Clements Gap BESS SCADA System Functional Design Specification

PSD1834-200-001

Prepared for

ENZEN/PACIFIC BLUE

psdenergy

16 Williams Circuit

Pooraka SA 5095

Telephone: +61 (0)8 8259 8100

Fax: +61 (0)8 8259 8101

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1. Scope

1.1. Purpose

This specification describes the SCADA BoP system for Clements Gap Battery Energy Storage System (BESS). The SCADA BoP covers the following functional areas, namely:

- 33kV Substation,
- BESS Plant including inverters,
- Power Plant Manager (PPM),
- Interfaces to AEMO/ElectraNet,
- Interface to the existing Windfarm,
- Interface to Client
- BoP HMI Servers and clients
- Remote Access

The SCADA system provides a single point to manage and control the site.

1.2. Background

Clements Gap is an operating wind farm owned by Pacific Hydro in South Australia and is located within the Barunga Ranges on farmland in the Mid North region of the State. The wind farm is comprised of 27 Suzlon 2.1MW wind turbines with a total installed capacity of 56.7 MW. Clements Gap substation is the wind farm substation which connects to the 132 kV transmission network via an ElectraNet owned 132 kV switchyard named Red Hill substation.

The 60 MW/ 120 MWh Lithium-Ion type Battery Storage System (BESS) facility is proposed to be located adjacent to the existing wind farm substation, at the new Clements Gap BESS substation.

1.3. Hold Points

None.

2. Standards & specifications

2.1. Precedence

Unless otherwise stated herein, all work associated with this project shall be designed, constructed, installed, tested, commissioned and documented in accordance with the requirements of the Australian Standards.

Where relevant Australian standards do not exist, the following relevant international standards and codes of practice shall apply:

- International Electrotechnical Commission (IEC)
- International Organization for Standardization (ISO)
- Institute of Electrical and Electronics Engineers (IEEE)
- American Society for Testing and Materials (ASTM)

In addition to the above equipment and work must comply or exceed the minimum requirements of the NEM Rules.

Metering equipment forming part of the revenue metering must meet or exceed the accuracy requirements of the electricity market.

2.2. Applicable Standards

The main standards relating to the equipment within this specification are:

Table 1 - Reference Documents

Drawing / Document Number	Rev	Description
12546421-SPC-001	2	Pacific Hydro Clements Gap BESS BESS Technical Specification
12546421-SPC-003	2	Pacific Hydro Clements Gap BESS BESS Substation and BoP Specification
IEC62443-3-3	2013	Security for Industrial Automation and Control Systems System security requirements and security levels
TCA	NA	ElectraNet TCA Appendix A - Scope of Works
IEC60870-5-103/DNP3/Modbus TCP/RTU	NA	Communication protocols
PSD1834-200-004	0	Substation Master I/O Schedule (Signal list Local, EMS, PPC, AEMO)

2.3. Abbreviations and acronyms

Acronyms used throughout this document are listed below.

Table 2 - Acronyms and Abbreviations

AEMO	Australian Energy Market Operator
AVR	Automatic Voltage Regulator
BATT	Battery
BESS	Battery Energy Storage System
BCU	Bay Control Unit
BoP	Balance of Plant
DNP	Distributed Network Protocol
DWG	Drawing
EMS	Energy Management Systems
FDS	Functional Design Specification
GPS	Generator Performance Standards
HTTP	HyperText Transfer Protocol
HMI	Human Machine Interface
IED	Intelligent Electronic Device (protection relay, DRMCC, RTU)
LAN	Local Area Network
MVSG	Medium Voltage Switch Gear
NEM	National Energy Market
OPC	Open Platform Communications
PQM	Power Quality Meter
PPC	Power Plant Controller
PPM	Power Plant Manager
POC	Point of Control
RSTP	Rapid Spanning Tree Protocol
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SNMP	Simple Network Management Protocol
SNTP	Simple Network Time Protocol
TCP/IP	Internet Protocol
TNSP	Transmission Network Service Provider
VRR	Voltage Regulator Relay
WAN	Wide Area Network

3. System Overview

3.1. BESS Overview

Clements Gap BESS consists of a single 33/132kV transformer and a single 132kV line connecting to Redhill Substation, which is an ElectraNet asset. At Redhill substation there is also a connection to the existing Clement Gap Windfarm.

The substation has a single 33kV switchboard with seven feeders. The feeders are listed below for information purposes: -

- 33kV +1F01 Feeder (CG1)
- 33kV +1F02 Feeder (CG2)
- 33kV +1F03 Feeder (CG3)
- 33kV +1F04 Incomer
- 33kV +1F05 Feeder (CG4)
- 33kV +1F06 Feeder (CG5)
- 33kV +1F07 Feeder (Harmonic Filter)

In the BESS area there are a total of 25 MVPS each containing the following:

- MV Switchgear (MVSG)
- One MVPS-4200-S2-10 (SCS 3600 UP) Inverters
- 33kV inverter step-up transformer
- 2.5 kVA Auxiliary transformer

The BESS consists of the following equipment:

- 50 of Elementa G2 (8 racks) with a nominal capacity of 3258.72kWh and nominal power of 1629.36kW.

3.2. Plant layout

The following drawings detail the primary plant and electrical schemes used at CG BESS.

- PSD1834-110-001-001/004 - SIMPLIFIED SINGLE LINE DIAGRAM
- PSD1834-110-002-001/004- PROTECTION SINGLE LINE DIAGRAM
- PSD1834-110-003-001/002- METERING SINGLE LINE DIAGRAM

3.3. Naming Conventions

3.3.1. Plant and equipment

The following plant or equipment naming conventions are used: -

Table 3 - Equipment or Plant Naming Conventions

Prefix	Description
Naming conventions that apply to locations or product	
+	Location (IEC 81346) e.g. +1 Control Room 1, 33kV Switchboard, Feeder +1F01
-	Product (IEC 81346)
=	Function (IEC 81346)
Naming conventions that apply to 33/220kV – typically used in the substation	
TFxx	Transformer (xx denotes transformer number)
Qxx	Isolator (xx denotes number)
QxxE	Earth Switch (xx denotes number)
Qx0	Circuit breaker (x denotes number)
PQM	Power Quality Meter
PROT	Protection Relay
VRR	Voltage Regulating Relay
PPC / PPM x	Power Plant Controller
NER	Neutral Earthing Resistor
GEN x	Diesel Generator
CAP BANK	Capacitor Bank
BCU	Bay Control Unit
Naming conventions that apply to Medium Voltage – typically used in the MVPS	
MVPSxx	Medium Voltage Power Station (xx denotes MVPS number)
MVSGxx	Medium Voltage Switch Gear (xx denotes MVSG number)

Prefix	Description
TF	Transformer
SCx	Sunny Central (x denotes inverter number)
Naming conventions that apply to BESS	
BATTxxA/B	Battery Container = BANK (xx denotes container number). A BANK contains x number of racks
RACKxx	Battery Rack (xx denotes rack number). A Rack contains a number of packs.
PACKxx	Battery Pack (xx denotes rack number). A pack contains a number of battery cells.
Naming conventions that apply to communication and automation	
Ethernet Switch xx	Ethernet Switch number.
HMI x	HMI Client
Server x	SCADA Server Main / Backup
Engineering Work Station x	Engineering Workstation
Gateway x	Gateway Main / Standby
Firewall x	Firewalls (xx denotes firewall number)
Router x	Routers used for LAN segregation
KVM x	Remote access to certain key automation equipment
PRN x	Printers
NAS x	Backup Network Access Storage
GPSx	GPS Clock

3.3.2. Virtual Device Naming Conventions

For virtual connectivity between automation products especially those that can be accessed via a windows network or domain should use the following naming convention: -

<site abbreviation><location><function><suffix>

The following table lists the common abbreviations

Table 4 - Virtual Device Naming Conventions

Prefix	Description
Site	
CGB	Clements Gap BESS
Location	
CON	Control Room / building
OAM	O&M Building
Function	
MVPS	Medium Voltage Power Station
BESS	Battery Energy Storage System
IV	Inverter
IOK	Moxa I/O controller
SW	Ethernet Switch
PQx	Power Quality Meter
SSV	SCADA Server
GW	Gateway
GPS	GPS Clock
RTR	Router
FW	Firewall
TF	Transformer
XP	X Prot
YP	Y Prot
VR	Voltage Regulator
BCU	Bay Control Unit
XDC	X DC Controller
YDC	Y DC Controller
DC	Domain Controller
HIS	Historian

Prefix	Description
PRN	Printer
IPP	IP Phone
ESX	VMware ESXi

3.3.3. Tag Names

Tag naming convention follows this general convention

<location><function><suffix>

Tags and naming conventions will be detailed in the I/O lists

3.4. Control System Overview

The SCADA system provides a single point of control for the entire site. The following systems make up the SCADA system:

- Redundant HMI servers;
- Redundant substation gateways;
- Redundant networking, routing and firewalls;

The SCADA system communicates with various pieces of equipment to either provide control functionality and or facilitate control functionality.

The HMI provides a local point for viewing for all the information from the BESS plant and the substation.

The substation Gateway facilitates communications to various areas, namely: -

- Substation,
  - Protection Relays
  - Station I/O
- PPM / EMS (Power plant manager / Energy Management System),
- AEMO / ElectraNet,
- Clements Gap Windfarm (CGWF). This will be dependent on the information the Windfarm is looking for,
- OEM BESS SCADA (May need to communicate with this system to aggregate information for AEMO / ElectraNet / CGWF),
- Medium voltage switchgear (MVSG).

The HMI servers will communicate with the following systems: -

- Substation Gateways
- OEM BESS SCADA (to collect and control BESS, and inverters)

3.5. Control and Monitoring Philosophy

3.5.1. Control levels

There are three tiers of control, namely: -

- Device / local control;
- Bay control (IED);
- Remote Control which includes either the HMI or AEMO;

Device or local control is performed at the plant, which is your highest form of control. This control is normally subject to interlocking requirements and the equipment placed into local control mode, which allows safe operation of the equipment and plant.

Bay control are controls performed via push buttons at the control panels. These controls are normally also subject to interlocking and bay level local control mode.

Remote control is your lowest form of control, and is normally subjected to bay level and plant level interlocks and remote controls modes;

3.5.2. Point of Control (POC)

For controlling the power plant manager (PPM) the SCADA system defines three point of control modes, namely:-

- Grid Control (AEMO can send and receive setpoints);
- Local HMI control (control from the HMI, therefore any setpoint received from AEMO will be blocked);
- PPM control (Local control, therefore any setpoints received from either the HMI or AEMO will be blocked);

3.5.3. Control blocking

Control blocking is normally controlled at the bay or local level, using local / remote switch or interlocking controls.

Some controls or setpoints on the HMI can be set to disable/enable as per operational requirements, however these features are not safety controls, but are rather soft controls.

3.5.4. Plant Control and setpoints

The HMI provides facilities to control the following plant or equipment: -

Table 5 - Plant Control

Plant	Control Type
Substation	
132kV Circuit Breaker	Open/Close
132kV Disconnectors	Open/Close

Plant	**Control Type**
132kV Earth switches	None (manual operation)
132kV Point on Wave (POW)	Not applicable
33/132kV Transformer tap position	Tap Raise / Lower
33/132kV Transformer AVR Control Mode	Auto / Manual
33kV Switchboard Circuit Breaker	Open/Close
33kV Switchboard Disconnector / Earth switch	Open/Close/Earthed
Power Plant Manager (PPM)	
Control Mode	Active Power / Reactive Power Modes / Voltage
Setpoints	MW / MVar / Ramp rate / Voltage / PF
Meduim Voltage Power Station (MVPS)	
33kV MVSG Circuit Breaker	Open/Close
33kV MVSG Disconnector / Earth switch	None
Inverter Operating Control Mode	Stop / Operation
Battery Energy Storage Unit (BESS)	
BANK	DC Connection (Start/Stop) Insulation Sampling (Enable/Disable)
Rack	Enable/Disable (TBC)

3.6. Control System Communications

3.6.1. Overview

Figure 1 details the communications flow between the various aspects of the BoP SCADA system and other systems. AEMO/ElectraNet dispatch and setpoint control of the plant will interface with the substation Gateways. This will pass on the data to the Controller/PPM. The substation gateways will also communicate with the protection IEDs in the substation. It will also communicate with the OEM BESS SCADA for the MVSG status and control. The BoP SCADA (HMI Servers) will communicate wit the OEM BESS SCADA for the relevant BESS information to be displayed to the operators.

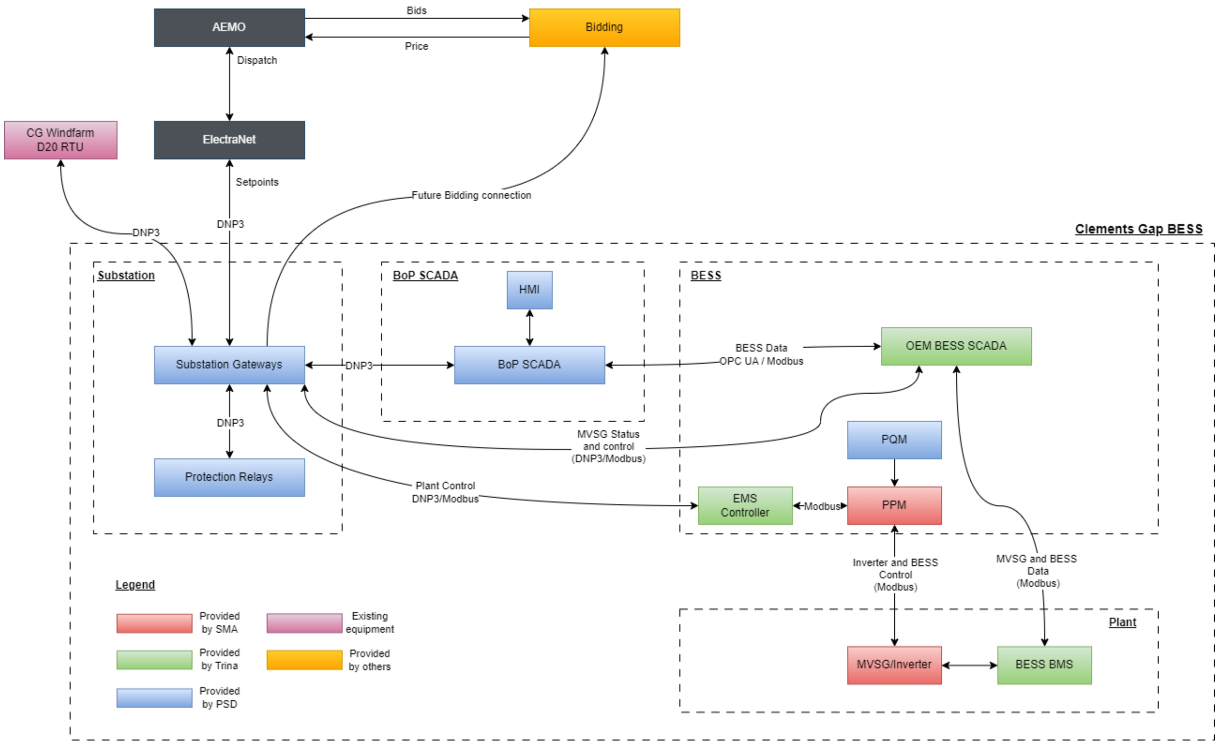


Figure 1 – SCADA Communications Flow Overview

The SCADA system communicates to the following: -

Table 6 - Communication Protocols

Interface	Communication Protocol
Substation Gateways	
ElectraNet (incl AEMO)	DNP3 TCP/IP
Substation IEDs	DNP3 TCP/IP
HMI Server	DNP3 TCP/IP
Controller / PPM	DNP3 TCP/IP or Modbus TCP/IP
OEM BESS SCADA	DNP3 TCP/IP or Modbus TCP/IP
HMI Servers	
Substation Gateways	DNP3 TCP/IP
HMI Client PC's	HTTP / HTTPS and OPC
Ethernet Switches	SNMP
OEM BESS SCADA	OPC UA or Modbus TCP/IP

3.6.2. Scan Rates

The scan rates are detailed below and are in line with AEMO requirements: -

Table 7 - Scan Rates

Type	Period
Sampling period	
Analog Metering	2s
Digital Statuses and alarms	1s

3.6.3. Quality, timestamping and resolution

The SCADA system uses the quality flag to report when points are typically offline due to equipment being out of service or communications failures.

Table 8 - Quality and timestamping

Protocol	Type	Timestamp	Quality
DNP	DI's	Yes	Yes (Online/Offline + remote / local forced)
	AI's	No	Yes (Online/Offline)
Modbus	DI's/AI's	Yes (only upon the reception of the data as Modbus protocol does not support a timestamp).	Yes (only upon communications failure at the master as Modbus protocol does not support a quality).

The following table provides a guideline for the required minimum accuracy of the data captured in the SCADA system: -

Table 9 - Point Resolution and Dead bands

Analogue parameter	Resolution (Primary)	Dead band (Primary)
Power (MW/KW/MVAR/KVAR)	0.1	1% of range
Voltage > 10kV	0.1kV	1% of range
Current	1A	1% of range
Temperature	0.1°C	0.05°C
Wind speed	0.1 m/s	0.05 m/s
SOC	0.1%	0.05%

Final scaling, resolution and dead bands will be detailed in the applicable I/O lists.

3.7. Control System Networking and zoning

As shown in Figure 2 the SCADA system comprises of the following zones: -

- Substation Zone
- OT Zone (HMI Servers, HMI Clients)
- BESS Zone
- DMZ Zone

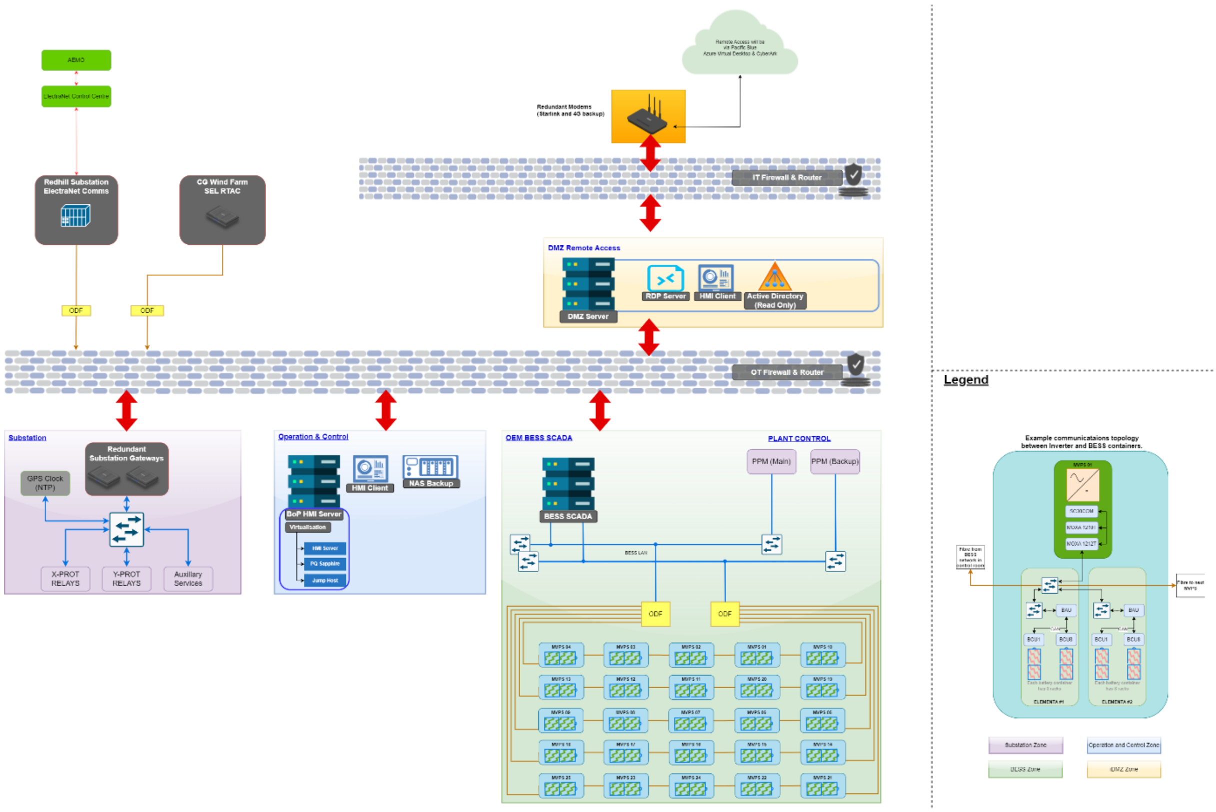


Figure 2 - Network and Zoning

Communications between zones will be handled by the OT Firewall. Inter-communication dependencies will be detailed in the IP addressing and zoning document.

Remote access will be serviced through Pacific Blue Azure virtual desktop and CyberArk system. It is assumed that Pacific Blue will supply the modem pre-configured with the VPN connections. A port on each of the IT firewalls will be designated for the Pacific Blue Modem. This will be considered the WAN connection.

The interface to ElectraNet and AEMO will use DNP3 over TCP/IP from the substation Gateways. The OT firewall will provide a NAT facility to route the external ElectraNet control centre IP Addresses to the internal address of the substation gateways.

If required a connection to the existing CG Windfarm SEL-3530 RTAC will use DNP3 over TCP/IP from the substation gateways. The OT firewall may have to provide a NAT facility depending on the connection type (server / client).

The BESS Zone includes the OEM BESS SCADA and EMS system. Communication to the battery containers and inverters is currently designed in five rings. Each ring will connect five MVPS and ten battery containers.

The substation zone provides the HV electrical infrastructure communications, control and monitoring. It consists of redundant gateways, L2 LAN and GPS clocks and protection relays. DNP3 TCP/IP will be used to communicate between the gateways and the protection relays. Communication from the gateways to the PPM will be facilitated by the OT firewalls.

The Operation & Control Zone consists of HMI servers, PQ Sapphire, and a jump host. The HMI servers will communicate to the substation gateways and the OEM BESS SCADA.

The DMZ zone provides an RDP interface for remote access. This is where users can view the HMI, extract reports, and or access the OT zone if required.

3.8. Control System Time Synchronisation

As per the requirements their will be two GPS clocks providing high accuracy time synchronisation via NTP/SNTP.

All protection and OT systems will be time sync’ed via NTP. The accuracy for time synchronisation should be < 10ms.

3.9. Alarm / Event Handling

3.9.1. Conditions

The alarm system has the following conditions: -

Table 10 - Alarm Conditions

Condition	Description
Critical	Alarm is indicated as red
Major	Alarm is indicated as yellow
Minor	Alarm is indicated as blue
Event (Process)	Event is indicated as grey
Event (System)	Event is indicated as white

3.9.2. Severity

The SCADA system has the following alarm severities

Table 11 - Alarm Severity

Severity	Description
Critical	Generation loss, CB trip, transformer, fire, intruder, DC, genset, AEMO/NSP alarms, major SCADA failure
Major	Abnormal operation but not affecting plant generation or visibility. BoP alarms, minor SCADA failure
Minor	Abnormal operation or minor SCADA alarm
Event	Process / System

The operator can sort and filter the alarm list to suit their requirements.

3.9.3. Alarm Sequencing

By default, the SCADA system will sequence alarms by time and severity.

Events are sequenced by time.

3.10. Historian

The HMI has a built-in historian which is part of the server. Only important data will be historised. The server can be configured to retain historised data in four categories (52, 12, 4, 1) weeks. Selection of historised data will be determined in the IO list.

3.11. Redundancy

The substation gateway's will be configured in a Hot-Hot redundant mode. This is a typical configuration that is used with ElectraNet.

The HMI servers will be configured in a Primary-Standby configuration. If the primary server fails the standby server will become the active server.

The HMI has built in redundancy between the servers and is configured in a Hot-Standby Pair. The HMI servers are also separated on redundant hardware.

All networking and firewalls will be redundant.

3.12. Ancillary services

Virtual machines (VMWare) are used on physical servers to allow multiple hosts and software to use a single physical server. Ancillary services include the following Windows Active Directory (AD) and domain controller (Main and backup), Veeam backup server, Jump Host (RDP), VMWare VCentre, IDS systems and syslog servers.

In this project the Windows Domain controller (DC) is hosted back at pacific blue. A read only DC will be hosted in the DMZ.

Any access to computers and servers is limited unless the computer is part of the domain. This provides security and control on changes applied to each computer on the domain.

Pacific Blue will have to provide the domain name for site.

The Veeam backup server provides a central place where all windows computers are backed up. Veeam takes a snapshot of the entire computer image and therefore if the PC hardware fails, getting the system back is easy.

Backups are run daily for each computer or virtual host.

3.13. Passwords

Passwords are controlled via the domain controllers. Each user will have their own password and can only be reset by a domain admin account.

Passwords for all equipment are controlled through a tool called KeePass. This will be handed over to the client once the project is complete.

3.14. Power Requirements

Power for the servers, network equipment shall be provided by two separate sources. One source will be UPS power, and the other source will be standard AC power.

In accordance with the NER v205 section §5.2.6.2 (2) the UPS must keep remote monitoring and control equipment available for at least 3 hours.

SCADA gateways and equipment associated with protection systems power will be supplied from X & Y battery chargers respectively. This equipment (Protection) related must be powered for a minimum of 8 hours in accordance with the NER.

4. SCADA Components

4.1. Networking

The following components make up network interfaces: -

Table 12 - Network Components

Type	Function
Hirschmann GRS1030	Substation Zone switches
Hirschmann GRS105 (Aggregate switch)	OT Zone switches
Palo Alto PA-440	OT Zone firewalls
Cisco C9200	DMZ Switches
Palo Alto PA-440	DMZ Firewalls
Starlink and 4G Backup	DMZ Modems

Equipment selection and model numbers will be developed during the detailed design phase.

The functional requirements for the Substation Zone switches are:

- Managed ethernet switch,
- Support access roles,
- Dual power supplies,
- Mirror port capability,
- Support for Hivision,
- Combination of Copper / Fiber ports supporting connectivity to protection relays, automation equipment and uplink ports,
- Support redundancy like RSTP, MRP or hyper-ring,
- Support ACL control lists,
- Support VLANs,
- Support syslogs,
- Support time sync via NTP.

The functional requirements for the OT Zone switches are same as above with additional functionality:

- High bandwidth,
- Network load control (QoS/Priority),

The functional requirements for the OT Zone firewalls are:

- Support Active / Passive failover (HA)
- Advanced threat protection
- Layer 7 packet inspection
- Centralised Management
- Throughput > 1 Gbps with threat protection enabled

4.2. Automation and control

The following components make up Automation and control interfaces: -

Table 13 - Automation Components

Type	Function
SEL3555	Substation Gateway 1 -
SEL3555	Substation Gateway 2 -
SEL2488	GPS Clock
SEL2240	Station BCU

The functional requirements for the Substation Gateway are:

- Comply with TNSP standards,
- Dual power supplies,
- Support DNP3 TCP/IP, Modbus TCP/IP as a minimum,
- Support SOE event logging,
- Role based access,
- Support comms multiple interfaces,
- Support IEC 61131 logic,
- Support NTP time sync.

The functional requirements for the GPS Clock are:

- Dual power supplies,
- Accurate time sync via GNSS,
- Support NTP, IRIG-B.

The functional requirements for the Station BCU are:

- Dual power supplies,
- Enough I/O for auxiliary functions (including spares),
- 24 VDC DI inputs,
- Support NTP, IRIG-B.

4.3. HMI

The following components make up the HMI interfaces: -

Table 14 - HMI Components

Type	Function
DELL R660xs	HMI SCADA Server 1
DELL R660xs	HMI SCADA Server 2
Schneider GeoSCADA	HMI Server (Redundant)

The functional requirements for the HMI SCADA Servers are:

- Dual power supplies,
- Dual CPUs,
- Memory 128 GB,
- Storage
  - 2x 480GB BOSS Raid 1 (used for hosting VMWARE ESXi),
  - 3x 960GB SSD SATA Raid 5 (Used for VMs),
  - 3x 2.4TB Hard Drive SAS Raid 5 (Used for Historian Data on VMs),
- Minimum of 4x1Gb NICs,
- iDRAC Enterprise.

For specific server details and allocation of VMs refer to PSD1834-200-002

The functional requirements for the HMI SCADA software (GeoSCADA) are:

- Redundant Server configuration,
- Minimum of 1 Year historic data,
- Estimated tag count between 60,000 to 70,000 will be required for site,
- 5 ViewX client licenses.

GeoSCADA will be setup in a redundant configuration. Below is an example of the setup of a redundant system.

Only one of the servers will be active at any point, with all data being synchronised to the standby server. If one primary server is shutdown then the standby server will take over and become the primary server.

HMI clients use software called ViewX. This software communicates to one of the servers with a backup link to the standby server should the primary server fail or be shut down.

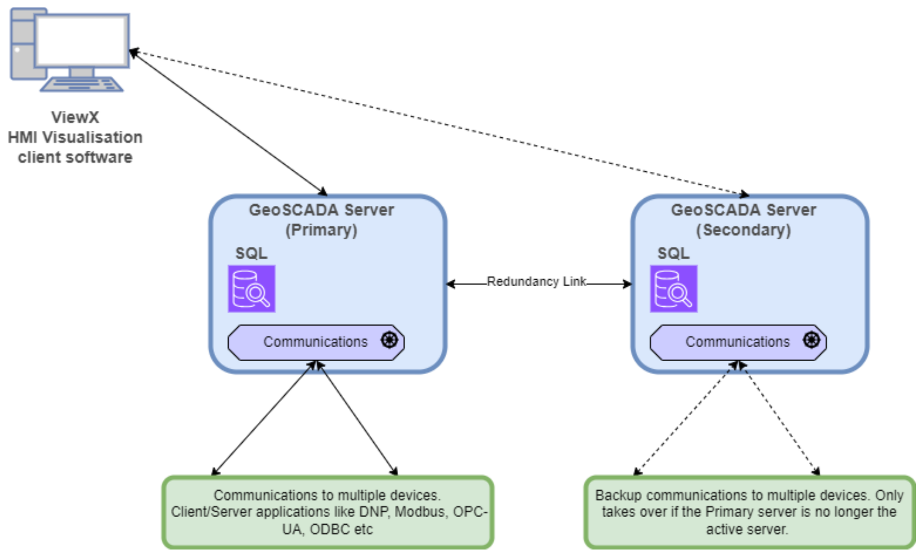


Figure 3 - GeoSCADA Architecture

4.4. Historian

Part of the HMI Server listed above.

4.5. Ancillary services & backup storage

Table 15 - Ancillary Service Components

Type	Function
Synology RS822RP+	NAS backup storage
VMWare Vsphere essentials or equivalent	Virtualisation

The functional requirements for the NAS backup storage are:

- Dual power supply,
- Minimum of 2TB drive space to store 7 years of PQM data,
- Minimum of 5TB drive space to store VM backup snapshots (3 weeks data retention).

5. *HMI*

5.1. User Access Control

User access can be configured depending on the end users' requirements.
Currently there are three levels of access to the HMI namely: -

- Guest - The Guest access level provides default read only access to the HMI,
- Operator – The Operator access level provides read / write access for operational control of the plant,
- Admin – The Admin access level provides configuration access to change settings etc.

We understand that Pacific Blue requirements indicate 6 levels of access control, however we would need to assess this against using the domain users to apply access permissions.

5.2. Layout

5.2.1. Introduction

The example HMI system detailed below is Geo SCADA by Schneider. This HMI will be the primary HMI system used for controlling the entire site. The following sections details of the main screens that have been developed will be shown. Note that this example is for a solar farm and the BESS will be developed as part of this project.

5.2.2. ViewX Overview

Figure 4 shows the Multiple Document Interface (MDI) layout of the HMI. The MDI layout is called ViewX and is a configuration and visualization tool.

ViewX has a couple of windows or panes that can be displayed during operation or during configuration editing. The left window can display either the database tree structure / OPC data / Queries etc. The bottom details an alarm banner showing the top few important alarms.

The main screen shows the overview page. This is named the Home page and is the default start up page when ViewX is started. Changing screens can be achieved by using the quick access menus.

Figure 4 - HMI Layout

5.2.3. HMI Conventions

The following conventions have been used for the HMI.

5.2.3.1. Line colouring

The table below details the colouring conventions used in the HMI: -

Table 16 - HMI Colours

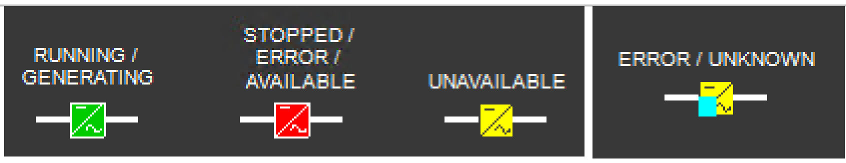
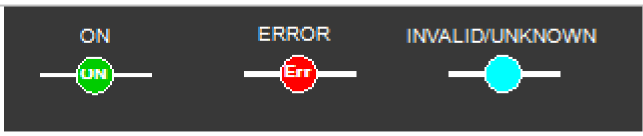
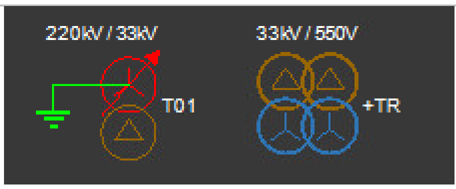
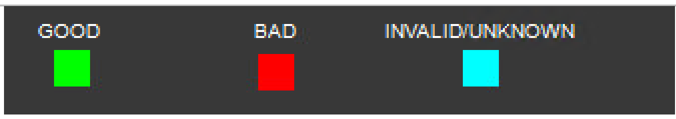
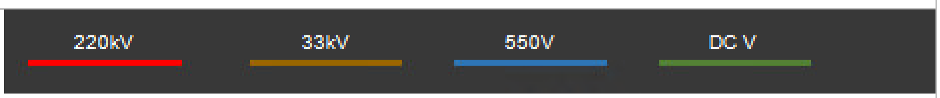
Designation	Colour	Application
Dynamic Colouring		
Gen On/ CB Closed / Local	Red	Plant Status
Gen Off / CB Open	Green	Plant Status
Intermediate	Yellow	Plant Status
Error / Bad Quality	Light Pale Blue	All dynamic indication
Analog Value	Dark Pale Blue	Analog Measurements
Eng. Value Exceeded	Magenta	Analog Measurements
Analog High-High Limit	Red	Analog Measurements
Network Equipment Fault	Red	Equipment Health
Network Equipment Healthy	Green	Equipment Health
Port Down	Red	Ethernet Link Status
Port Up	Green	Ethernet Link Status
Static Colouring		
275kV	Magenta	275kV Line Colour
132kV	Brown	132kV Line Colour
33kV	Green	33kV Line Colour
400V	Dark Pale Blue	400V Line Colour
Earth	Light Green	Earth Symbol Colour

5.2.3.2. Symbols

The following dynamic symbols have been used for the HMI.

Pls note the symbols below are from the example project and some of the colouring will be changed in accordance with pacific blue standards.

Table 17 - HMI Symbols

Designation	Symbols
Circuit Breaker	
Disconnector / Isolator	
Inverter	
Inverter Key Switch	
Transformer Symbols	
Device Health (Communications)	
BUS Voltage colouring	
Access Road	

5.2.4. Overview (Home Page)

The figure below shows the main home page, which is an overview of the plant, plant CB statuses, key MET station values and key PPC control and setpoint values.

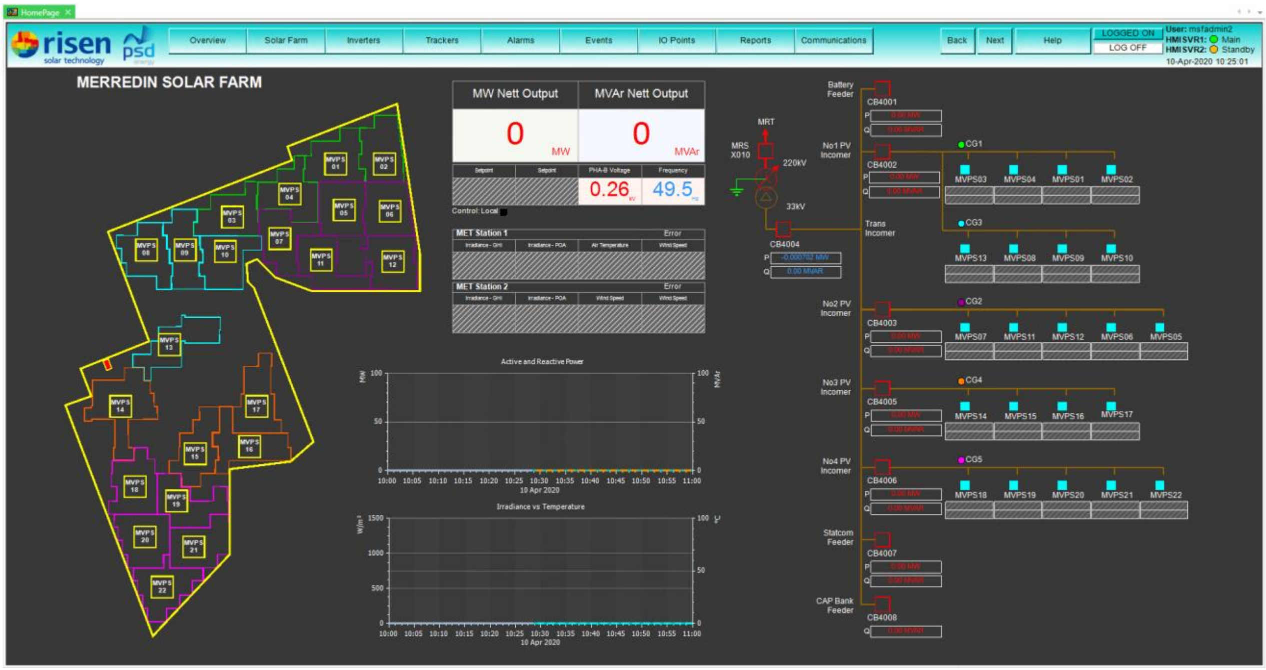


Figure 5 - Home Page

Clicking in one of the MVPS will open the applicable MVPS page as shown below. This displays the electrical status and power flow from each inverter.

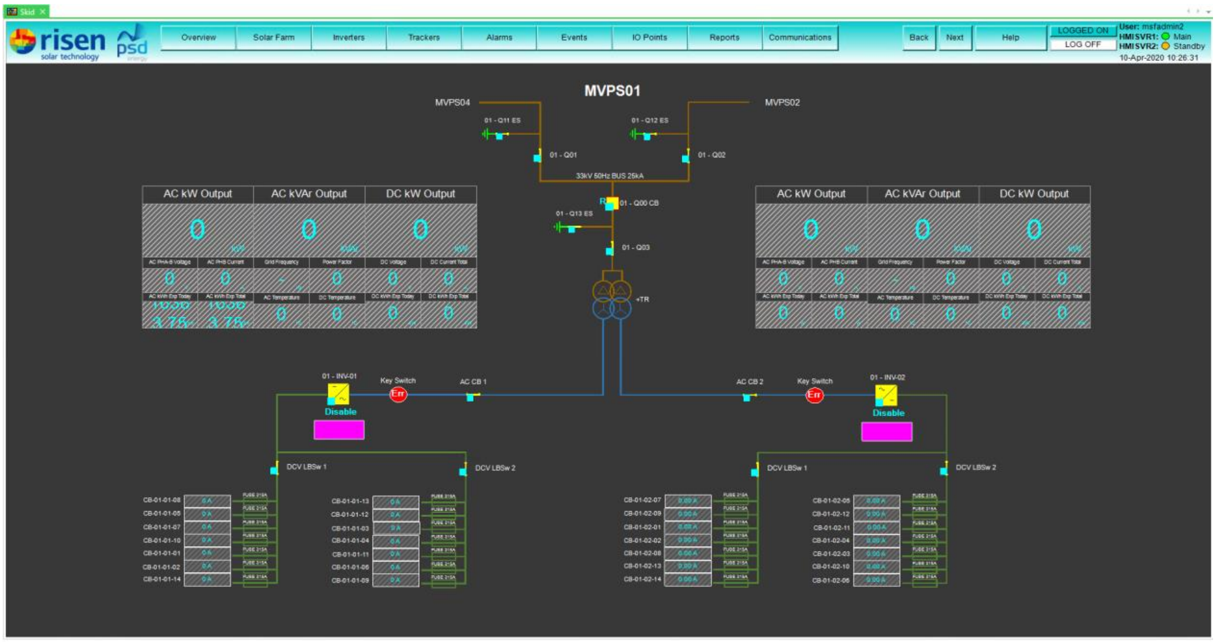


Figure 6 – MVPS Detail Page

5.2.5. Substation Overview

The figure below shows the substation overview. This page details all the plant statuses and key metering values. Accessing the detailed pages for the substation can be performed by hovering the mouse over the area as shown in Figure 8.

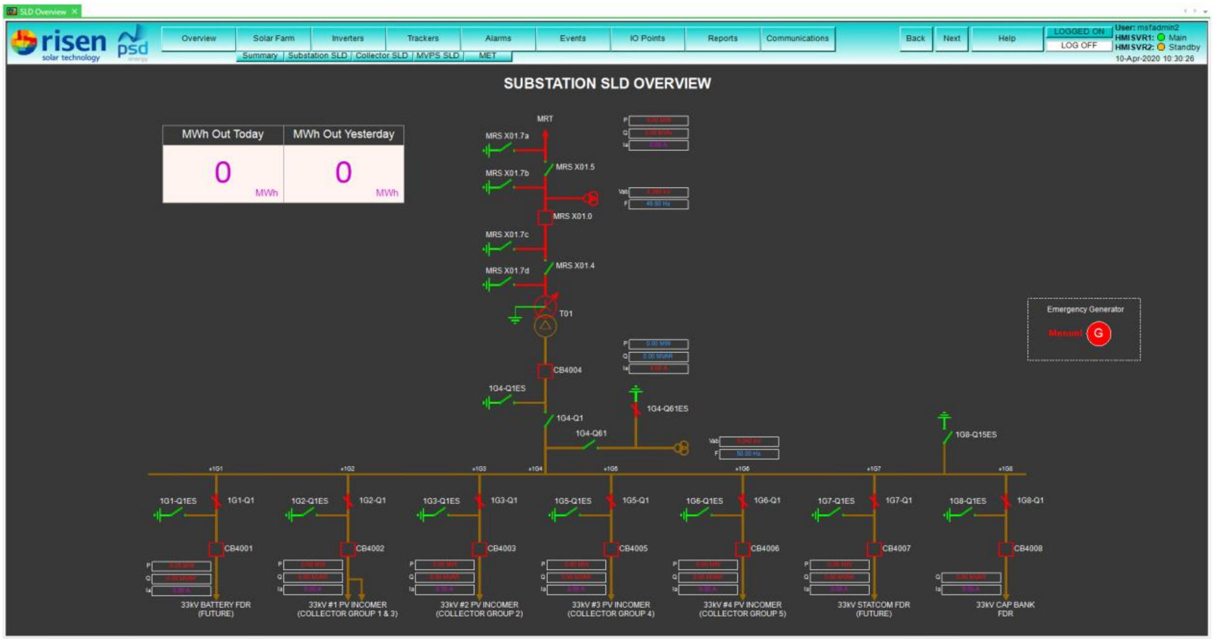


Figure 7 - Substation SLD Overview Page

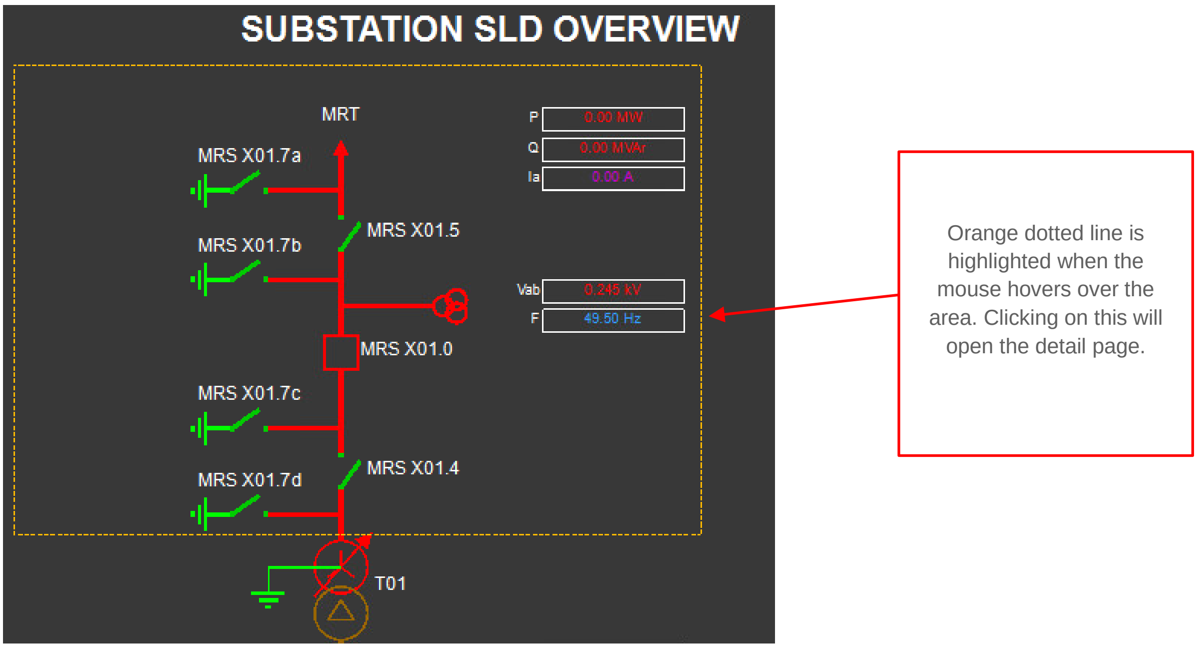


Figure 8 - Page Linking

Below is an example line detail page.

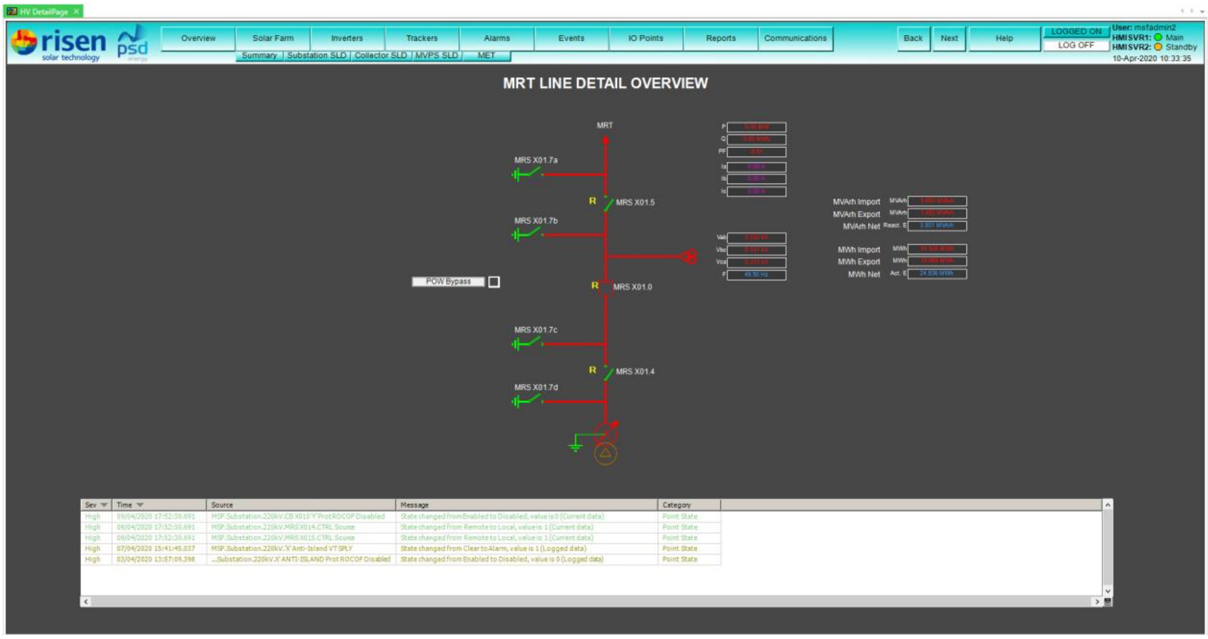


Figure 9 - MRT Line Bay Page

Below is the 33/220kV transformer control detail page.

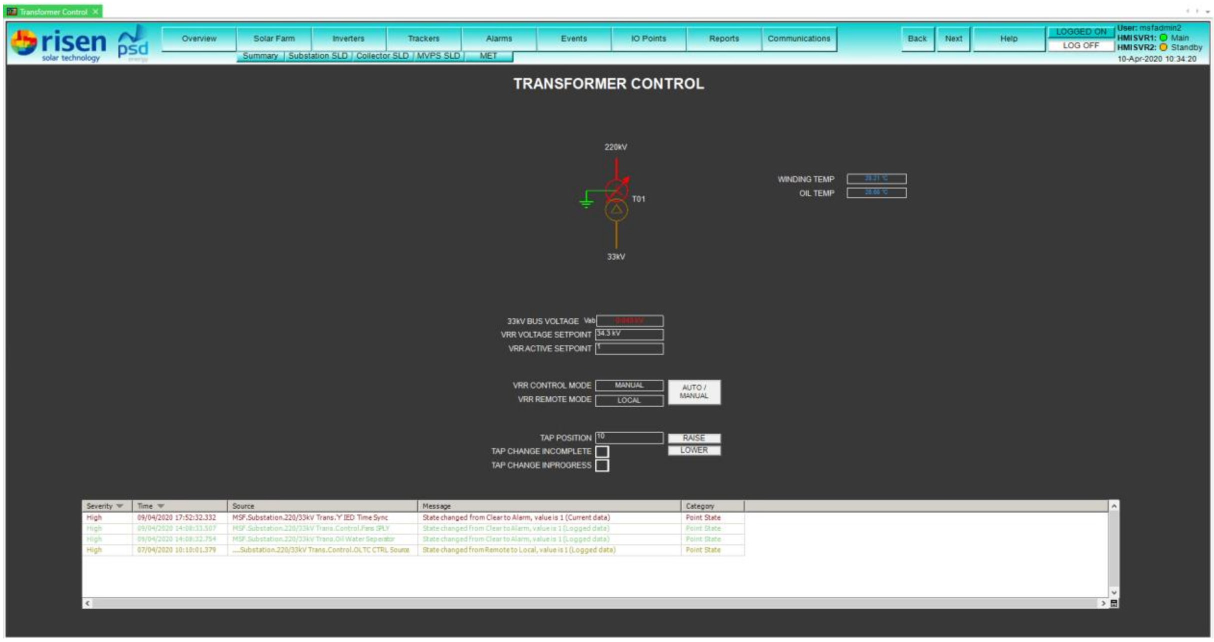


Figure 10 - 33/220kV Transformer Page

5.2.6. MVSG SLD

The figure below shows the Medium Voltage Switch Gear (MVSG) key plant status. This page can be used to see which MVPS is in / out of service. Accessing each MVPS can be achieved by clicking on the box.

Figure 11 - MVSG SLD Page

5.2.7. PPC (Power Plant Controller)

The figure below shows a typical PPC screen. This is where all setpoints for operating the plant can be controlled from.

Figure 12 - PPC Screen

5.2.8. Inverters – MVPS

Below figure shows the list of MVPS and their associated inverter power and status. Clicking on the MVPS number will display the details for each MVPS.

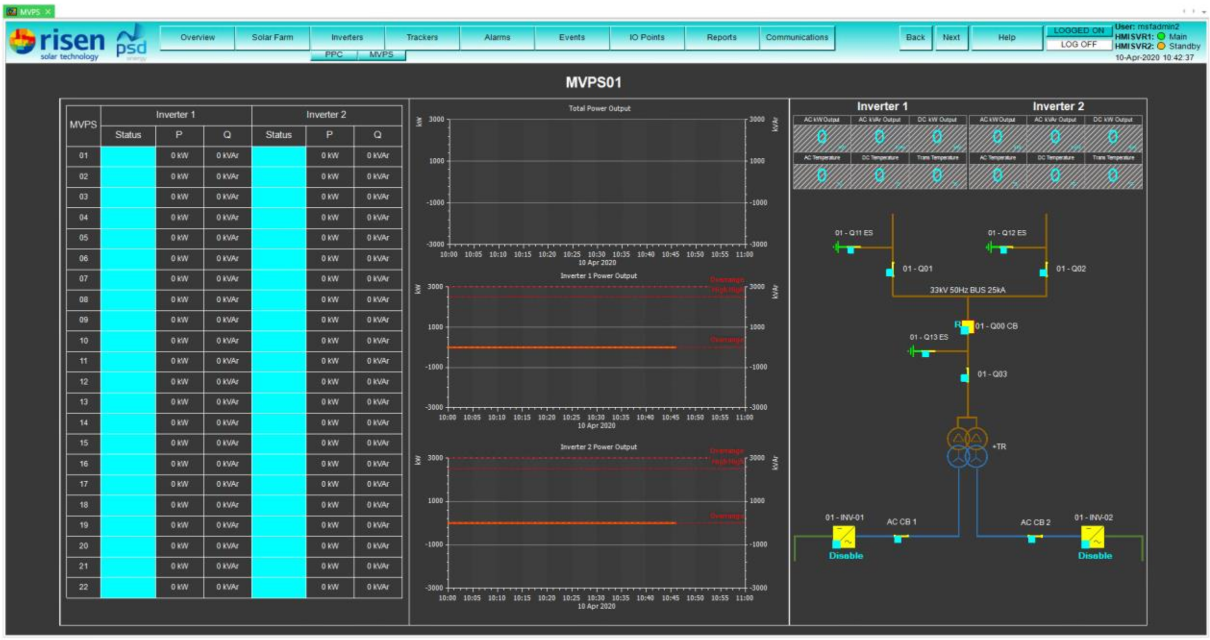


Figure 13 - MVPS Summary Page

5.2.9. Trending

Figure 14 displays one of the trends detailing the MWh accumulation over a month period. Different style trends can be displayed depending on the requirements. Operators can also dynamically create their own trends for fault finding requirements.

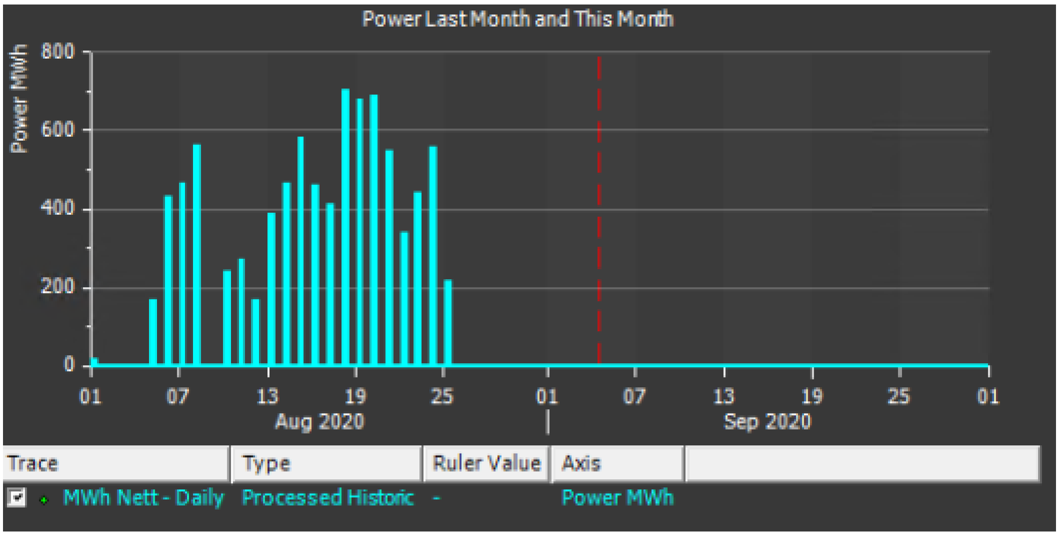


Figure 14 - Trends

5.2.10. Alarms and Events

The figures below show the alarms and event page. The information displayed here assists the operator in attending critical alarms first and non-critical alarms later.

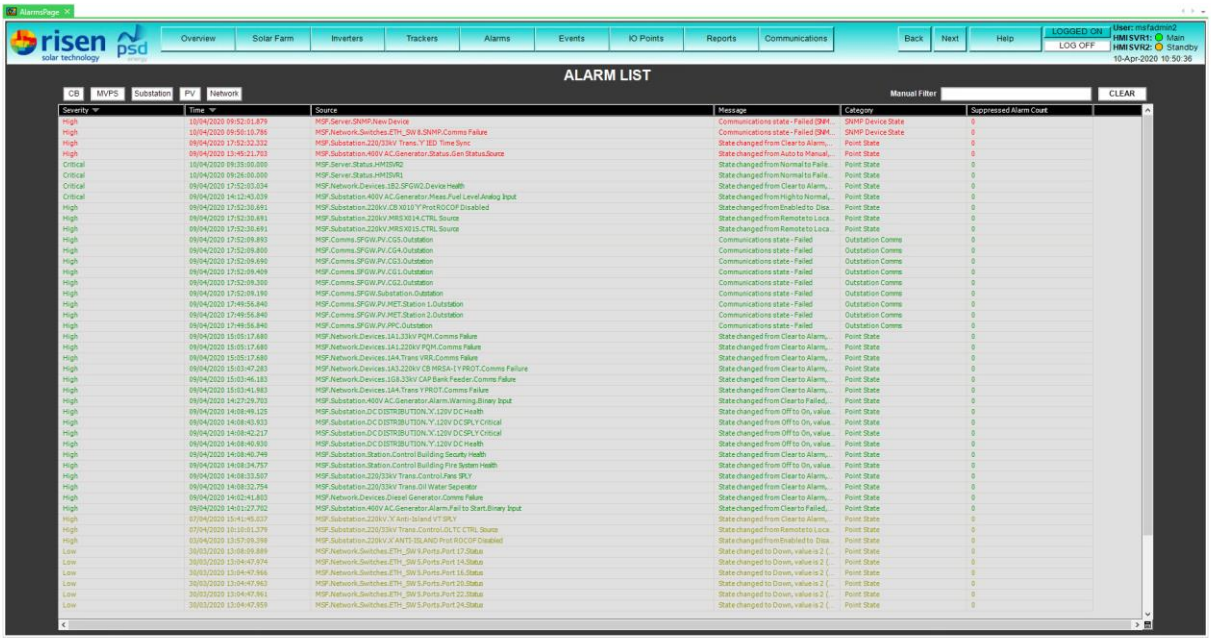


Figure 15 - Alarms Page

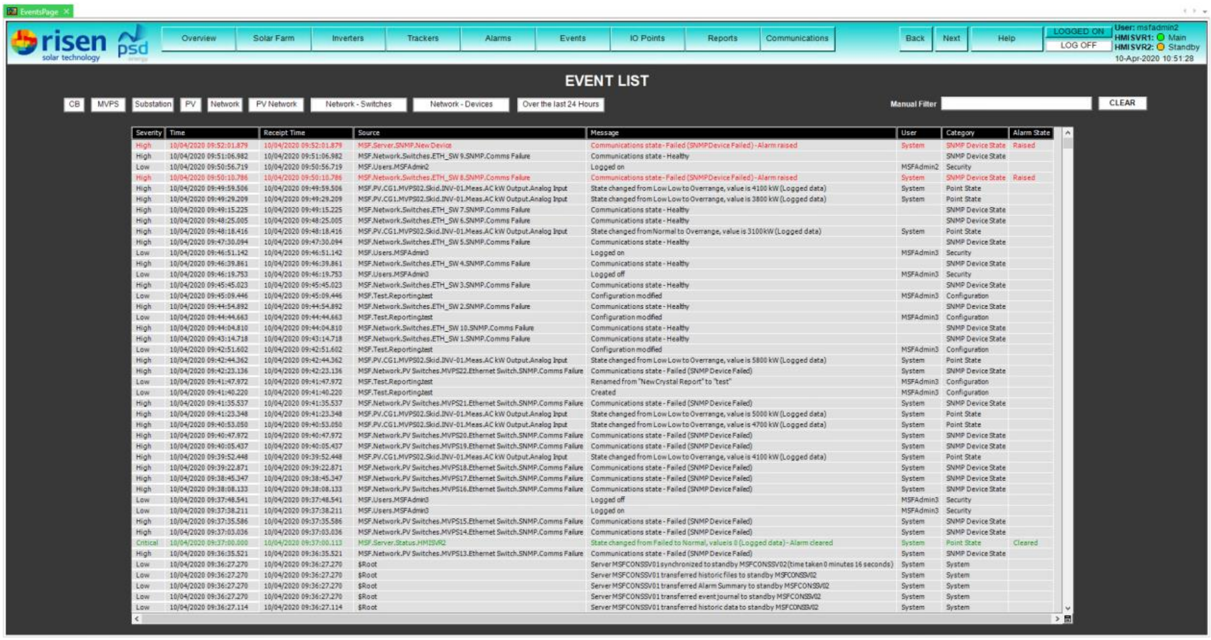


Figure 16 - Events Page

Figure 17 shows the options available for handling alarms. Alarms can be acknowledged, disabled or filtered depending on the requirements.

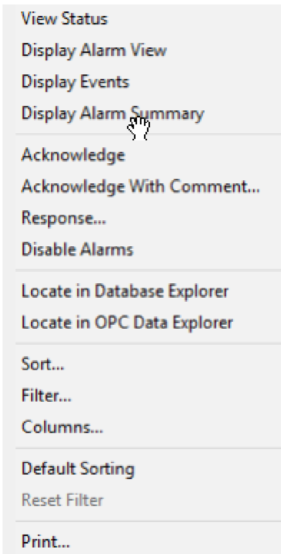


Figure 17 - Alarm Functionality

5.2.11. IO Points

The I/O points page details each tag and the status of that tag. The user can perform some high level predefined filters to narrow the search.

Figure 18 - I/O Points Page

5.2.12. Communications

The figures below show the communications overview, network topology and device statuses.

The communication overview displays the communication status of the HMI to each outstation. An outstation is terminology used by Geo SCADA representing the device the HMI is communicating to.

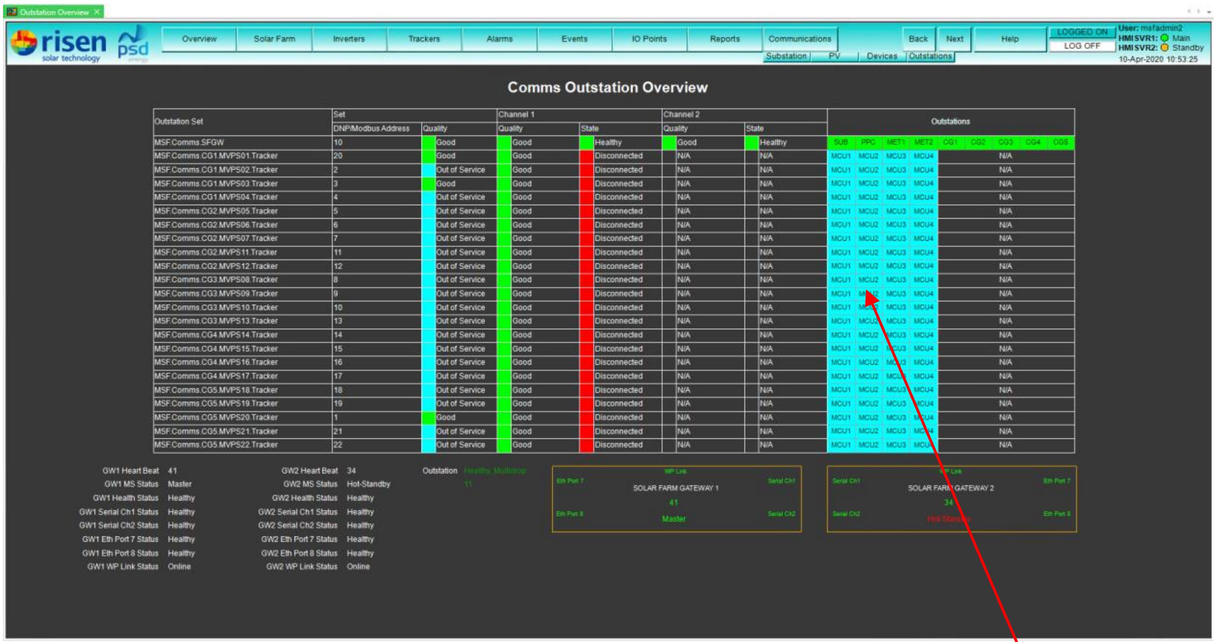


Figure 19 - Communications Overview page

Clicking on the outstation will display the Settings and communication status for that outstation as shown in Figure 20.

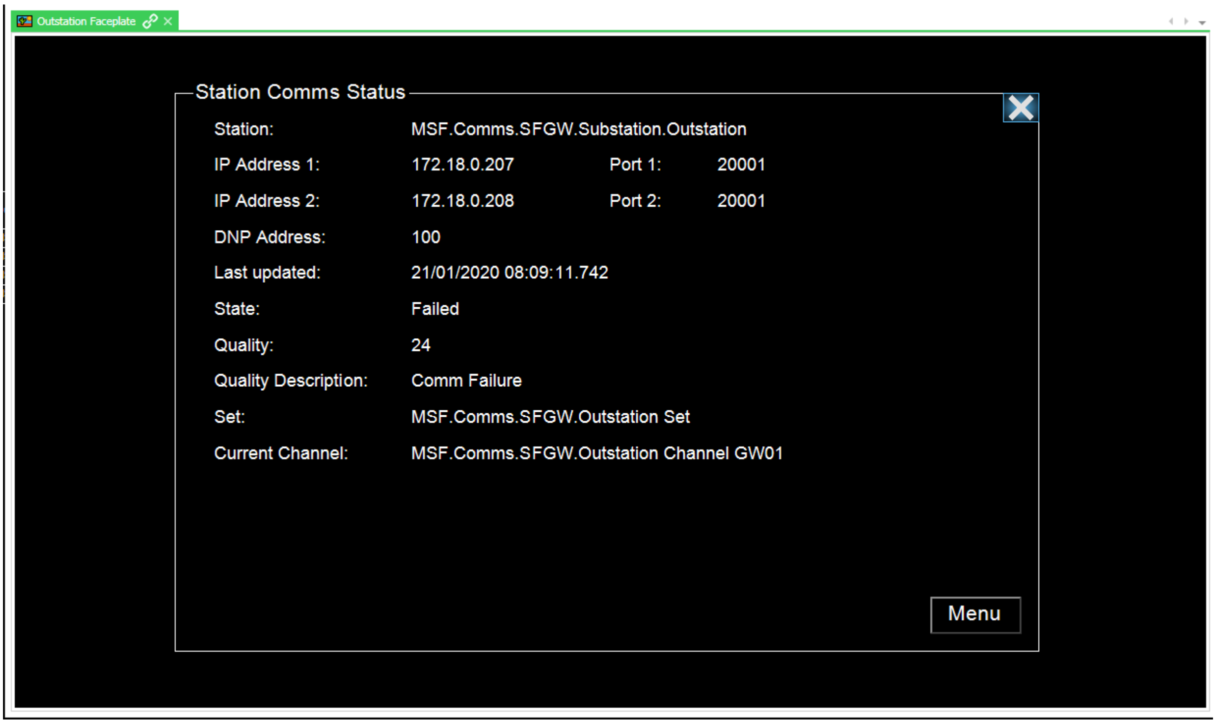


Figure 20 - Outstation Communications Status

The communications section also details the Network Communications overview for the entire site. This details all the ethernet switch connections to every device. The ethernet switch port status is monitored via SNMP, so any ethernet port link that fails will be detected, alarmed and displayed.

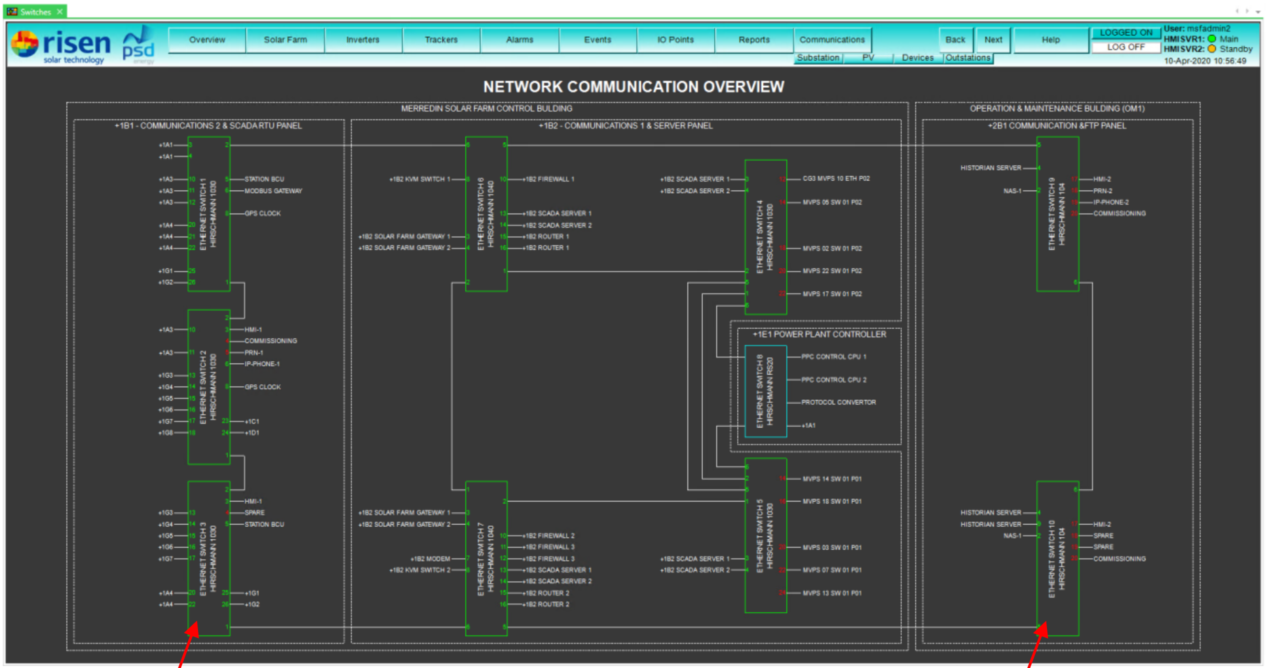


Figure 21 - Network Overview Page

Clicking on the port description will open the device page as shown in Figure 23

Clicking on the ethernet switch will display the settings and communication status for that switch as shown in Figure 22.

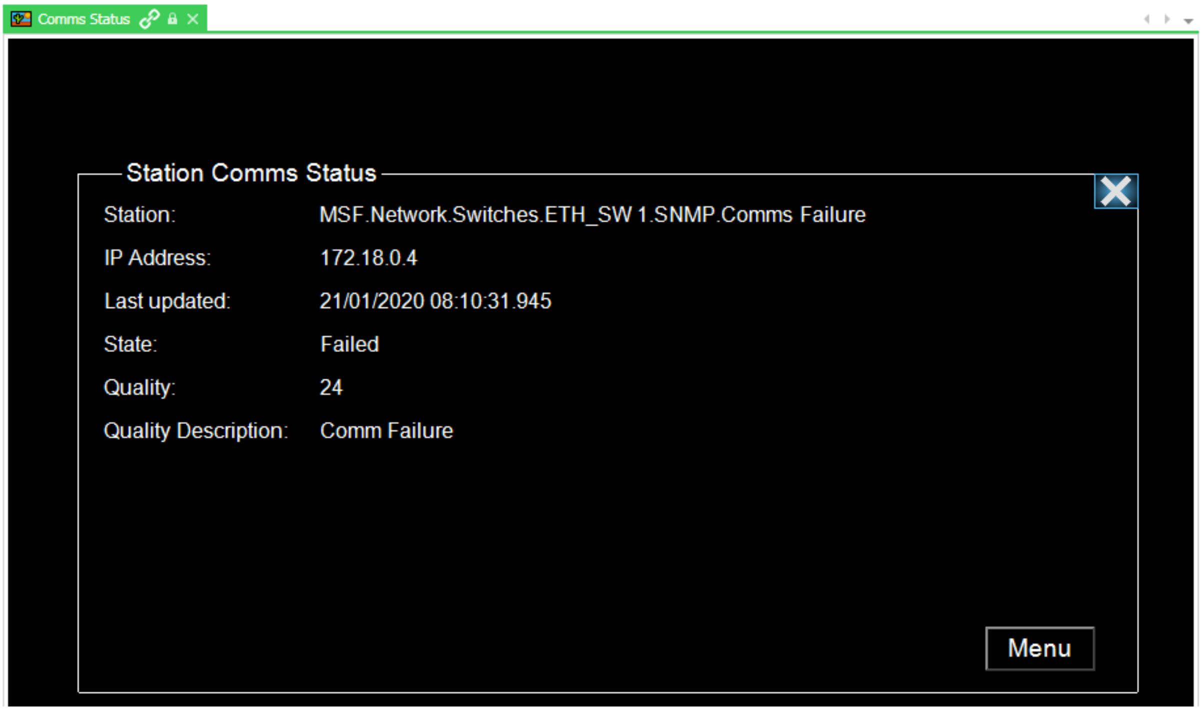


Figure 22 - Ethernet Switch SNMP Communications Status

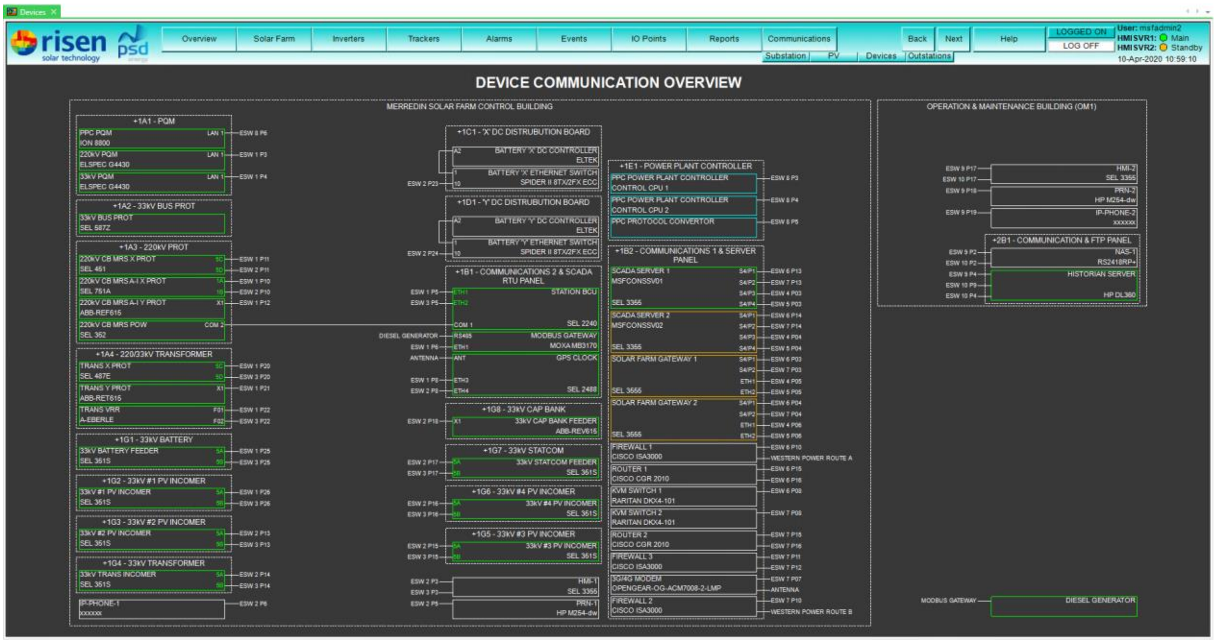


Figure 23 - Device Communications Overview Page