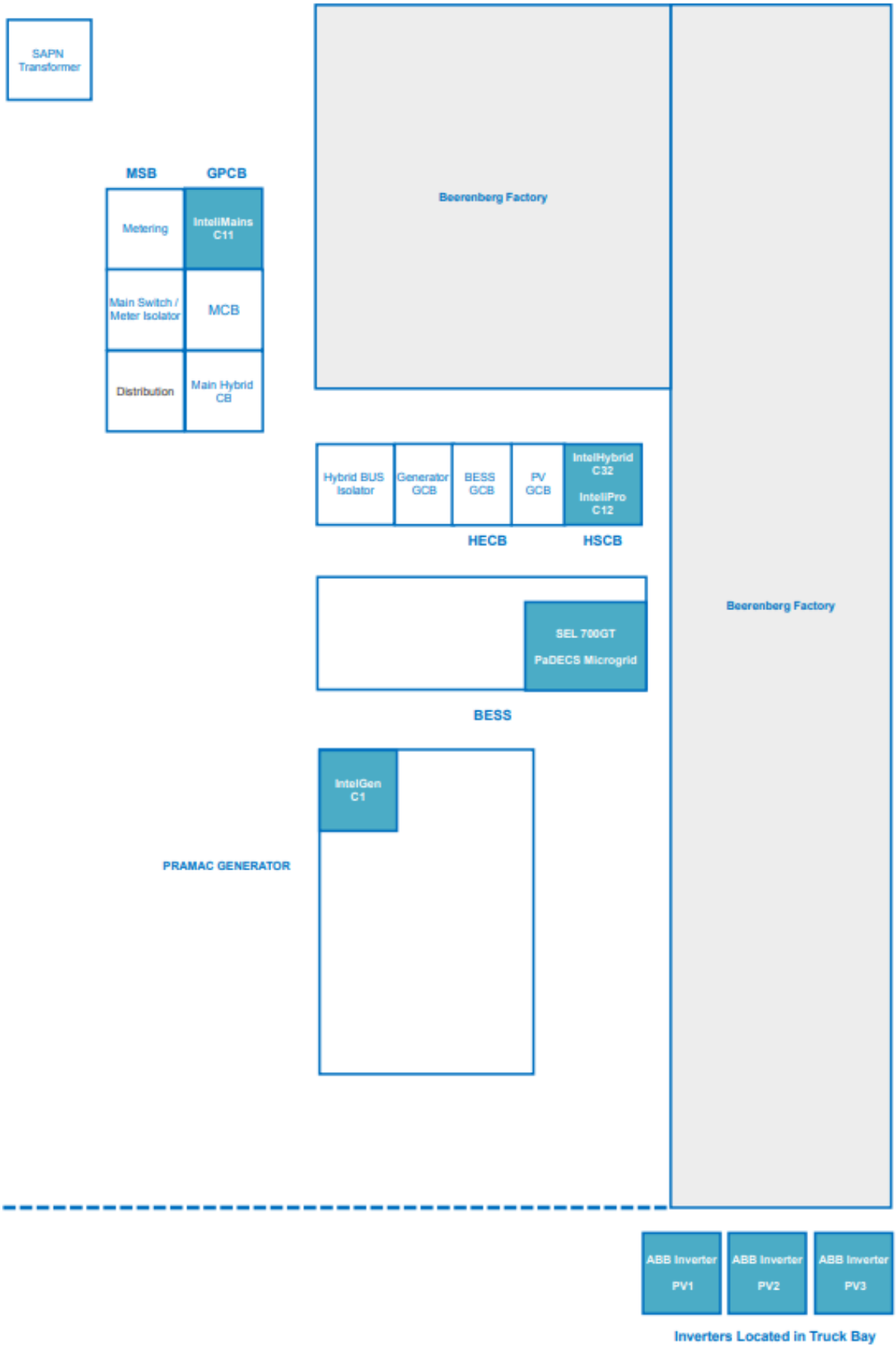
Controller	Manufacturer	Location
InteliMains	ComAp	GPCB
InteliPro	ComAp	HESB / HSCB
InteliGen	ComAp	Genset
InteliHybrid	ComAp	HESB / HSCB
PaDECS Microgrid	PowerTech	BESS Cabinet
SEL 700GT	PowerTech	BESS Cabinet

Communications are performed via CANBUS and MODBUS connections. Details of the communications are included in the Operating Philosophy.

SYSTEM COMPONENT	PRIMARY			SECONDARY / CENTRAL		
	BY	TRIPS	TRIP CIRCUIT	BY	TRIPS	TRIP CIRCUIT
SOLAR	SOLAR INVERTERS	INTERNAL	N/A	IS-NTC-HYBRID	PV GCB UVT COIL PV GCB OPEN COIL	TRIP C
BESS	BESS SEL PROTECTION RELAY AND INVERTER	INTERNAL	TRIP A	IM-NTC-BB	MCB SHT COIL MCB OPEN COIL	TRIP D
DIESEL GENSET	IM-NTC-BB	MCB SHT COIL MCB OPEN COIL	TRIP B	IPRO	MCB SHT COIL	TRIP E

SYSTEM COMPONENT	BREAKER FAIL / BACKUP		
	BY	TRIPS	TRIP CIRCUIT
SOLAR	NOT IMPLEMENTED FOR IEC 62116 COMPLIANT CURRENT SOURCE INVERTER		
BESS	IS-NTC-HYBRID	BESS GCB UVT COIL BESS GCB OPEN COIL	TRIP F
DIESEL GENSET	IM-NTC-BB	GENSET GCB UVT COIL	TRIP G
	IPRO	INTERTRIP TO IM-NTC-BB INTERTRIP TO IS-NTC-HYBRID	TRIP H

Protection Equipment Locations



Single Line Diagram

Refer to attached drawing AUS-DWG-20-0110-0301_1 RevC for details of the proposed site electrical and protection configuration.

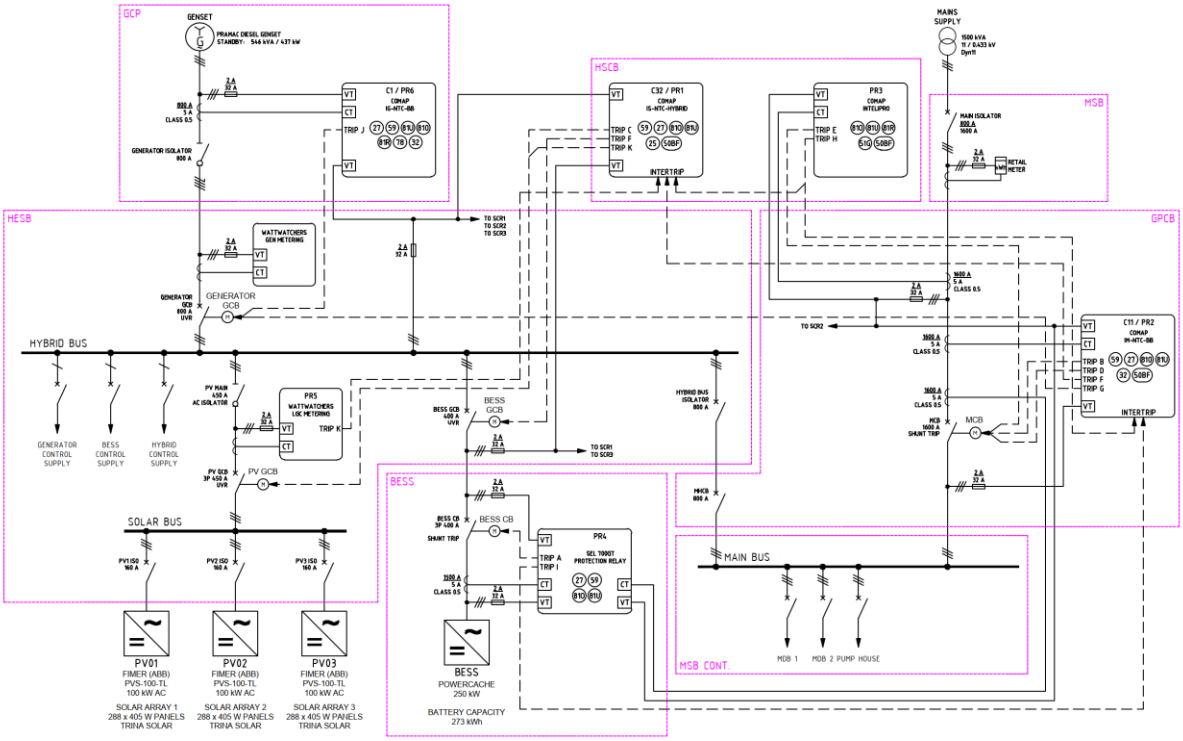


Figure 1 - Single Line Protection Diagram

Grid Protection Scheme

In accordance with the requirements of SA Power Networks' Beerenberg Pty Ltd Hahndorf Generating System Connection Engineering Report NC-015175, the following grid protection scheme is proposed:

Table 1 – Grid Protection Scheme Overview

Trip Circuit ID	Protection Relay ID	Protection Relay Model	Device Operated	Trip Circuit Enabled
TRIP A	PR4	SEL 700GT	BESS CB UVT	MCB CLOSED
TRIP B	PR2	ComAp IM-NTC-BB	MCB SHT MCB MOC	MCB CLOSED GCB CLOSED
TRIP C	PR1	ComAp IS-NTC-HYBRID	PV GCB UVT PV GCB MOC	MCB CLOSED
TRIP D	PR2	ComAp IM-NTC-BB	MCB SHT MCB MOC	MCB CLOSED
TRIP E	PR3	ComAp InteliPro	MCB SHT	MCB CLOSED
TRIP F	PR2-PR1	ComAp IM-NTC-BB - ComAp IS-NTC-HYBRID	BESS GCB UVT BESS GCB MOC	MCB CLOSED
TRIP G	PR2	ComAp IM-NTC-BB	GCB UVT	MCB CLOSED GCB CLOSED
TRIP H	PR3	ComAp InteliPro	PR1 INTERTRIP PR2 INTERTRIP	MCB CLOSED GCB CLOSED
TRIP I	PR4	SEL 700GT	PR2 INTERTRIP	MCB CLOSED
TRIP K	PR5-PR1	WattWatchers – ComAp IS-NTC-HYBRID	PV GCB UVT PV GCB MOC	MCB CLOSED

KEY:
UVT = UNDERVOLTAGE RELEASE TRIP COIL
SHT = SHUNT TRIP COIL
MOC = MOTOR OPERATOR OPEN COIL

All trip circuits proposed for the grid protection scheme are to be hard wired low level 240 VAC or UPS backed 24 VDC signals. No wireless or communications-based trip circuits are proposed.

IES Primary Protection

Four inverter energy systems are proposed for installation as follows:

Table 2 – IES Primary Protection Certifications

ID	Manufacture	Model	Rated Power	Protection Compliance	Accreditation No.	Accreditation Expiry
PV01	FIMER	PVS-100-TL	100 kW	AS/NZS 4777.2 IEC 62116	AZ 69022327	18/12/2021
PV02	FIMER	PVS-100-TL	100 kW	AS/NZS 4777.2 IEC 62116	AZ 69022327	18/12/2021
PV03	FIMER	PVS-100-TL	100 kW	AS/NZS 4777.2 IEC 62116	AZ 69022327	18/12/2021
BESS	VACON	Vacon NXP	250 kW	SAPN NC-015175	-	-

The three solar PV IES units are certified to comply with AS/NZS 4777.2:2015 which includes the active anti-islanding certification to IEC 62116:2014.

The BESS inverter is operating in voltage source mode (VF mode) and is grid forming. The BESS OEM protection system (SEL 700GT) detects mains failure when operating in parallel with the mains and sends an intertrip (TRIP I) to the ComAp protection systems (PR2).

The following passive anti-islanding protection settings will be implemented within the IES units and SEL 700GT:

Table 3 – IES Primary Protection Settings

ANSI Code	Protection Element Description	Trip Settings	Maximum Disconnection Time
59	PHASE OVERVOLTAGE – 1	260 V L-N	1 s
59	PHASE OVERVOLTAGE – 2	265 V L-N	0.2 s
27	UNDER VOLTAGE	180 V	1 s
59	SUSTAINED OVER VOLTAGE (10 MINUTE AVERAGE)	258 V	3 s
81O	OVER FREQUENCY	52 Hz	0.2 s
81U	UNDER FREQUENCY	47 Hz	1 s
MINIMUM RECONNECTION TIME			60 s

All four IES units will also be programmed to provide the following dynamic grid support functions:

Table 4 – IES Dynamic Grid Support Functions – Volt Watt Response

Reference	Grid Voltage	Real Power Output Limit
V1	207 V L-N	100%
V2	220 V L-N	100%
V3	250 V L-N	100%
V4	265 V L-N	20%

PV Central Protection

Central protection for the PV inverter units is provided using a ComAp InteliSys Hybrid IS-NTC-HYBRID protection relay, compliant with IEC 60255.

This protection relay has been given the designations:

- Controller 32 (C32)
- Protection Relay 1 (PR1)

The protection functions provided by PR1 for the IES units act on the following trip circuit outputs:

- TRIP CIRCUIT C
  - PV GCB – 240 VAC Undervoltage Release
  - PV GCB – 240 VAC Motor Operator Open Coil

PR1 TRIP CIRCUIT C provides the following protection functions:

Table 5 – IES Central Protection Scheme – PR1 TRIP CIRCUIT C Protection Settings

ANSI Code	Protection Element Description	Trip Settings	Maximum Disconnection Time
59	OVER VOLTAGE	260 V	2 s
27	UNDERVOLTAGE	180 V	2 s
59	SUSTAINED OVER VOLTAGE (10 MINUTE AVERAGE)	258 V	15 s
81O	OVER FREQUENCY	52 Hz	2 s
81U	UNDER FREQUENCY	47 Hz	2 s

TRIP CIRCUIT C is inhibited when the MCB is open to allow for islanded operation of the PV inverter units during a mains failure event.

Additionally, a remote intertrip is proposed using TRIP CIRCUIT K. A signal can be initiated remotely from SAPN via the Wattwatchers (PR5) meter, and an intertrip signal is sent from PR5 to PR1 using TRIP CIRCUIT K, which will trigger the PV GCB UVT and MOC.

BESS Central Protection

Central protection for the BESS inverter unit is provided using a ComAp InteliMains NTC BaseBox IM-NTC-BB protection relay, compliant with IEC 60255.

This protection relay has been given the designations:

- Controller 11 (C11)
- Protection Relay 2 (PR2)

The protection functions provided by PR2 for the IES units act on the following trip circuit outputs:

- TRIP CIRCUIT D
  - MCB – 240 VAC Motor Operator Open Coil
  - MCB – 24 VDC Shunt Trip

PR2 TRIP CIRCUIT D provides the following protection functions:

Table 6 – IES Central Protection Scheme – PR2 TRIP CIRCUIT D Protection Settings

ANSI Code	Protection Element Description	Trip Settings	Maximum Disconnection Time
59	OVER VOLTAGE	260 V	2 s
27	UNDERVOLTAGE	180 V	2 s
59	SUSTAINED OVER VOLTAGE (10 MINUTE AVERAGE)	258 V	15 s
81O	OVER FREQUENCY	52 Hz	2 s
81U	UNDER FREQUENCY	47 Hz	2 s

Additionally, a breaker failure scheme is proposed using TRIP CIRCUIT F. If PR2 does not receive MCB open feedback within 2 seconds, an intertrip signal is sent to the ComAp InteliSys Hybrid IS-NTC-HYBRID (PR1) protection relay using TRIP CIRCUIT F to prevent energisation of the mains during a mains failure event (anti-islanding). In the event of the breaker failure element activating the protection will be latched until an operator acknowledges and resets the alarm.

- TRIP CIRCUIT F
  - BESS GCB – 240 VAC Undervoltage Release
  - BESS GCB – 240 VAC Motor Operator Open Coil

Table 7 – Non-IES Primary Protection Scheme – PR2 TRIP CIRCUIT F Protection Settings

ANSI Code	Protection Element Description	Trip Settings	Maximum Disconnection Time
50BF	BREAKER FAILURE	MCB CLOSED	2.0 s
MINIMUM RECONNECTION TIME			LATCHED

TRIP CIRCUIT F is inhibited when the MCB is open to allow for islanded operation of the BESS inverter units during a mains failure event.

Non-IES Primary Protection

Primary protection for the non-IES synchronous generator unit is provided using a ComAp InteliMains BaseBox IM-NTC-BB protection relay, compliant with IEC 60255.

This protection relay has been given the designations:

- Controller 11 (C11)
- Protection Relay 2 (PR2)

The protection functions provided by PR2 for the non-IES units act on the following trip circuit outputs:

- TRIP CIRCUIT B
  - MCB (Q1) – 240 VAC Motor Operator Open Coil
  - MCB (Q1) – 24 VDC Shunt Trip

PR2 TRIP CIRCUIT B provides the following protection functions:

Table – Non-IES Primary Protection Scheme – PR2 TRIP CIRCUIT B Protection Settings

ANSI Code	Protection Element Description	Trip Settings	Maximum Disconnection Time
59	OVER VOLTAGE	253 V	0.4 s
27	UNDER VOLTAGE	216.2 V	0.4 s
59	SUSTAINED OVER VOLTAGE (10 MINUTE AVERAGE)	258 V	15 s
81O	OVER FREQUENCY	52 Hz	0.4 s
81U	UNDER FREQUENCY	47 Hz	0.4 s
32	DIRECTIONAL POWER – 1	199 kW	120 s
32	DIRECTIONAL POWER – 2	298.5 kW	0.4 s

TRIP CIRCUIT B are inhibited when the GCB (Q2) is open to prevent unnecessary MCB operation and loss of site load.

Additionally, a breaker failure scheme is proposed using TRIP CIRCUIT G. If PR2 does not receive MCB open feedback within 2 seconds, a backup trip signal is sent to the GCB to prevent energisation of the mains during a mains failure event (anti-islanding). In the event of the breaker failure element activating the protection will be latched until an operator acknowledges and resets the alarm.

- TRIP CIRCUIT G
  - GCB – 240 VAC Undervoltage Release

Table 8 – Non-IES Primary Protection Scheme – PR2 TRIP CIRCUIT G Protection Settings

ANSI Code	Protection Element Description	Trip Settings	Maximum Disconnection Time
50BF	BREAKER FAILURE	MCB CLOSED	2.0 s
MINIMUM RECONNECTION TIME			LATCHED

Non-IES Backup Protection

Backup protection for the non-IES synchronous generator unit is provided using a ComAp InteliPro protection relay, compliant with IEC 60255.

This protection relay has been given the designations:

- Protection Relay (PR3)

The protection functions provided by PR3 for the non-IES units act on the following trip circuit outputs:

- TRIP CIRCUIT E
  - MCB (Q1) – 240 VAC Motor Operator Open Coil
- TRIP CIRCUIT H
  - INTERTRIP to PR1 and PR2

PR3 TRIP CIRCUIT E and TRIP CIRCUIT H provide the following protection functions:

Table 9 – Non-IES Backup Protection Scheme – PR3 TRIP CIRCUIT E & TRIP CIRCUIT H Protection Settings

ANSI Code	Protection Element Description	Trip Settings	Maximum Disconnection Time
59	OVER VOLTAGE	253 V	0.4 s
27	UNDER VOLTAGE	216.2 V	0.4 s
81O	OVER FREQUENCY	52 Hz	0.4 s
81U	UNDER FREQUENCY	47 Hz	0.4 s
81R	RATE OF CHANGE OF FREQUENCY - 1	3 Hz	1 s
81R	RATE OF CHANGE OF FREQUENCY - 2	4 Hz	0.25 s

TRIP CIRCUIT E and TRIP CIRCUIT G are inhibited when the GCB (Q2) is open to prevent unnecessary MCB operation and loss of site load.

Synchronism Check Protection

Synchronism check protections are provided for the MCB when paralleling the embedded microgrid bus to the mains.

- Primary Sync Check
  - PR2
- Secondary Sync Check
  - SCR2

Sync check protection settings are proposed as follows:

Table 10 – MCB PR2 Primary Sync Check Settings

ANSI Code	Protection Element Description	Activation Settings	Minimum Dwell Time
25	SYNCHRONISM CHECK – PHASE ANGLE DIFFERENTIAL	5°	0.5 s
25	SYNCHRONISM CHECK – VOLTAGE DIFFERENTIAL	10%	0.5 s
25	SYNCHRONISM CHECK – DEAD BUS CLOSURE	Dead Bus Closure Allowed from Mains to Bus	

Table 11 – MCB SCR2 Backup Sync Check Settings

ANSI Code	Protection Element Description	Activation Settings	Minimum Dwell Time
25	SYNCHRONISM CHECK – VOLTAGE DIFFERENTIAL	10%	0.0 s
25	SYNCHRONISM CHECK – DEAD BUS CLOSURE	Dead Bus Closure Allowed from Mains to Bus	

Synchronism check protections are provided for the BESS CB when paralleling the BESS to the embedded microgrid bus to the mains.

- Primary Sync Check
  - PR1
- Secondary Sync Check
  - SCR1
  - SCR3

Sync check protection settings are proposed as follows:

Table 12 – MCB PR1 Primary Sync Check Settings

ANSI Code	Protection Element Description	Activation Settings	Minimum Dwell Time
25	SYNCHRONISM CHECK – PHASE ANGLE DIFFERENTIAL	5°	0.5 s
25	SYNCHRONISM CHECK – VOLTAGE DIFFERENTIAL	10%	0.5 s
25	SYNCHRONISM CHECK – DEAD BUS CLOSURE	Dead Bus Closure Allowed from Bus to BESS	
25	SYNCHRONISM CHECK – DEAD BUS CLOSURE	Dead Bus Closure Allowed from BESS to Bus	

Table 13 – BESS CB SCR1&3 Backup Sync Check Settings

ANSI Code	Protection Element Description	Activation Settings	Minimum Dwell Time
25	SYNCHRONISM CHECK – VOLTAGE DIFFERENTIAL	10%	0.0 s
25	SYNCHRONISM CHECK – DEAD BUS CLOSURE	Dead Bus Closure Allowed from Bus to BESS	
25	SYNCHRONISM CHECK – DEAD BUS CLOSURE	Dead Bus Closure Allowed from BESS to Bus	

Breaker Control Interfaces

The breaker control functions outlined in Table 14 have been implemented to achieve functionality described in this document.

Table 14 – Breaker Control Requirements

Breaker	Switchboard	Breaker ID	Functions Required	Description
MCB	GPCB		24 VDC Shunt Trip 240 VAC Motor Operator Auxiliary Position Contacts Sync Check Relay with Dead Bus Function	Remote Control Position Feedback Backup Protection
GENERATOR GCB	HESB		240 VAC Undervoltage Release 240 VAC Motor Operator Auxiliary Position Contacts Sync Check Relay with Dead Bus Function	Failsafe Operation Remote Control Position Feedback Backup Protection
PV CB	HESB		240 VAC Undervoltage Release 240 VAC Motor Operator Auxiliary Position Contacts	Failsafe Operation Remote Control Position Feedback Backup Protection
BESS GCB	HESB		240 VAC Undervoltage Release 240 VAC Motor Operator Auxiliary Position Contacts Sync Check Relay with Dead Bus Function	Failsafe Operation Remote Control Position Feedback Backup Protection
BESS CB	BESS		240 VAC Undervoltage Release 240 VAC Motor Operator Auxiliary Position Contacts Sync Check Relay with Dead Bus Function	Failsafe Operation Remote Control Position Feedback Backup Protection
MDB 1 FEEDER	MSB		Auxiliary Position Contacts	Position Feedback
MDB 2 FEEDER	MSB		Auxiliary Position Contacts	Position Feedback
PUMP HOUSE	MSB		Auxiliary Position Contacts	Position Feedback

Generator Protection Scheme

Protection for the non-IES synchronous generator unit is provided using a ComAp InteliGen BaseBox IG-NTC-BB. This device has been given the designation:

- Controller 1 (C1)
- Protection Relay 6 (PR6)

The protection functions provided by PR6 for the genset units act on the following trip circuit outputs

- TRIP CIRCUIT J
  - GCB – 240 VAC Motor Operator Open Coil
  - GCB – 240 VAC Undervoltage Release

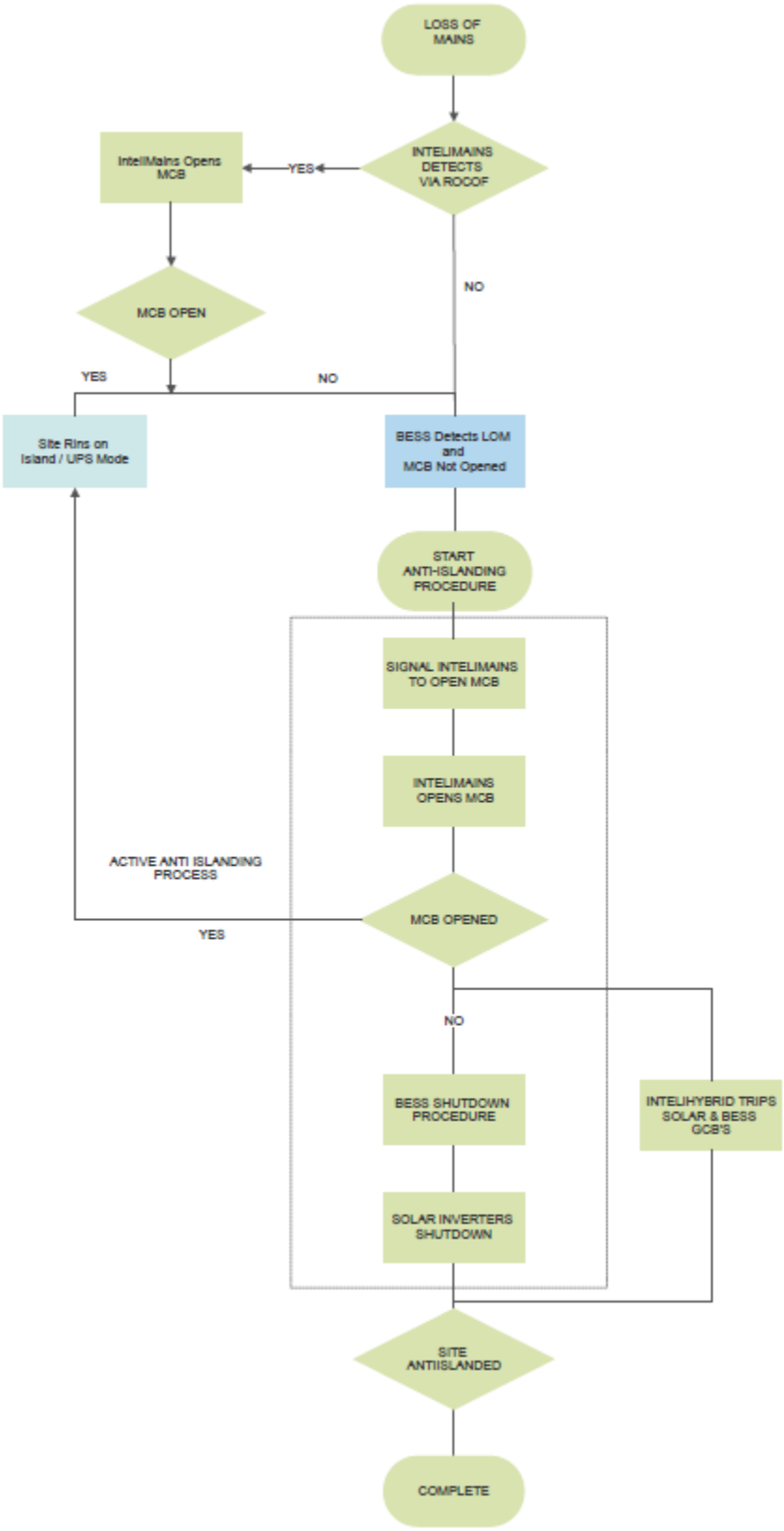
PR6 TRIP CIRCUIT J provides the following protection functions:

Table 15 – Genset Protection Scheme – PR6 TRIP CIRCUIT J Protection Settings

ANSI Code	Protection Element Description	Trip Settings	Maximum Disconnection Time
27	PHASE UNDERVOLTAGE	180 V	2 s
59	OVER VOLTAGE	260 V	2 s
59	SUSTAINED OVER VOLTAGE (10 MINUTE AVERAGE)	255 V	15 s
81U	UNDER FREQUENCY	47 Hz	2 s
81O	OVER FREQUENCY	52 Hz	2 s
81R	RATE OF CHANGE OF FREQUENCY	3 Hz	0.5 s
78	VOLTAGE VECTOR SHIFT	12°	0.5 cycles / 10 ms
32	DIRECTIONAL POWER	10%	5 s
MINIMUM RECONNECTION TIME			LATCHED

Anti Islanding

As the system is designed to work as a UPS through the BESS, the system will island itself during a loss of mains event (LOM event can also be caused by Grid Protection Relay) by opening the MCB. In the event that the MCB is not opened, an anti-islanding protection will kick in led by the BESS as shown in the following flowchart.



Part A: Pre-Connection Offline Testing

	Document No.	Date
Protection test results for the protection relay(s)	**E5000-Beerenberg - ComAp InteliSys_Hybrid-21-09-23** **E5000-Beerenberg - ComAp InteliPro_Mains BU-21-09-23** **E5000-Beerenberg - ComAp InteliMain_Main Board-21-09-23**	**23-09-2021**
Written statement from protection technician	**E5000-Statement Letter_Rev 1-21-09-23**	**23-09-2021**
NPU Injection Test	**E5000-Beerenberg - ComAp InteliPro_Mains BU-21-09-23**	**23-09-2021**
Commissioning Plan	**E5000-SAPN Commissioning Witnessing Plan REV 5**	**08-10-2021**
Compliance Monitoring Plan	**E5000-Plan-002-CMP - Compliance Monitoring Plan - Rev1**	**07-10-2021**
Single Line Diagrams (as built)	**AUS-DWG-20-0110-0301_1 RevD**	**17-09-2021**
All new low voltage inverters are compliant with the voltage ride through regulation requirements and are included in the Technical Regulator's list of approved Inverters	**PVS-100-TL confirmed**	**N/A**
A copy of the instructions to be followed by the installer to commission the Remote disconnection / reconnection technical solution per the provider's specifications.	**Wattwatchers Auditor 6M instructions**	**N/A**

Part B: Compliance Testing

Inverter Protection Witnessing

Solar Inverter Protection Witnessing Methodology		
Location(s)	**Method(s) of Demonstration**	**Responsible Qualified Person**
ABB Inverters in truck bay near to Power System installation	Setpoint Manipulation on software portal on Laptop	Westside Energy Evans Electrical ComAp
Steps to undertake Controlled Testing		
1. Access HSCB and ABB Inverters as per declared location above 2. ABB Inverters are energized. 3. ABB Inverters are confirmed operational. 4. Evans Electrical to access ABB Inverter Control Panel with password. 5. Evans Electrical to conduct ABB Inverter and Protection Relay Settings Checks as per method of demonstration. 6. Set points returned to correct settings on ABB Inverter.		

BESS Inverter Protection Witnessing Methodology		
Location(s)	**Method of Demonstration**	**Responsible Qualified Person**
BESS Inverter inside BESS container installed at the Power System location	Setpoint Manipulation on software portal on Laptop	Westside Energy PowerTech ComAp
Steps to undertake Controlled Testing		
1. Access BESS Inverter and Control System as per declared location above. 2. Inverter and SEL 700GT+ Protection Relay at BESS Control System is energized. 3. SEL 700GT+ Protection Relay is confirmed operational. 4. PowerTech to access SEL 700GT+ Protection Relay Control Panel with password. 5. PowerTech to conduct Protection Relay Settings Checks as per method of demonstration. 6. Set points returned to correct settings at SEL 700GT+ Protection Relay. 7. Fail-safe operation shown by disconnecting power to SEL 700GT+ Protection Relay.		

PV Secondary/Central Protection Relay Witnessing

Secondary/Central PV Protection Witnessing Methodology INTELIHYBRID		
Location(s)	**Method of Demonstration**	**Responsible Qualified Person**
HSCB - INTELIHYBRID	Setpoint Manipulation on software portal on Laptop	Westside Energy ComAp
Steps to undertake Controlled Testing		
1. Access HSCB as per declared location above 2. InteliHybrid Relay at HSCB is energized. 3. InteliHybrid Relay is confirmed operational. 4. Export limit verified at 199 kW as shown on Controller Display. 5. ComAp to access InteliHybrid controller with password. 6. ComAp to conduct InteliHybrid, Protection Relay Settings Checks as per method of demonstration. 7. Set points returned to correct settings on InteliHybrid. 8. Fail-safe operation shown by disconnecting power to Protection Devices		

BESS Secondary/Central Protection Relay Witnessing

Secondary/Central BESS Protection Witnessing Methodology INTELIMAINS		
Location(s)	**Method of Demonstration**	**Responsible Qualified Person**
GPCB - INTELIMAINS	Setpoint Manipulation on software portal on Laptop	Westside Energy ComAp
Steps to undertake Controlled Testing		
1. Access GPCB as per declared location above 2. InteliMains Relays at GPCB is energized. 3. InteliMains is confirmed operational. 4. ComAp to access InteliMains controller with password. 5. ComAp to conduct InteliMains Protection Relay Settings Checks as per method of demonstration. 6. Set points returned to correct settings on InteliMains. 7. Fail-safe operation shown by disconnecting power to Protection Devices		

Generator Protection Relay Witnessing

Primary Diesel Genset Protection Relay Witnessing Methodology INTELIMAINS		
Location(s)	**Method(s) of Demonstration**	**Responsible Qualified Person**
GPCB - INTELIMAINS	Setpoint Manipulation on software portal on Laptop	Westside Energy ComAp
Steps to undertake Controlled Testing		
1. Access GPCB as per declared location above 2. InteliMains at GPCB is energized. 3. InteliMains is confirmed operational. 4. ComAp to access InteliMains Control Panel with password. 5. ComAp to conduct Protection Settings Checks as per method of demonstration. 6. Set points returned to correct settings on InteliMains. 7. Fail-safe operation shown by disconnecting power to Relay		

Secondary/Central Diesel Genset Protection Relay Witnessing Methodology INTELIPRO		
Location(s)	**Method(s) of Demonstration**	**Responsible Qualified Person**
HSCB - ITELIPRO	Setpoint Manipulation on software portal on Laptop	Westside Energy ComAp
Steps to undertake Controlled Testing		
1. Access HSCB as per declared location above 2. InteliPro at HSCB are energized. 3. InteliPro is confirmed operational. 4. ComAp to access InteliPro Control Panel with password. 5. ComAp to conduct Protection Relay Settings Checks as per method of demonstration. 6. Set points returned to correct settings on InteliPro 7. Fail-safe operation shown by disconnecting power to Relay		

Part C: On-Line Commissioning

The following tests will be performed during on-line commissioning to demonstrate the system compliance.

Test	Location (E.g.: Web portal, control panel, etc)	Method of Demonstration (E.g.: Global setpoint manipulation, control panel adjustment, etc)	Responsible Qualified Person (Proponent)
Control Tests	InteliHybrid – Located in Hybrid System Control Board (HSCB)	As per ComAp Test Sheet	Westside Energy ComAp

Control tests will be performed for export management and the battery system. There is no requirement for SCADA testing as the export limit dictates that SCADA control is not required. Communications testing will be performed for the remote disconnect/reconnect function per the relevant agent requirements. The following summarises the method to test the control and communication systems.

Export Control Tests

Required Preparation and Steps to enable Export Control Tests
1. AUS-ENG-ITP-20-0110-0001 ALL – Issue B (Full System Test Sheets)
2. AUS-ENG-ITP-20-0110-0002 GEN – Issue B (InteliGen Controller)
3. AUS-ENG-ITP-20-0110-0003 MCB – Issue B (InteliMains Controller)
4. AUS-ENG-ITP-20-0110-004 SOLAR – Issue B (Solar Controls)
5. AUS-ENG-ITP-20-0110-0006 IP – Issue B (InteliPro Controller)

Battery Control Tests

Required Preparation and Steps to enable Battery Control Tests
1. AUS-ENG-ITP-20-0110-0005 CHEMS – Issue B (InteliHybrid Controller)

Loss of Mains

Required Preparation and Steps to enable Loss of Mains Tests
1. AUS-ENG-ITP-20-0110-0003 MCB – Issue B (9.00 Functional Testing - Automatic Mains Failure Operation)
2. AUS-ENG-ITP-20-0110-0005 CHEMS -Issue B (15.00 Functional Testing Mains Failure)
3. AUS-ENG-ITP-20-0110-0001 ALL – Issue B (7.00 Failure & Recovery Testing - Mains Controller)

Return to Mains

Required Preparation and Steps to enable Loss of Mains Tests
1. AUS-ENG-ITP-20-0110-0003 MCB – Issue B (9.08 Simulate mains return by closing QA3M)
2. AUS-ENG-ITP-20-0110-0005 CHEMS -Issue B (15.07 Return the mains supply by closing CB MCB QA3M)
3. AUS-ENG-ITP-20-0110-0001 ALL – Issue B (7.11 Simulate Mains Return by closing QA3M)

Peak Lopping

Required Preparation and Steps to enable Peak Lopping Tests
1. AUS-ENG-ITP-20-0110-0005 CHEMS -Issue B (14.20 Generator)

Appendix A – SAPN Witnessing Checklists

Part A

Pre-Commissioning Smarter Homes Compliance Checks	Response	
Relevant Agent appointed for the generating system	YES	
Technical solution used for Remote disconnection and reconnection	SAPN via WattWatcher Auditor 6M	
New plant installed is as per the original approved application. The proponent accepts responsibility to rectify this if found to be incorrect.	Yes	No (do not proceed)

Sign-off for Compliance	**Proponent**		**SAPN**	

Pre-Connection Checks
Electrical Certificate of Compliance for the Generating System(s)
Installers Electrical Certification viewed
Bi-directional/import/export meter installed
Protection relay installed and ready for testing
Main Circuit Breaker will open upon detecting protection relay failure
Site National Meter Identifiers (NMI) Correct as per Engineering Report
Power quality logger installed for 7-day measurement (2 days prior to gen online)

Sign-off for Compliance	**Proponent**		**SAPN**	

Outstanding Issues – Off-line Testing
Any observed defects affecting safety (ie AS/NZS3000/S&IR non-compliance) communicated to owner/installer (D)Note: also apply DEI process if required

The **marker (M)** denotes **mandatory** compliance for witness procedure, while **(D)** denotes **defect or concern to be noted** with record of communication to REC to be kept (this paperwork). Note that these checks do not constitute approval of compliance to the Service & Installation Rules by the SA Power Networks commissioning officer and the onus remains on the Customer/Proponent to ensure the installation complies with the relevant rules.

Item	Rule	Comment	SAPN
Connection Point – Common Point of Coupling – Main Switch Board			
Confirm revenue meter aligns with NMI. (Available from PM) (M)	Aligns with SEG/LEG approval		
Meter, CTs, voltage taps etc. physically and electrically located correctly. (M)	S&IR 7.5.1, 8.5, 8.14		
No unmetered equipment or connections. (M)	S&IR - 7.8.2.3		
PV labels at MSB. (M)	AS/NZS 4777.1 6.5		
'Main Switch' label(s) correct size / colour. (M)	AS/NZS 4777.1 - 6 AS/NZS3000 - 2.3.3.5		
Drawing showing generating units' location(s) (D)	AS/NZS 4777.1 6.4		
Switchboard – Main or Sub-boards			
Fire panel labels and drawings in place(D)	AS/NZS 4777.1 – 6.1		
Main Switch for inverter able to be secured in the open position. (M)	AS/NZS 4777.1 – 3.4.3(b) AS/NZS3000 - 2.3.3.6		
Isolation switches are readily available	AS/NZS 4777.1 – 5.3.1		
Maximum of two solar main switches	AS/NZS 4777.1 – 5.5.3.2		
Drawing showing generating units' location(s) (D)	AS/NZS 4777.1 6.4		
Hybrid Energy System Board (PV BUS & Isolator Section)			
Solar Meets Restricted Access Requirements. (D)	AS/NZS 4777.1 - 1.3.27		
Main Isolator Label. (M)	AS/NZS 4777.1 - 6		
Shut Down Procedure Label. (M)	AS/NZS 4777.1 - 6.7		
Network Protection Unit			
Main Isolator Isolates Entire Board. (D)	AS/NZS 4777.1 - 3.4.3		
Motorised CB or isolator used as isolator must be able to be secured in the open position and must only be manually resettable. (M)	AS/NZS3000 - 2.3.3.6		
Number of Main Isolators. (D)	AS/NZS 4777.1 - 5.5.1 AS/NZS 3000 - 2.3.3.3		
Protection Relay Label. (M)	SAPN Requirement		

Part B

PRIMARY MAINS ANSI PROTECTIONS

PV INVERTERS

Solar (Primary)	Setting		Trip Time		PV-1	PV-2	PV-3	Prop	SAPN
Over Voltage Level 1 (V)	260 V	113%	1.0 s	50 cyc					
Over Voltage Level 2 (V)	265 V	115%	0.2 s	10 cyc					
Under Voltage (V)	180 V	78%	1.0 s	50 cyc					
10min Average Sustained Voltage	258 V	112%	3.0 s	150 cyc					
Over Frequency (f)	52 Hz	104%	0.2 s	10 cyc					
Under Frequency (f)	47 Hz	94%	1.0 s	50 cyc					
Active anti-islanding	Yes								
Soft Ramp Up after Reconnect	Enabled 16.67%								
Reconnect Time	60sec								

Note: Inverter Volt Watt Settings to be checked as per Table 16 – IES Dynamic Grid Support Functions – Volt Watt Response

Reference	Grid Voltage	Real Power Output Limit	PV-1	PV-2	PV-3	Prop	SAPN
V1	**207 V L-N**	**100%**					
V2	**220 V L-N**	**100%**					
V3	**250 V L-N**	**100%**					
V4	**265 V L-N**	**20%**					

Inverter No	Checked Inverter Serial No	Verified Settings and Serial Numbers as Expected?	Notes
PV – 1			
PV – 2			
PV – 3			

BESS INVERTER

BESS (Primary)	Setting		Trip Time		BESS SEL 700GT+ Protection Relay	Prop	SAPN
Over Voltage Level 1 (V)	260 V	113%	1.0 s	50 cyc			
Over Voltage Level 2 (V)	265 V	115%	0.2 s	10 cyc			
Under Voltage (V)	180 V	78%	1.0 s	50 cyc			
10min Average Sustained Voltage	258 V	112%	3.0 s	150 cyc			
Over Frequency (f)	52 Hz	104%	0.2 s	10 cyc			
Under Frequency (f)	47 Hz	94%	1.0 s	50 cyc			
Active anti-islanding	Yes						
Soft Ramp Up after Reconnect	Enabled 16.67%						
Reconnect Time	60sec						

Note: BESS Inverter Ramp up after Trip Reconnect only.

Note: Inverter Volt Watt Settings to be checked as per Table 17 – IES Dynamic Grid Support Functions – Volt Watt Response

Reference	Grid Voltage	Real Power Output Limit	Prop	SAPN
V1	**207 V L-N**	**100%**		
V2	**220 V L-N**	**100%**		
V3	**250 V L-N**	**100%**		
V4	**265 V L-N**	**20%**		

Sign-off for Compliance	Proponent		SAPN	

Inverter No	Checked Inverter Serial No	Verified Settings and Serial Numbers as Expected?	Notes
BESS			

MAINS PV ANSI PROTECTIONS – INTELIHYBRID (C32 + HMI)

Secondary INTELIHYBRID	Measured Values		
Make/Model & Serial Number	InteliHybrid Protection Relay (SN: 194907FB / INTELIHYBRID)		
Voltage (Ø-N)	(R) V	(W) V	(B) V

Observed Grid Frequency: _____ Hz

MAINS ANSI PROTECTIONS (PV GCB) INTELLIHYBRID (C32 + HMI)

Secondary INTELLIHYBRID	Approved Setting		Trip Time		Tested Setting	Prop	SAPN
Over Voltage (V)	260 V	113%	2.0 s	100 cyc	220 V		
Under Voltage (V)	180 V	78%	2.0 s	100 cyc	250 V		
10min Average Sustained Voltage	258 V	112 %	15.0 s	750 cyc	220 V		
Over Frequency (f)	52 Hz	104%	2.0 s	100 cyc	48 Hz		
Under Frequency (f)	47 Hz	94%	2.0 s	100 cyc	52 Hz		

MAINS BESS ANSI PROTECTIONS – INTELIMAINS (C11 + HMI / PR2)

Secondary INTELIMAINS	Measured Values		
Make/Model & Serial Number	InteliMains Protection Relay (SN: 21022D1 / INTELIMAINS)		
Voltage (Ø-N)	(R) V	(W) V	(B) V

Observed Grid Frequency: _____ Hz

MAINS ANSI PROTECTIONS - INTELLIMAINS (C11 + HMI /PR2)

Secondary INTELIMAINS	Approved Setting		Trip Time		Tested Setting	Prop	SAPN
Over Voltage (V)	260 V	113%	2.0 s	100 cyc	See Note 1		
Under Voltage (V)	180 V	78%	2.0 s	100 cyc	"		
10min Average Sustained Voltage	258 V	112 %	15.0 s	750 cyc	"		
Over Frequency (f)	52 Hz	104%	2.0 s	100 cyc	"		
Under Frequency (f)	47 Hz	94%	2.0 s	100 cyc	"		
Synchronisation	5		See Note 2		No test		
Circuit Breaker Fail	0.1 S after breaker fail detected				See Note 3		
Protection Relay Failure	0.1 S after Relay fail detected				Remove Supply		
Tamper seal serial number	Password						

Note 1: Protections as listed are less stringent than protections specified in same relay later in test document.

Note 2: Sync Check Relays used as backup to ComAp internal Sync Check. These measure the Mains, Hybrid BUS and BESS Voltages.

Note 3: CB fail tests by disabling CB feedback on trip and observing backup trip

MAINS SECONDARY ANSI PROTECTIONS – INTELIPRO (C12)

Secondary – INTELIPRO	Measured Values		
Make/Model & Serial Number	InteliPro Protection Relay (SN: 204502DC / INTELIPRO)		
Voltage (Ø-N)	(R) V	(W) V	(B) V

Observed Grid Frequency: _____ Hz

Secondary - INTELIPRO	Approved Setting		Trip Time		Tested Setting	Prop	SAPN
Over Voltage (V)	253 V	110%	0.4 s	20 cyc	220 V		
Under Voltage (V)	216.2 V	94%	0.4 s	20 cyc	250 V		
10min Average Sustained Voltage	258 V	112 %	600 s	10 cyc	220 V		
Over Frequency (f)	52 Hz	104%	1 s	50 cyc	48 Hz		
Under Frequency (f)	47 Hz	94%	1 s	50 cyc	52 Hz		
ROCOF	±4 Hz/Sec		0.25 s	12.5 cyc	0 Hz/Sec		
Voltage Imbalance	3%		0.4 s	20 cyc	No test		
Circuit Breaker Fail	0.1 S after breaker fail detected				See Note 1		
Protection Relay Failure	0.1 S after Relay fail detected				Remove Supply		
Tamper seal serial number	Password						

Sign-off for Compliance	Proponent		SAPN	

Note 1: CB fail tests by disabling CB feedback on trip and observing backup trip

MAINS ANSI PROTECTIONS INTELIMAINS (C11+HMI)

Backup INTELIMAINS	Measured Values		
Make/Model & Serial Number	InteliPro Protection Relay (SN: 21022D1/ INTELIMAINS)		
Voltage (Ø-N)	(R) V	(W) V	(B) V

Observed Grid Frequency: _____ Hz

Secondary - INTELIPRO	Approved Setting		Trip Time		Tested Setting	Prop	SAPN
Over Voltage (V)	253 V	110%	0.4 s	20 cyc	220 V		
Under Voltage (V)	216.2 V	94%	0.4 s	20 cyc	250 V		
10min Average Sustained Voltage	258 V	112 %	600 s	10 cyc	220 V		
Over Frequency (f)	52 Hz	104%	0.4 s	150 cyc	48 Hz		
Under Frequency (f)	47 Hz	94%	0.4 s	50 cyc	52 Hz		
Circuit Breaker Fail	0.1 S after breaker fail detected				See Note 1		
Protection Relay Failure	0.1 S after Relay fail detected				Remove Supply		
Tamper seal serial number	Password						

Sign-off for Compliance	Proponent		SAPN	

Note 1: CB fail tests by disabling CB feedback on trip and observing backup trip

Outstanding Issues – Compliance Testing

Part C

Pre-Commissioning Control Checks	Settings				
Loss of supply all inverters isolate from network	Yes		No		
Control Method	Protection Relay		Manager		Inverter
Export / Import controller	PLC		Manager		Inverter
Control device(s) - Serial number(s)	InteliMains Protection Relay (SN: 21022D1 / INTELIMAINS)				
Sign-off for Compliance	**Proponent**		**SAPN**		

Directional Power Export Limit

Parameter			Setting
Control method of disconnection			INTELIMAINS trips MCB
Connection point control trip value	Export		199 kW for 120 s
	Export		298.5 kW for 0.4 s
Connection point fixed power factor value			0.95 absorbing Vars from the Network

Communications

Parameter	Outcome
Communications Failure – Intelimains to InteliHybrid (PLC)	All internal sources disconnect

Solar Power Control

Step & Parameter	Control	Site Load	Mains Load	Solar Feed
1) Enable Solar Control	-		-	-
2) Observe Solar inverters respond to power requests from Intelihybrid	-	kW	kW	kW
3) Observe Mains import/export accurately reflects Sum of Load and Solar	-	kW	kW	kW
4) Observe import power factor remains within agreed limits	-	kW	kW	kW
5) Ensure Normal Operation	-	kW	kW	kW

Sign-off for Compliance	**Proponent**			**SAPN**	

Battery Control

Step & Parameter	Control	Measured Battery Value and Status	Measured Load and Status	Measured Gen. and Status
1) Enable BESS Control		%	-	-
2) Check Battery Inverter Status		%	kW	kW
3) Charge Battery from Grid		%	kW	kW
4) Discharge Battery to Grid		%	kW	kW
5) Allow Automatic Control and Check Status		%	kW	kW
6) Ensure Normal Operation		kW	kW	kW

Sign-off for Compliance	Proponent		SAPN	

Outstanding Issues – Power Control Tests

Comments

Final Agreement	Proponent	SAPN
Go ahead has been received from all parties		
Site Witness sticker placed on NPU panel		

Customer/Proponent Representative	
Name:	
Signed:	
Date:	

SA Power Networks Representative	
Name:	
Signed:	
Date:	

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