حكومة دبي
GOVERNMENT OF DUBAI

هيئة كهرباء ومياه دبي
Dubai Electricity & Water Authority

D33 SOLAR PV INITIATIVE
MONITORING AND CONTROL SPECIFICATIONS

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1. Introduction and Context

1.1 Document Scope and References

1. This document defines the requirements / specifications for the monitoring and control of solar photovoltaic (PV) plants connected under the D33 solar PV initiative to DEWA grid. These requirements set forth the functional and technical specifications for the various components of the PV system, covering the power plant controller (PPC), the inverter(s), and the communication equipment(s).

2. This document complements DEWA standards relevant to the project scope "Standards for Distributed Renewable Resources Generators Connected to The Distribution Network", referred to as DRRG Standards;[1]

1.2 D33 Solar Feed-in Tariff Policy

3. In accordance with the D33 Initiative's Feed-in Tariff policy under "Connection Conditions for Captive Generators of Electricity for D33 Solar PV Initiative", DEWA grid operator has the right to limit the active power generated from the PV plant, i.e., limit any excess generation not used for self-consumption from being fed into the grid. The active power control limitation does not entail the load to be disconnected from DEWA grid. This right from DEWA to limit excess generation and hence export to DEWA grid is referred to in this document as D33 Solar Feed-in Tariff Policy.

4. The D33 Solar Feed-in Tariff Policy can be utilised by DEWA in both winter and summer depending on the grid operating conditions. As per Connection Conditions for Captive Generators of Electricity for D33 Solar PV Initiative the excess generation fed into DEWA grid shall be compensated under a Feed-in Tariff scheme only for the period between 1st March till 30th November, whereas for the period between 1st December till 28th February (29th in case of leap years), no compensation shall occur.

5. The D33 Solar Feed-in Tariff Policy is in place to ensure the safe and reliable operation of DEWA's distribution and transmission systems during normal and emergency situations. This includes circumstances such as electricity grid constraints, ongoing grid maintenance, or to prevent oversupply during winter.

1 https://www.dewa.gov.ae/-/media/Files/Customer/DEWA_Standards_for_Distributed_Renewable_Resources_Generators.ashx

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1.3 DEWA - D33 Customer RASCI Matrix for D33 Monitoring and Control

Table 1-1 RASCI matrix for D33 installations.

Item	DEWA	Customer	Remarks
Supply and installation of PV inverter(s) and PV modules	C	A/R	DEWA will approve design as per DRRG standards and complementary requirements / specifications mentioned in this document in section 3.1
Supply, installation, configuration of PV power plant controller (PPC)	C	A/R	DEWA will approve design as per DRRG standards and complementary requirements / specifications mentioned in this document in section 3.2
Supply and installation of DC System	C	A/R	DEWA will approve design as per DRRG Standards and complementary requirements / specifications mentioned in this document in section 3.3
Site readiness for telecommunication equipment	C	A/R	Installation requirements for telecommunication equipment will be provided by DEWA after site survey. The customer is accountable and responsible for supply, installation, configuration of communication equipment.
Supply, installation, configuration of telecommunication equipment	R	A/R	

Table 1-2 RASCI matrix legend.

Legend RASCI	
A = Accountable	The one ultimately answerable for the correct and thorough completion of the deliverable or task, the one who ensures the prerequisites of the task are met and who delegates the work to those responsible.
R = Responsible	Those who do the work to complete the task. There is at least one role with a participation type of responsible, although others can be delegated to assist in the work required (see support).
S = Supportive	Resources allocated to support the responsible. Unlike consulted, who may provide input to the task, support helps complete the task.
C = Consulted	Those whose opinions and approvals are sought.
I = Informed	Those who are kept up to date on progress, often only on completion of the task or deliverable; and with whom there is just one-way communication.

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2. PV Plant Connection Under D33

6. The connection of PV plants to DEWA grid shall follow the DRRG requirements under "Table-2 - Segmentation of New Renewable Resource Generating Plants".

7. For plants with maximum continuous active power (indicated as Pmc) above 0.4 MW, they will be connected to the MV network;[2] the PV plants shall follow the connection schemes as outlined in Figure 2-1 and Figure 2-2.

8. The PV inverters shall be connected to the feeders via step-up transformers, with several inverters sharing one. The interface switch can be on the MV side as in Figure 2-1 or on the LV side as in Figure 2-2, respectively.

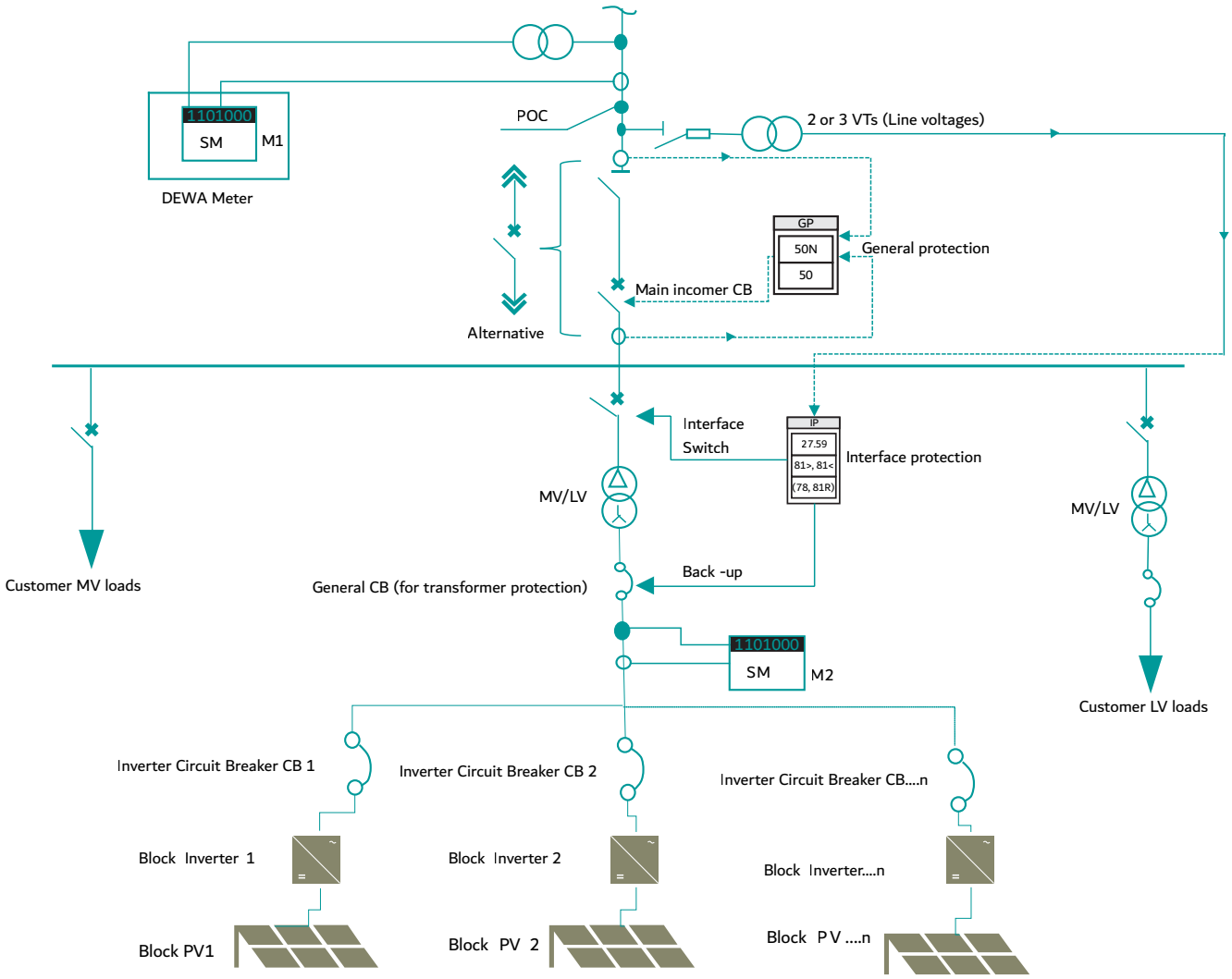

Figure 2-1 D33 PV plants connection scheme to DEWA grid on MV network - interface switch on MV side. (Source: DEWA DRRG Standards)

2 A connection to a lower voltage level network is deemed feasible (in case of a feeder which can bear power larger than the threshold as per Table 1 under the DRRG Standards).

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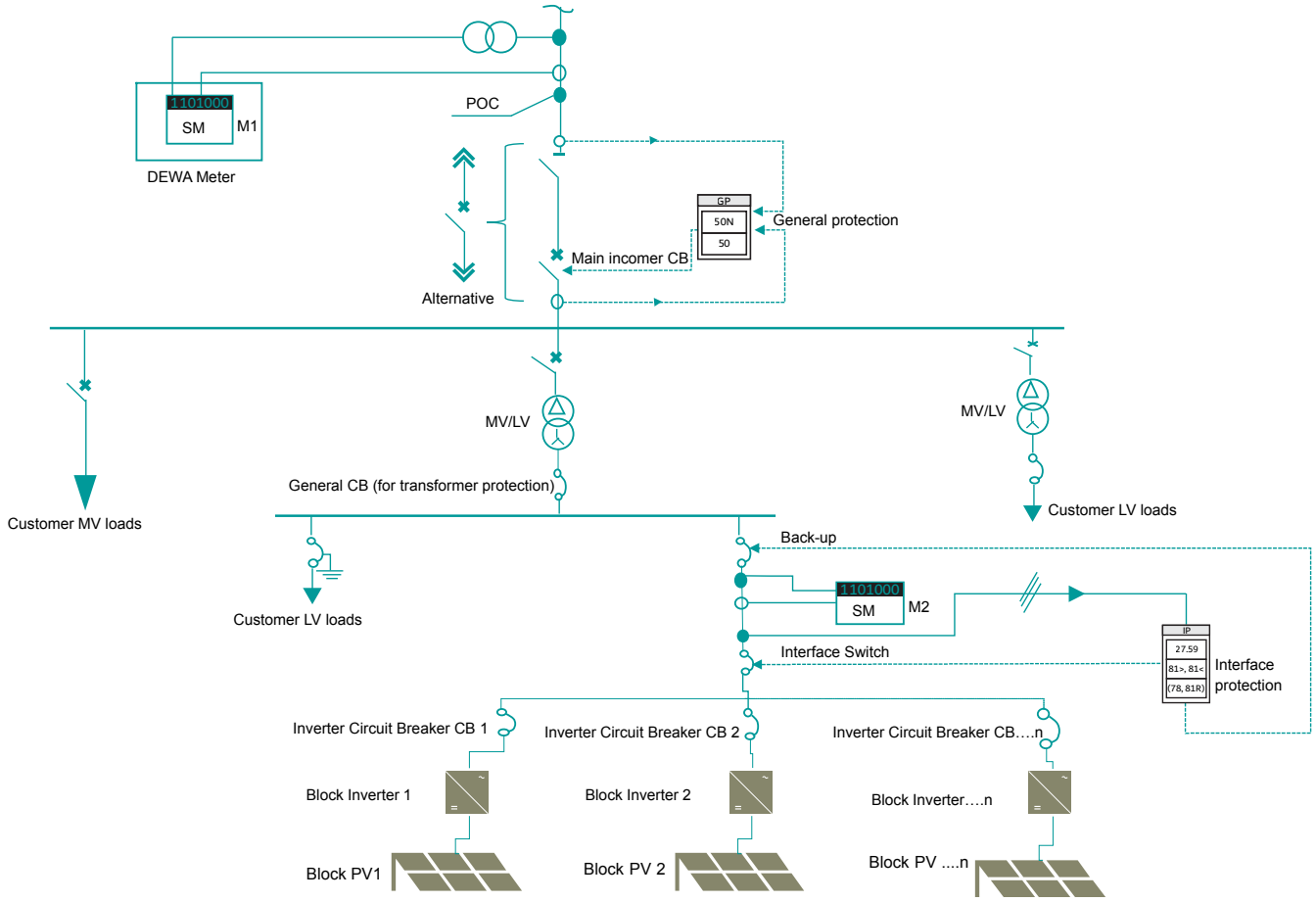

Figure 2-2 D33 PV plants connection scheme to DEWA grid on MV network - interface switch on LV side. (Source: DEWA DRRG Standards).

9. The control requirement under D33 initiative mandates the inclusion of a PPC. Figure 2-3 shows the high-level architecture for the PV Plant system including all necessary data flow and communication between different components within the PV plant and the connection with external control system, i.e., DEWA control centre.

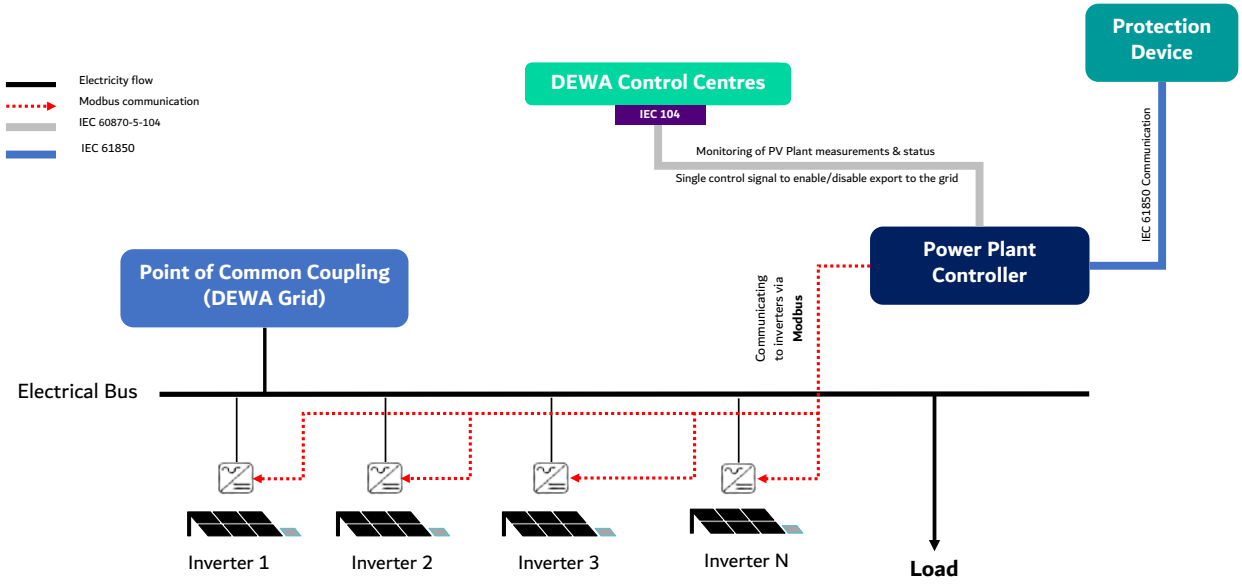

Figure 2-3 High-level architecture of the PV plant, connected to the PPC and receiving control commands from DEWA Control Centres.

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3. Specifications of PV System Components under the D33 Solar PV Initiative

3.1 Inverter

3.1.1 Existing Technical Specifications for Inverters under Shams Dubai

10. Inverters' technical requirements, as part of the DRRG Standards under Section 2 "technical requirements", define equipment ratings, protection grades, earthing and protection schemes, power quality, and safety requirements.

11. Additional requirements for the inverters to communicate with the external PPC shall be outlined hereafter.

3.1.2 Amending with Monitoring and Control Specifications for Inverters

12. All inverters connected under the D33 Solar PV Initiative shall be able to communicate with an external PPC via Modbus TCP or Modbus RTU RS 485 protocol, depending on the available interface.

13. The PPC will monitor measurements from the inverter, as well as send set / reference points as the control command to the inverter to regulate the active power and reactive power in accordance with the DRRG Standards or D33 Solar Feed-in Tariff Policy.

14. **Monitoring requirement(s):** The monitoring of inverter measurements, as well as alarms and status shall be in accordance with the defined **Signal List in subsection 4.2** under **Table 4-5**.

15. **Control requirement(s):** As per the DRRG Standards, the active power output of renewable resources shall be controllable and capable of receiving an instruction containing a required set point, given manually or through automatic remote-control system, i.e., commands of ramping-up or ramping-down power as elaborated hereafter.

3.1.2.1 Active power control

16. The following diagram for the inverter control shows either (i) the options for remote-control via an external command or (ii) the DRRG requirements section 2.4.3. The selection will take place through the switch as outlined in the control diagram.

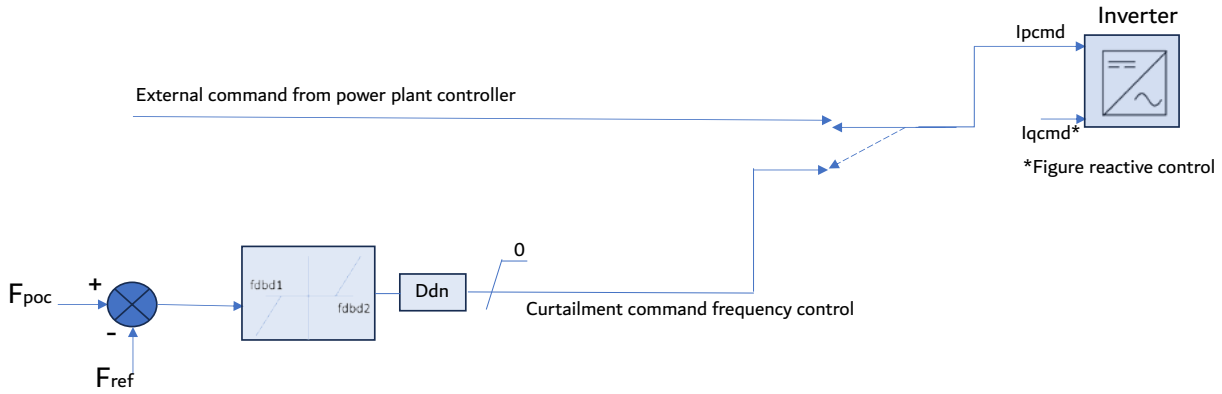

Figure 3-1 Switching between active control via remote-control external signal or internally via the inverter to meet DDRG requirements.

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17. The inverters shall have the ability to control the active power in case of the elevation of the frequency above a reference point, currently at 50.3 Hz threshold under DRRG Standards. Above this value, the active power shall be curtailed according to the curve shown in Figure 3-2. It shall be decreased linearly by a minimum of 45.5% (droop equivalent to 4.4%) of nominal active power per Hz until 52.5 Hz. The deviation in the frequency is multiplied by a gain that converts it to a change in power signal and hence a curtailment command is sent to the inverters to reduce the active power according to the droop function.

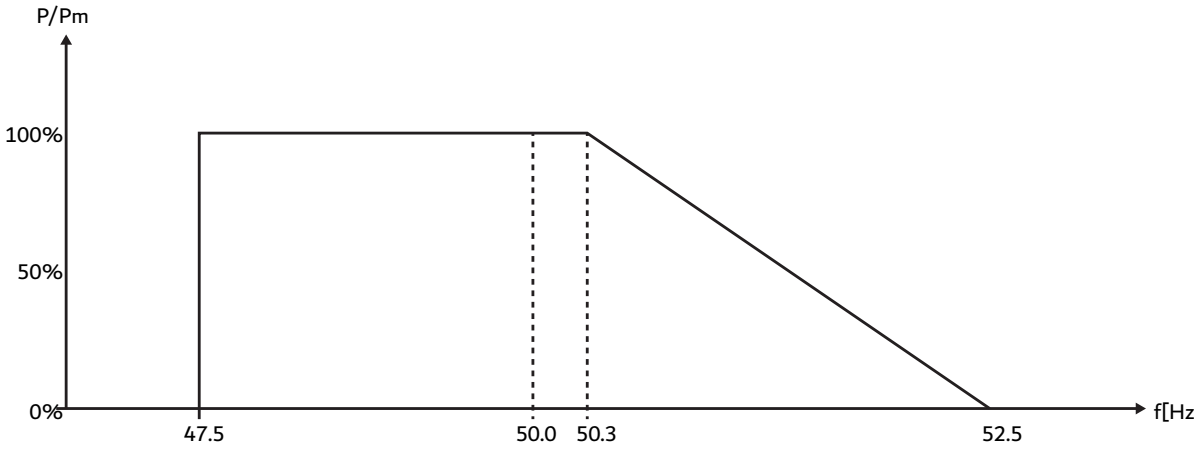

Figure 3-2 Curtailment curve as per DRRG requirements. (Source: DRRG Standards).

3.1.2.2 Reactive power Control

18. As per DRRG Standards section 2.4.4, non-synchronously connected renewable resource generating units with a maximum capacity larger than 400 kW, connected to the MV Distribution Network, shall be able to provide a reactive power as a function of the active power, according to a semi-circular capability curve as outlined in Figure 3-3. This curve represents the acceptable range of operation for nominal voltage, as illustrated by the hatched area.

19. For a low produced apparent power, i.e., S ≤ 10% Sn, due to the uncertainty of the inverter behaviour, there are no particular requirements in terms of reactive power provision.

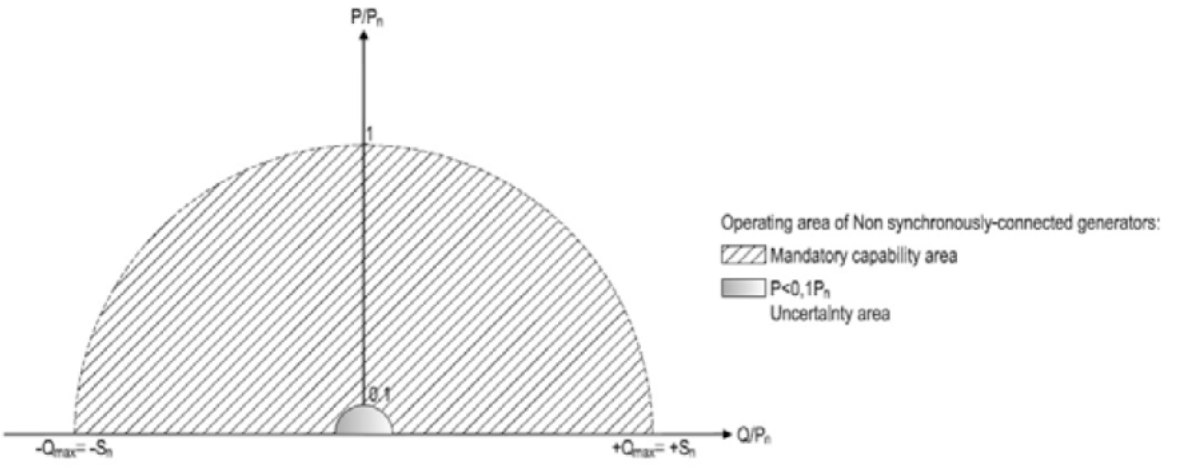

Figure 3-3 Non-synchronous connected generator operation area. (Source: DRRG Standards).

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20. To achieve voltage regulation for a renewable resource connected to MV distribution network, the provision of reactive power shall be automatic, with a local logic, according to one of these two (2) methods:

- Fixed and settable power factor (as in Figure 3-4 curve type a).

- Power factor as a function of the produced active power (P), according to a curve defined by three points A, B, C (as in Figure 3-4 curve type b). This is activated when P > 0.5 P_n and when $V_{inv} > V_{locking}$ and deactivated otherwise.

21. The voltage at the inverter terminals shall also be discriminating, making this contribution possible only when the voltage exceeds a lock-in voltage adjustable in the range 1.0 V_n - 1.1 V_n and stopping it when the voltage falls below a lock-out voltage settable in the range 0.9 Vn – 1.0 V_n, with V_n as the nominal voltage at the inverter terminals.

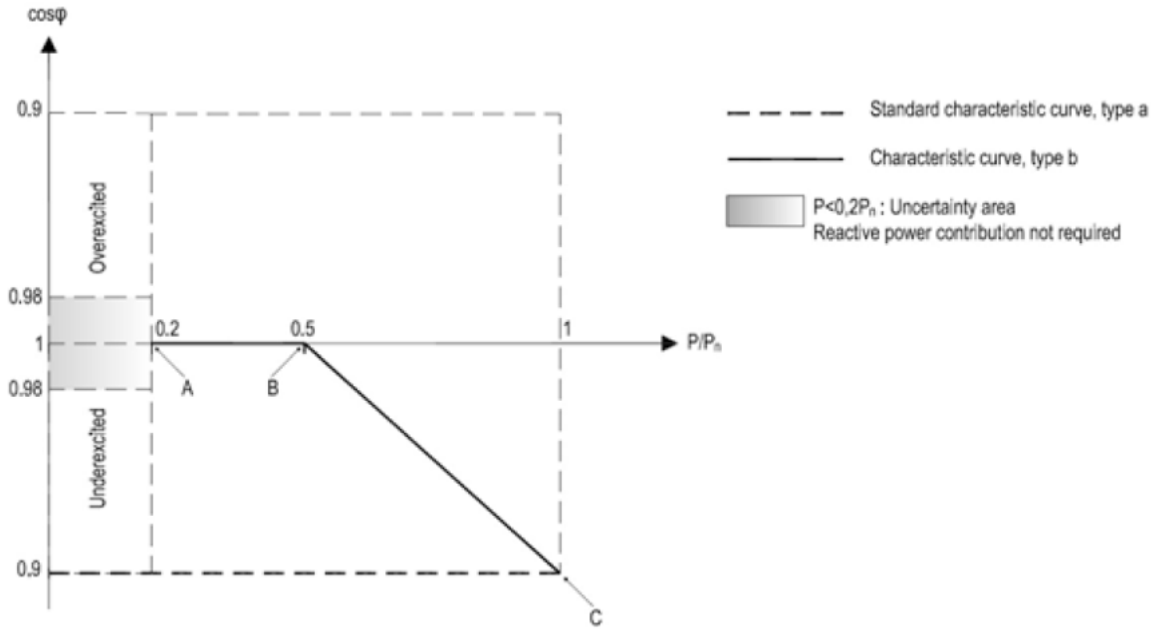

Figure 3-4 Reactive power (cos ϕ) as a function of the active power. (Source: DRRG Standards).

22. Similar to active control, upon the request of DEWA operator, the control signal to the inverter shall take place via (i) the options for remote-control suing an external command / set point; (ii) internally to meeting the DRRG requirements; or (iii) by setting phase angle cos(ϕ) to unity. The selection will take place through the switch as outlined Figure 3-5.

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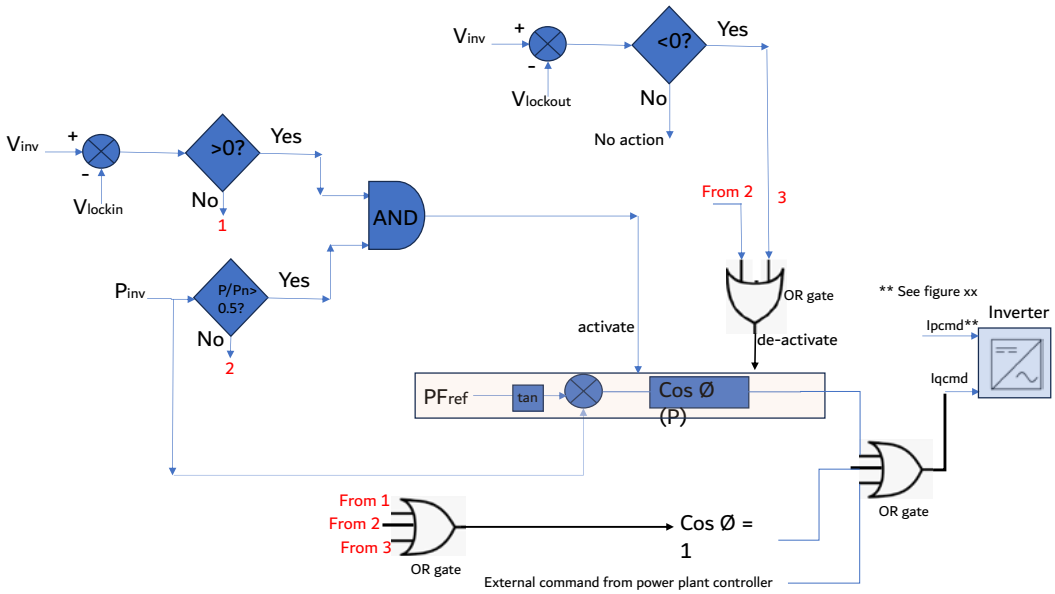

Figure 3-5 Switching between reactive control via remote-control external signal or internally via the inverter to meet DDRG requirements.

3.2 PV Power Plant Controller

23. The PV PPC is the component controlling the inverters, thus enabling D33 Solar Feed-in Tariff Policy. The PPC also acts as the interfacing component with DEWA CONTROL CENTRES enabling remote monitoring and control of the PV plant from DEWA Control Centres in real-time.

24. The functionality of zero-export in a solar PV system would requires an additional new bi-directional power-meter on the incoming side point of grid interconnection (POC). This power meter must have Modbus Protocol Communication capability enabling communication with the PPC device for reading active power values.

3.2.1 PV PPC Inverter Control Interface

25. The interfacing between the PPC, the inverter and the DEWA grid is outlined in Figure 3-6 and follows and consists of three (3) key models:

26. **Power Plant Controller Model**: It measures several magnitudes at the point of interface (POI), solves the algorithms and sends the power commands (P_{CMD} and Q_{CMD}) to the control model.

27. **Control Model:** It measures voltage at inverter terminals and receives power commands from the PPC model, then computes the current loops and sends the new active and reactive current commands (Id_{CMD} and Iq_{CMD}) to the generator model.

28. **Generator Model:** It injects active and reactive current into the grid in response to control commands.

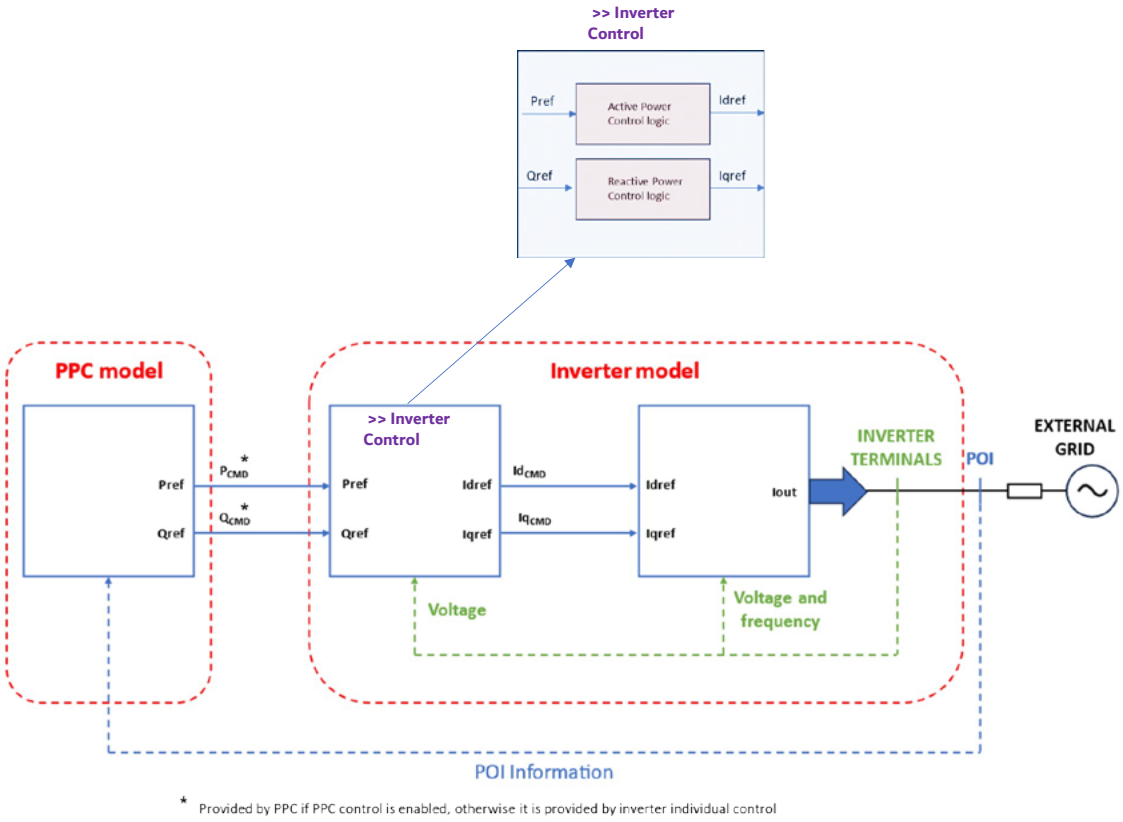

Figure 3-6 Interfacing between PPC, the inverter and the DEWA grid.[3]

3.2.2 PPC General requirements

29. The PPC/RTU shall be programmable, based on a microcomputer interconnection system, with a real-time clock, synchronized by an external source, process Input and Output (I/O) modules, CPU, memory and data transmission equipment.

30. The PPC/RTU shall be modular type and expandable by adding additional I/O modules.

31. The PPC/RTU shall be fully equipped for the actual amount of data to be acquired and commands to be executed based on actual site design and the DEWA Signal list under Table 4-5.

32. The PPC/RTU shall be capable of operating with an ungrounded or grounded (either polarity) input power supply of 24 VDC.

33. Diagnostic tools shall be provided to monitor fault inside the PPC/RTU related to hardware and firmware (e.g. buffer overflow, communication failure, firmware halt, time synchronization failure, module failure, SD card removed, etc.),with the capability to transmit this data to master station as two grouped alarms (major and minor).

34. The PPC/RTU shall have the facility for database and parameter setting by menu-controlled dialogues from a local PC and remotely from central location with remote downloading function.

3 Generator and control are part of the inverter model.

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35. The I/O modules shall be replaced without reprogramming, redefinition of configuration parameters or rewiring of any PPC/RTU part.

36. The PPC/RTU to be supplied and installed shall provide at least the following functions:

i. Single command outputs, double command outputs (direct execute & check back before executing).

ii. Single and double state digital inputs.

iii. Analogue measured input function.

iv. Analogue setpoint command output function.

v. Sequential Event Recording (SER) with time stamping of events at the PPC/RTU.

vi. PPC/RTU time synchronization from the master station via NTP, with all NTP parameters configurable (e.g. polling interval, Sync timeout, local time format, etc.).

vii. Self-testing and diagnostic functions for detection and reporting of any error.

viii. Automatic safe mode restarting function.

37. The PPC/RTU shall have a common port for parameter / firmware downloading and diagnostic capability.

38. The PPC/RTU shall include remote downloading and diagnostic communication with separate authentications.

39. All the materials used shall operate within a temperature range of +65 degrees Celsius and humidity up to 95%.

40. The cyber-security requirement is outlined in appendix 6.2.

41. Upon DEWA's request, type test certificates/reports for the PPC/RTU shall be submitted to DEWA.

3.2.3 PV PPC Logic

42. The PV PPC shall be capable of providing a ramp-up or ramp-down command to control the inverters' active power. Three (3) cases are highlighted below, in addition to the control action required in each case.

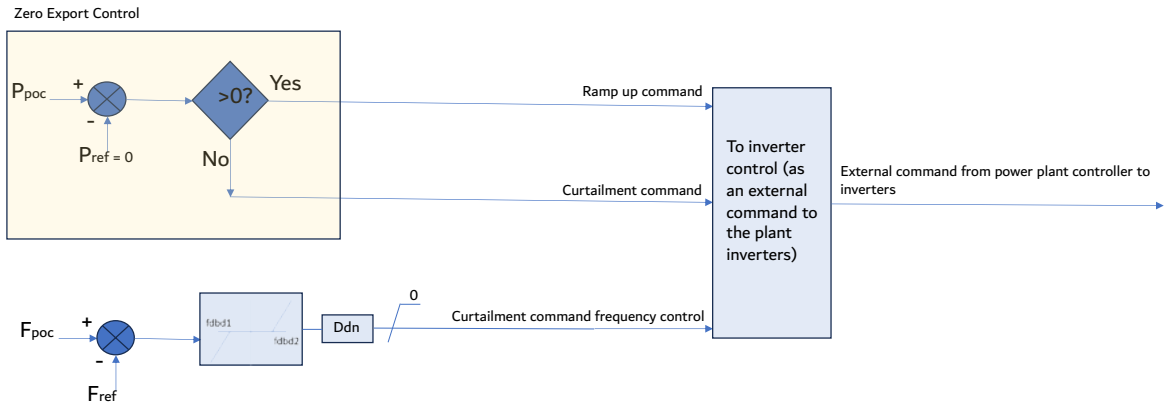

Figure 3-7 Logic of control commands provided by the zero-export controller to inverters.

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3.2.3.1 Case 1: $\Sigma P_{gen} > P_{load}$

43. Under this case, the generated power from the PV modules is higher than the load / demand at the customer side. This leads to a situation where excess power is exported towards the grid; here, P_{poc} shall have a negative value, i.e., less than zero, and hence a curtailment command shall be issued to the inverters to reduce the generated power, achieving the D33 Feed-in Tariff policy requirement.

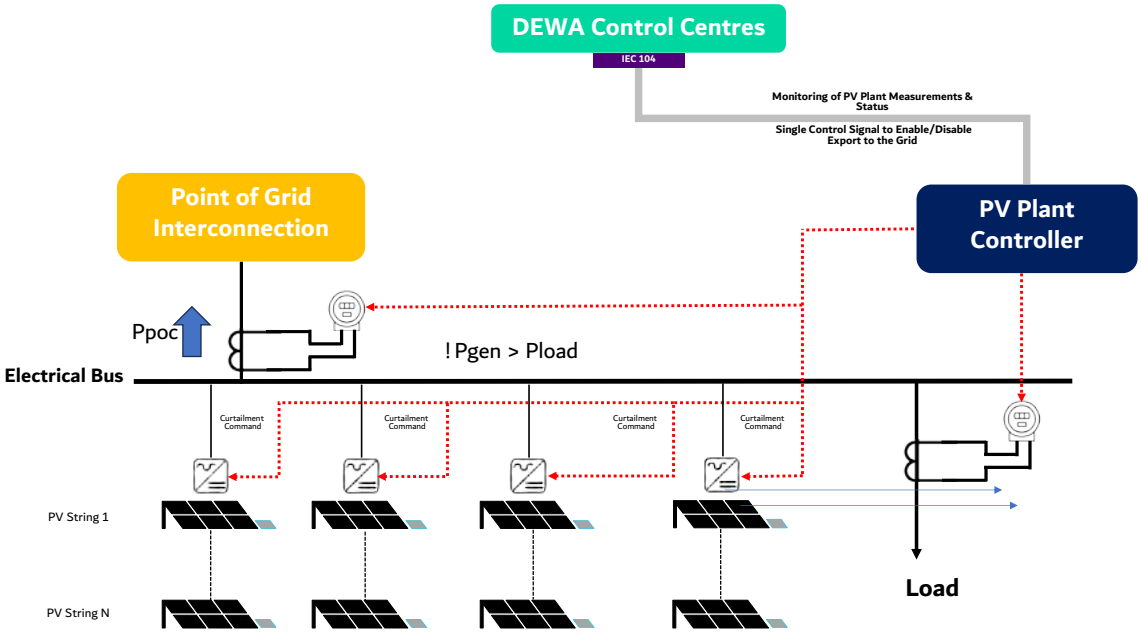

Figure 3-8 Case-1 $P_{gen} > P_{load}$ resulting in negative P_{poc} at PCC.

3.2.3.2 Case 2: $\Sigma P_{gen} < P_{load}$

44. In this case, the generated power from the PV modules is less than the load / demand at the customer side, where power is exported towards the plant; here, P_{poc} shall have a positive value, i.e., higher than zero, and hence a ramp-up command shall be issued to the inverters to increase the generated power, achieving the inverter maximum utilisation requirement while still keeping zero export to grid.

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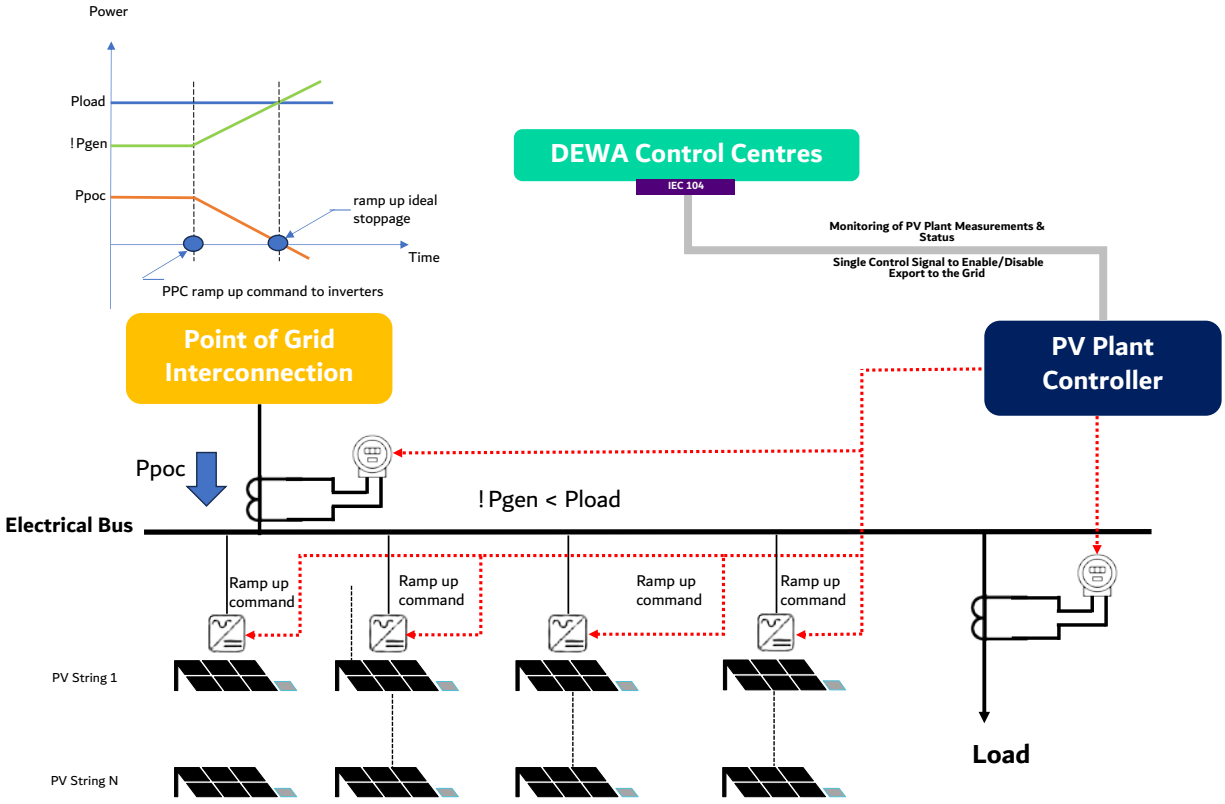

Figure 3-9 Case-2 $P_{gen} < P_{load}$ resulting in positive P_{poc} at PCC.

3.2.3.3 Case 3: $\Sigma P_{gen} = P_{load}$

45. Under this case, no action is required. The PPC shall also have the capability to control the active power in case of frequency deviation and to control plant reactive power using the same methodologies described earlier in the inverter control section.

46. Controlling active power and reactive power due to the frequency deviations is an optional requirement and subject to DEWA's needs in the future.

3.2.3.4 Additional requirements

47. To minimise frequent control actions, the control logic must have a dead-band region where the power flow in either direction does not trigger an action from the PPC. Figure 3-10 outlines the different control actions of PPC within different control conditions/regions.

48. The values of power flow in either direction which set the boundaries of this region (within 5%) shall be subject to DEWA's decision.

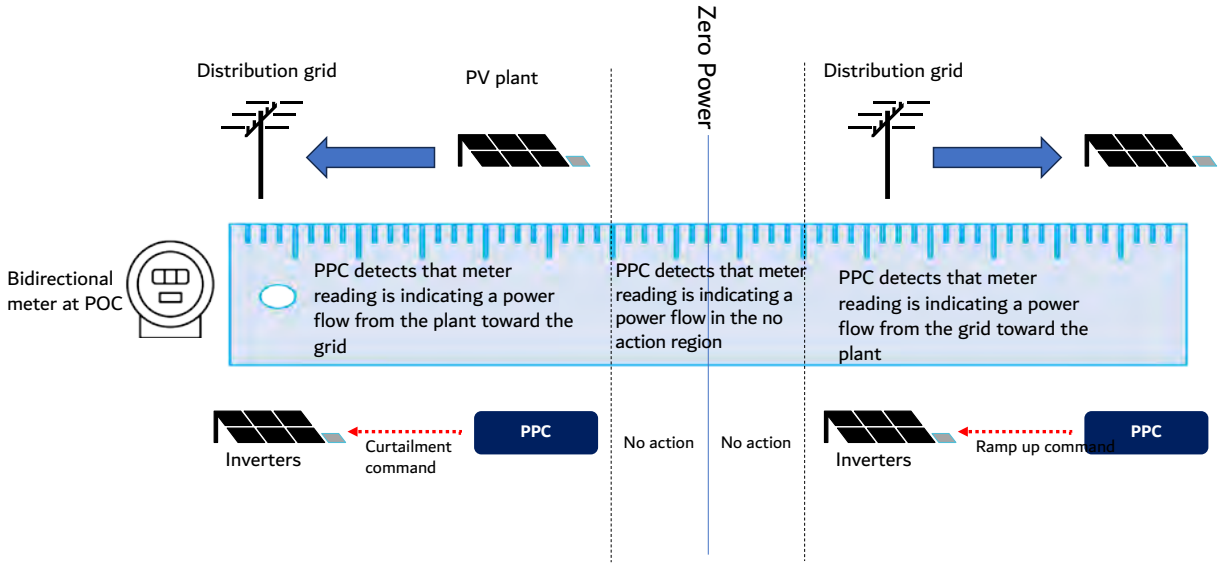

Figure 3-10 Proposed dead-band region to minimize frequent control actions.

49. The temporary interruption of the production of active power during the ride-through period of short circuit faults (i.e. single-phase, two-phase and three-phase short circuits) is allowed, this allowance can be optionally controlled through the PV PPC. Moreover, the restoration of the export of active and reactive power to the network to what it was before the fault occurrence, with a maximum tolerance of ±10% of the renewable plant's rated power, can also be managed by the PPC → PPC can optionally manage to maintain the inductive reactive power after fault clearance to be the same as prior to the occurrence.

3.2.4 PV PPC Function

50. The PV PPC shall have the following basic functions, including remote control, measurement, event/alarm detection, recording, data communication, remote/local switching, internal clock, time synchronisation, time stamp/tag, data holding, and self-diagnosis of failures etc.

51. The detailed requirements are mentioned in the following sub-sections.

3.2.4.1 Configuration Database

52. The configuration of the PV PPC database shall accommodate pseudo-input points, which define expressions with selectable operators and operands based on other points from hardware or the database. At regular programmable time intervals, the PV PPC shall evaluate the expressions and update any database point associated with the pseudo-input point.

3.2.4.2 Configuration Language

53. The PV PCC shall provide the capability to write control programmes using a configuration language based on the IEC 61131-3 standard. The configuration language shall facilitate the use of points defined in the database.

3.2.4.3 Transmission of Status and Alarm Signal

54. When any status change and alarm are detected, the PV PPC shall transmit it with timestamp to DEWA Control Centres.

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55. All the status and alarm signals in the designated inverter and interface protection shall be sent when requested by DEWA CONTROL CENTRES as integrity transmission function. The signal list is provided in subsection 4.2 under Table 4-5.

56. The PPC/RTU shall be capable of communicating with two control centres as well as two gateways simultaneously in different modes (e.g. Active-Listen, Controlling-Standby, All active, etc.) as per standard communication protocols. The PPC/RTU should be implemented with the standard IEC 60870-5-104 communication protocol.

57. The PPC/RTU shall have a standard Ethernet communication interface port (RJ 45) which shall be connected to any communication devices via IEC 60870-5-104. The RTU shall communicate with distribution control centres over DEWA communication network using standard Ethernet communication ports (RJ 45) for interface with DEWA Telecommunication equipment.

58. The PPC/RTU shall have the facility of configuring the following parameters under IEC 60870-5-104 communications protocol:

- 4 IP addresses for control centres.
- 2 IP addresses for NTP.
- 2 IP addresses for remote access (future use).
- 2 IP addresses for syslog (future use).
- 4 Gateway IP addresses.
- 4 Subnet IP addresses; and
- PPC/RTU IP addresses

59. Timeout parameters under IEC 60870-5-104 communications protocol (i.e. t_0, t_1, t_2 and t_3) shall be configurable.

3.2.4.4 Remote Control

60. The PV PPC shall provide set point signals to the different PV plant inverters based on the D33 Solar Feed-in Tariff Policy. The active power export restriction will be enabled from DEWA Control Centres via single command type depending on DEWA needs.

61. The PV PPC shall be able to send setpoints from the secondary level control loops to each inverter with the primary level controls. The PV PPC shall check the availability of the inverters as well as the available capacity within each inverter and control the inverters based upon DEWA Control Centres request.

62. The PV PPC shall provide active power control to regulate the output exchanged with the grid by sending active power setpoints to the inverters. (e.g., to curtail the active power output in demand of the utility)[4]

- The PV PPC shall enable increasing or decreasing of active power output of the power plant by steps of a predefined percentage of the rated power per minute, i.e., at a ramp rate of 10% of the plant installed capacity per minute.
- The PV PPC shall be able to handle setpoints given by the grid operator such as at 100%, 70%, 50%, 30% and 0%, etc. These setpoints shall be achieved from any instantaneous operating point in any operation mode.

4 Subject to appropriate availability of solar irradiation at the instant when such variations are required.

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63. The PPC shall have the following active power control modes:

- Required under D33 Solar PV Initiative
    - Active power limitation (P-limit).
- Optional for future applications[5]
    - Frequency-dependent power influence (F-control).
    - Ramp control (MPPT-control).
    - Active power limitation without feedback (Open P-loop).

64. The PPC shall incorporate the following features:

- Response time of setpoint changes < 1 second.
- Controls in a continuous manner.
- Ability to accept setpoint changes from a remote location via DEWA CONTROL CENTRES

65. A control disable switch shall be provided, which is a manual key-type selector switch (Local/Supervisory), to locally disable the control output for the field circuit breaker (CB) and switches by breaking the power supply connection to the control output (without considering any logical verification from the PPC/RTU).

66. The key-type selector switch shall be installed at PPC/RTU panel, and supervisory indication shall be transmitted to master station. A dummy control test point command shall be permitted even if the selector (Local/Supervisory) switch set to local mode.

5 DEWA reserve the right for the optional PPC Functionalities to be added in the future.

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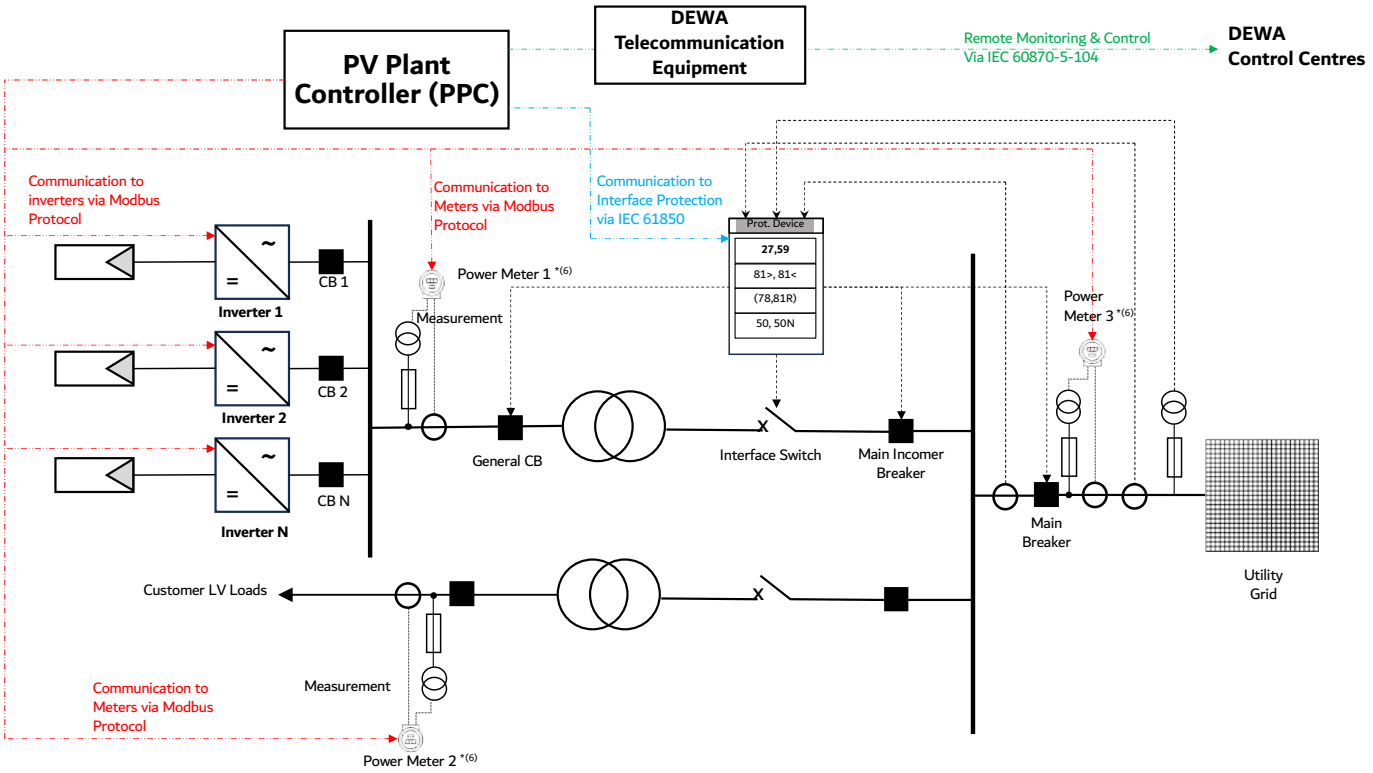

Figure 3-11 Data / information flow diagram.[6]

3.2.4.5 Data communication Protocol and Medium

67. The standard IEC 60870-5-104 shall be applied to the data communication between the PV PPC and DEWA Control Centres.

68. As a minimum, the following protocols shall be provided:

- **IEC 60870**: for data communication between PV controller & DEWA CONTROL CENTRES
- **MODBUS**: for data communication between PV Controller & Inverters
- **IEC 61850**: for data communication between PV Controller & Interface Protection

69. The protocol adopted for each PV PPC shall be configurable by the PPC/RTU maintenance tool. DEWA Control Centres will send a control command when DEWA Control Centres function is requested. Measured data shall be sent to DEWA Control Centres periodically. Event/Alarm shall be detected in the PV PPC and sent to DEWA Control Centres instantly without any delay.

70. The communication technology used to communicate between the PV Controller and DEWA CONTROL CENTRES will be decided by DEWA. Upon receiving the application for the PV system connection under the D33 Solar PV Initiative, DEWA communication team will schedule a site visit to assess the communication options. The options will include wired fiber optics or wireless via RF mesh or 3G/4G. The decision remains at DEWA's discretion and the corresponding technical specifications will be shared by DEWA accordingly.

6 All power meters are new additional dedicated power meters, DEWA smart meters will be installed separately from the power meters.

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71. IEC 60870-5-104 parameters for integration of the PPC with DEWA CONTROL CENTRES such as CADSU size, CASDU value, IOA address size, COT, etc. will be provided by DEWA Control Centres team based upon the suitable configuration parameters and the available addresses.

72. PPC configurations shall reflect all parameters provided by DEWA Control Centres to enable successful data communication with DEWA Control Centres and initiate the remote monitoring and control.

3.2.4.6 Internal Clock and Time Synchronization

73. The PV PPC shall be equipped with an internal clock of 1-millisecond resolution. The internal clock shall synchronize with the system clock of DEWA CONTROL CENTRES.

74. The time difference between the internal clock in the PV PPC and the system clock of DEWA CONTROL CENTRES shall be less than +/- 1 millisecond. In order to keep high accuracy of the internal clock in the PV PPC, the time synchronization shall be carried out in appropriate timing. The clock oscillator frequency of the internal clock shall have a stability of 10 ppm (parts per million) or better.

75. The PPC shall have the capability to synchronize via NTP Server, and PPC shall have the facility to configure 2 IP addresses for NTP in accordance with IEC 60870-5-104 requirements.

3.2.4.7 SOE and Time Stamp/Tag

76. Time stamping shall be provided to each Sequence of Event (SoE) points with 1-millisecond resolution using its internal time clock.

3.2.4.8 Diagnosis of Integrity

77. The PV PPC shall have self-diagnosis function for ascertaining the soundness of its internal components such as processor(s), memories, input/output cards, ADC, power supply, etc.

78. At least the following devices, circuits, and processes shall be checked by the PPC's self-diagnosis function;

- Processors.
- Command output process and circuits.
- ADC process and circuit.
- Input/output cards.
- Power supply.
- Buffer overflow.
- Communication to DEWA CONTROL CENTRES.
- Communication to Inverters & IEDs.
- Input signals (analogue value and status).

79. Output of control signal of PPC/RTU shall be restricted in case a serious failure is detected, and the abnormality of the above shall be sent to DEWA Control Centres.

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80. Based on critical internal alarms, the PPC shall automatically disable the PV PPC outputs upon the activation of these alarms, which are triggered by health monitoring software within the PV PPC.

3.2.5 Firmware and Database

81. Firmware and database including configuration file of the PV PPC shall be equipped with a non-volatile memory (e.g., Electrically Erasable and Programmable Read-Only Memory - EEPROM) in case of a power outage. The firmware and database shall exist independently of each other. In case of expansion of the PV PPC capacity, the firmware shall not change the logic and data structure.

82. The PV PPC shall have enough f work memory for the treatment of switching the firmware, database, and configuration files., etc., so that the PV PPC shall update them without interruption of its normal operation.

83. The contractor shall use standard firmware as much as possible. It shall not be necessary to perform modification to firmware, logic, or data for expansion within the sizing parameters defined for the PPC/RTU. The contractor shall deliver all firmware files and any required tools.

84. At the time the PPC/RTU is accepted, all firmware delivered must be up-to-date and in final form, including all standard firmware changes and field changes initiated by the Contractor or the Contractor's suppliers prior to acceptance. The firmware release note documentation must reflect these changes.

85. Any firmware update requirements (e.g., due to required functionality or required security updates) during project execution until final issuance of the Defect Liability Clearance Certificate shall be provided and implemented for all delivered PPC/RTU by the Contractor or the Contractor's suppliers with an official release note after DEWA approval. In any case, changing EPROMs or similar devices shall not be necessary when updating PPC/RTU firmware.

3.2.6 Availability

86. The PV PPC shall have high availability to manage the distribution grids effectively. Therefore, 99.98% or more of availability is required. To meet availability requirements, it is highly recommended to have redundancy for both the power supply module as well as the communication module.

3.2.7 Enclosure

87. The enclosure shall be of adequate size in accordance with PPC components and panel accessories, ensuring that the clearance between devices mounted in the enclosure shall be adequate to allow easy access to all terminals and devices.

88. The enclosure arrangement shall consider the full arrangement of definite and optional items without needing to change it in the future for adding the optional items.

89. The enclosure shall be constructed of sheet steel no less than 1.5 mm thick. The enclosure door shall be sheet steel no less than 2.0 mm thick, and the mounting plates shall be sheet steel no less than 2.5 mm thick.

90. The protection class of the enclosures shall be IP-64 as a minimum for indoor installation and IP-66 for outdoor installation. The conducted environmental tests shall be verified by DEWA, and test certificates shall be provided.

91. Provisions for bottom cable entry shall be provided, with proper sealing to maintain the IP protection class of the enclosures.

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92. A folding shelf to hold a laptop during PPC/RTU maintenance shall be provided on the inside of the PPC/RTU panel door.

93. Suitable safety ground within the enclosure (earthing studs outside the panel on the right-hand and left-hand sides) shall be earthed through a copper wire of at least 16 mm^2 to the main sub-station earth bar. The enclosure door shall be earthed through flexible copper braided wires of at least 16 mm^2.

94. Miniature Circuit Breakers (MCBs) with alarm contact shall be used for the main PPC/RTU DC supply, DC supply for digital output, AC supply and DC supply for digital input. The MCB for the digital output circuit shall isolate the full DC supply for local and remote operations.

95. Convenience outlets at 230 V AC shall be provided.

96. Sensors for temperature alarm and heater with a controller shall be provided.

97. A lighting system with a door limit switch shall be provided, along with a door limit switch with free contacts for a door open alarm.

98. A dummy control test point device shall be included for testing purposes (e.g., double point indication and double command).

99. Clear labelling for all components and wires shall be ensured.

100. A ventilation system (if required) with necessary protections that provides sufficient cooling for the components inside the enclosure to maintain high operational performance of the PPC/RTU shall be installed.

101. A protection facility to protect the panel from direct sunlight (in the case of outdoor installation) shall be in place.

102. Separate padlocks with a master key facility shall be provided for the PPC/RTU enclosure and local operation switches.

3.2.8 Interconnection and interposing replays

103. All connections between the PPC/RTU's termination facilities and field signal wiring shall be done by the contractor through barrier-terminal blocks with knife-switch isolation, mounted in the PPC/RTU panel to enable isolation for each signal individually, with clear label indications. CT/VT terminal blocks shall be provided to isolate CT/VT connections during measurement transducer maintenance (if required).

104. The interposing relays (24 V DC) for tele-commands shall be provided by the contractor. Plug-in type relays and sockets shall be used, with sockets directly mounted on a DIN rail. They shall operate within an ambient temperature range of +65 degrees Celsius and humidity up to 95%. The relays shall comply with the IEC 61810 standard.

105. The pull-in voltage shall be 18 V DC at minimum for the coil, and the continuous current shall be 5 A at minimum for the contacts.

106. All necessary arrangements shall be made to ensure that plugging in and out is easy and performed without any risk of damaging relay parts. The relays shall be fitted with a visual operation indicator, without a test button.

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3.3 DC System

3.3.1 DC System Technical Specifications.

107. The DC System described herein is used to ensure a proper DC Supply to the PPC/RTU and DEWA Telecommunication equipment and to provide backup power via the DC System' battery in case of interruption of AC supply to the mentioned devices.

108. The Contractor shall ensure the proper design of the DC system by considering all the affecting factors (PPC and telecommunication equipment load, operating temperature, back-up durations, PPC panel load, etc.) specific to Dubai weather conditions.

109. The DC system shall be designed for external input 230V AC supply and nominal 24V DC output power supply.

110. Battery and battery charger capacity calculation parameters for the D33 specification are as follows; the contractor shall propose a suitable battery and battery charger accordingly.

- Communication equipment load.
- Maximum power consumption of the proposed PPC/RTU with all signals included.
- Power consumption of the module shall be considered that all inputs and outputs are in operation at 24 VDC for a minimum 4-hour backup time.
- 10% extra tolerance shall be added to the battery charger capacity, and an aging factor of 25% shall be included in the battery sizing capacity calculation.
- The battery charger capacity shall be sufficient to provide the required DC current load to the PPC/RTU and charge the battery even if the battery is fully discharged.
- The required battery shall preferably be fully dry-type and maintenance-free or Ni-Cd type as an alternative. Valve-regulated lead-acid battery is not acceptable.

111. The battery's lifetime shall be a minimum of 15 years service life at 25 degrees Celsius average ambient temperature and a minimum of 8 years service life at 55 degrees Celsius for dry-type batteries.

112. The battery's lifetime shall be a minimum of 20 years service life at 25 degrees Celsius average ambient temperature and a minimum of 12 years service life at 55 degrees Celsius for Ni-CD batteries.

113. The batteries shall be sourced from reputable brands / manufacturers.

114. The battery's minimum life cycle shall be about 400-1000 cycles at 80% DOD for the dry-type batteries and 300-1000 cycles for Ni-CD batteries.

115. The battery charger unit shall be independent of the battery size. Future expansion in the battery size shall not affect the charger unit.

116. The battery charger design shall have separate output power supply terminals for the battery connection and load connection. One output terminal point for the battery connection and one output terminal point for the load connection shall be included.[7]

7 One spare MCB space for load shall be provided for future purpose if required.

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117. The contractor shall ensure proper protection for the DC system, which is to be approved by DEWA during the engineering stage.

118. Temperature sensors shall be provided with the battery and battery charger for monitoring.

119. A padlock and padlocking facility shall be provided for the battery charger panel if a separate panel is provided.

120. Nameplates shall be provided for the panels as per DEWA standards.

121. A panel lighting system shall be provided for the DC panels as per DEWA standards.

122. All incoming and outgoing cables shall be connected through cable glands to the final points.

123. The Singe Line Diagram (SLD) of the proposed 24VDC system is outlined in Appendix 6.1.4.

124. The Technical Particulars & Guarantees (TPG) data schedule of the proposed battery and charger shall be provided in the tables in Appendix 6.1.

125. All test reports, Material Safety Data Sheets (MSDS) shall be provided.

126. The materials' previous supply records and approvals, catalogues, and drawings of the battery and battery charger shall be submitted.

127. Proper earthing shall be ensured with the required size (16 mm^2 minimum) as per DEWA standards.

128. A rubber sheet/pad shall be provided for battery installation in the panel.

129. Batteries shall be fixed in insulated brackets/ supports to avoid falling or moving within the panel for safe operations.

130. The battery charger shall be SMPS type (Switch Mode Power Supply).

131. Remote battery auto charge/discharge configuration shall be included in the battery charger system irrespective of load current. This facility shall be implemented as per the battery manufacture's recommendations.

132. 2 nos. of battery charger communication port (Modbus RS485) shall be provided in the charger (one port for PPC/RTU connection and the second port for charger parameters access via a lap-top).

133. The battery charger shall be equipped with the following signals for local and remote indication/alarms.

    i. LV under voltage alarm (AC)

    ii. LV over voltage alarm (AC)

    iii. Battery healthiness status/battery low voltage alarm/battery fault

    iv. Charger failure alarm/AC mains failure

    v. Battery high impedance / battery & charger high temperature alarm

134. An automatic battery health check facility to be included in the battery charger for continuous monitoring, with the time interval set as per site requirements.

135. Battery health (maintenance-free) shall be ensured without any external load discharge.

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136. A low battery alarm facility shall be provided in the charger and monitored remotely in the control room.

137. An AC supply missing / complete shutdown monitoring facility shall be provided and communicated to the control room through the PPC/RTU panel in case of AC supply shutdown.

138. Battery live terminals shall be covered/shrouded with good quality of materials, subject to DEWA approval.

139. In case of a short circuit at any terminal (load or battery), the other terminals should remain unaffected.

140. Four (4) stages of battery charging - boost, absorption, float, and recovery- shall be available in the proposed charger.

141. Upon DEWA's request, battery charger type test reports shall be submitted from a third-party approved laboratory as per the applicable IEC standards: applicable IEC 61000 (EMC test), IEC 60950, IEC 60068, and IEC 60529.

142. In the case of crystal battery, an EMC test report shall be submitted.

143. The required DC system maintenance is to be provided by the D33 Customer.

3.3.2 DC System required submittals.

144. 24Vdc system design sizing calculation shall be provided, including all the required factors as per IEC standards.

145. Upon DEWA's request, type test certificates/reports for the proposed battery as per IEC 60623 and other applicable tests for the battery type, as well as type test certificates/reports for the battery charger, shall be submitted.

146. Detailed past supply records for the battery and battery charger in UAE/GCC countries shall be submitted for reference.

147. Battery charger software shall be provided for troubleshooting, maintenance, and operation.

148. Pre-commissioning test for the proposed battery and battery charger shall be conducted as per approved test formats.

149. The required training and troubleshooting guidelines shall be provided for the smooth operation of the DC system, without any additional cost to DEWA.

150. A separate enclosure for the battery and battery charger shall be required if mandated by the Material Safety Data Sheets (MSDS). The protection grade for DC system panel enclosure shall be IP-54.

3.3.3 Additional Requirement for Battery Alternative

151. Providing a single enclosure for the battery charger and the battery with 2 No. compartments is also acceptable. One compartment, for housing the battery charger, shall be at the top, for housing the battery, shall be at the bottom of the enclosure.

152. The IP class of the top battery charger compartment shall be a minimum of IP-64, and the IP class of the bottom battery compartment shall be IP-43.

153. Each compartment shall be independently accessible with individual doors, and a padlocking facility shall be provided.

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4. DERs Data Modelling & Information Exchange

154. PV Controller operators must constantly keep DEWA informed of the status of the DER under their control. Such communications should follow a communications protocol and periodicity prescribed by DEWA, enabling secure operation of the electrical grid. This information is required by DEWA on a renewable resource generating basis.

155. The following items should be communicated:

- Status of the DER, including controllability.
- Mode of operation for the DER.
- Available modes of operation.
- Services in which the DER is participating.
- Real-time available capability (P and Q).
- Real-time output and other monitored values (e.g., P, Q, V, etc.).
- Time-based projections of availability (e.g., 24-hour)

4.1 Asset Information for DEWA Future Use

156. DERs need to be represented in different systems to enable effective monitoring and control and to integrate them with other systems. Therefore, it is crucial to collect and model a significant amount of important information into DEWA asset information systems.

157. This information will be essential for grid modelling of DERs in DEWA Control Centres enabling a detailed overview of the distribution grid to DEWA Control Centres operator and allowing for future-proof monitoring and control of DERs such DERMS Solution.

158. Nameplate information covering the DER type, model, serial number, manufacturer, and rating should be provided, as highlighted in the tables below.

Table 4-1 Overview of required asset **nameplate** information.

Nameplate information	
Parameter	**Description**
Active power rating	Active power rating in watts at unity power factor
Apparent power maximum rating	Maximum apparent power rating in volt-amperes
Normal operating performance category	Indication of reactive power and voltage/power control capability (Category A/B as described in IEEE Std 1547-2018)
Abnormal operating performance category	Indication of voltage and frequency ride-through capability (Category I, II, or III, as described in IEEE Std 1547-2018)
Reactive power injected maximum rating	Maximum injected reactive power rating in VAR
Reactive power absorbed maximum rating	Maximum absorbed reactive power rating in VAR
Active power charge maximum rating	Maximum active power charge rating in watts
Apparent power charge maximum rating	Maximum apparent power charge rating in volt-amperes; may differ from the apparent power maximum rating
AC voltage nominal rating	Nominal AC voltage rating in root mean square (RMS) volts
AC voltage maximum rating	Maximum AC voltage rating in RMS volts
AC voltage minimum rating	Minimum AC voltage rating in RMS volts
Supported control mode functions	Indication of support for each control mode function
Reactive susceptance	Reactive susceptance that remains connected to the area EPS in the cease to energize and trip state
Manufacturer	Manufacturer
Model	Model
Serial number	Serial number
Version	Version

Table 4-2 Overview of required asset **location** information

Location Information	
Installation information	Includes the physical location either in geographical coordinates (latitude, longitude), street address, or tied to a utility customer ID account number. It can also include the last inspection or repair date if necessary. The installation information can be structured per the IEC Common Information Model (CIM), as defined in IEC 61968 and IEC 61970 (IEC 61968-5:2020; IEC 61970-301:2020)
Electrical location	Includes the service delivery point, meter ID, customer ID, as-built feeder segment ID, connection point identifier for distribution-connected DER, and number of DER units within the total capacity. It can also include phasing information indicating whether it is a single or three phase DER. If the device is single phase, the phase to which it is connected should be specified. There are other options for supplying the location information: DEWA CONTROL CENTRES can have a record of the electrical location and pass that on to the PV Controller. Interconnection details are addressed in IEEE Std 1547-2018. The IEC Common Information Model standards should be used to describe the electrical information (IEC 61968-5:2020; IEC 61970-301:2020).

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Table 4-3 Overview of required asset **Interconnection** information

Interconnection rating	
Nameplate Rating	Active power rating in watts at unity power factor
Net Active Power Exported	Active power point of common coupling (PCC) export rating in watts at unity power factor
Monitoring Key Data	Required DER data: alarm, status, measurement
Substation	Substation DER interconnected
Feeder	Distribution feeder DER interconnected
Service Node	Service node DER interconnected

Table 4-4 Overview of required asset **plant availability** information

Plant availability information	
In/out of service dates	There may be DERs that are only available during certain times of the year, month, week, or day depending on contracts, availability, scheduled maintenance, or other limiting factors. This information is needed for operational software applications that determine what DER is available and its capabilities as the applications monitor DER and determine control commands to send to accomplish the applications' goals.
DER modelling information	For the DER to be adequately modelled in software applications, certain electrical characteristics will be required. These modelling parameters should be similar to those used in electrical grid planning software. Parameters may include, but are not limited to, electrical impedances, fault contributions and resulting fault levels, thermal limits, and other information that is required for grid applications. The DER model may also include scenario modelling, generation profile of the DER/site, asset modelling, reaction to operating environment, and a physical model

4.2 Monitoring & Control List of DERs

159. A PV Controller should, at a minimum, be able to collect and provide the latest measured values for the parameters listed below.

Table 4-5 Signal list.

Inverter (For Each Inverter)			
Category	**Item**	**Signal Destination**	**Remark**
Status	Open/Close of CB	PPC, DEWA CONTROL CENTRES	Double status
Alarm	Inverter Healthy	PPC, DEWA CONTROL CENTRES	
	Inverter Faulty	PPC, DEWA CONTROL CENTRES	
	Inverter Stopped	PPC	
Measurement	Active power	PPC, DEWA CONTROL CENTRES	
	Reactive power	PPC, DEWA CONTROL CENTRES	
	Current	PPC, DEWA CONTROL CENTRES	
	Voltage	PPC, DEWA CONTROL CENTRES	
	THD Voltage L1	PPC, DEWA CONTROL CENTRES	
	THD Voltage L2	PPC, DEWA CONTROL CENTRES	
	THD Voltage L3	PPC, DEWA CONTROL CENTRES	
	Power Factor	PPC, DEWA CONTROL CENTRES	
	Active power set point feedback	PPC	
	Reactive power set point feedback	PPC	
	Power Factor set point feedback	PPC	
Analog Control	Active power set point	PPC	
	Reactive power set point	PPC	
	Power Factor set point	PPC	

Interface Protection			
Category	**Item**	**Signal Destination**	**Remark**
Status	Open/Close of Interface Switch	PPC, DEWA CONTROL CENTRES	Double status
	Open/Close of Main Incomer CB	PPC, DEWA CONTROL CENTRES	Double status
	Open/Close of Main General CB	PPC, DEWA CONTROL CENTRES	Double status
Control	Open/Close of Main Incomer CB	PPC, DEWA CONTROL CENTRES	CB will be controlled depending on secondary SS Ownership (DEWA or Private entity)
Alarm	OC/EF Trip	PPC, DEWA CONTROL CENTRES	
	Under Voltage Trip	PPC, DEWA CONTROL CENTRES	

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	Over Voltage Trip	PPC, DEWA CONTROL CENTRES	
	Protection Device Faulty	PPC, DEWA CONTROL CENTRES	
	Over Frequency Trip	PPC, DEWA CONTROL CENTRES	
	Under Frequency Trip	PPC, DEWA CONTROL CENTRES	
	Island detection (ROCOF)	PPC, DEWA CONTROL CENTRES	
	Island detection (Vector Shift)	PPC, DEWA CONTROL CENTRES	
Measurement (From Meter 1 on SLD)	Active power	PPC, DEWA CONTROL CENTRES	
	Reactive power	PPC, DEWA CONTROL CENTRES	
	Current	PPC, DEWA CONTROL CENTRES	
	Voltage	PPC, DEWA CONTROL CENTRES	

Customer Load			
Category	**Item**	**Signal Destination**	**Remark**
Status	Open/Close of Interface Switch	PPC, DEWA CONTROL CENTRES	Double status
	Open/Close of Main Incomer CB	PPC, DEWA CONTROL CENTRES	Double status
	Open/Close of Main General CB	PPC, DEWA CONTROL CENTRES	Double status
Measurement (From Meter 2 on SLD)	Active power	PPC, DEWA CONTROL CENTRES	
	Reactive power	PPC, DEWA CONTROL CENTRES	
	Current	PPC, DEWA CONTROL CENTRES	
	Voltage	PPC, DEWA CONTROL CENTRES	
	Power Factor	PPC, DEWA CONTROL CENTRES	

Point of Connection (PoC)			
Category	**Item**	**Signal Destination**	**Remark**
Status	Open/Close of Main General CB	PPC, DEWA CONTROL CENTRES	Double status
Control	Open/Close of Main General CB	PPC, DEWA CONTROL CENTRES	Double command / CB will be controlled depending on LV SS ownership (DEWA or Private entity)
	D33 Solar Feed-in Tariff Policy Enable	PPC, DEWA CONTROL CENTRES	Single command for enable/disable of Zero Export logic on PPC, based on DEWA needs
Measurement (From Meter 3 on SLD)	Active power	PPC, DEWA CONTROL CENTRES	
	Reactive power	PPC, DEWA CONTROL CENTRES	
	Current	PPC, DEWA CONTROL CENTRES	
	Voltage	PPC, DEWA CONTROL CENTRES	
	Power Factor	PPC, DEWA CONTROL CENTRES	
	Frequency	PPC, DEWA CONTROL CENTRES	

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General			
Category	**Item**	**Signal Destination**	**Remark**
Status	Dummy Status	PPC, DEWA CONTROL CENTRES	Double Point (ON/OFF)
Control	Dummy Control	PPC, DEWA CONTROL CENTRES	Double Command (ON/OFF)
Alarm	Inverter Communication Failure	PPC, DEWA CONTROL CENTRES	General alarm for any inverter communication failure
	PPC Internal Major Alarm	PPC, DEWA CONTROL CENTRES	General alarm for any major internal alarm of PPC such as power supply module failure, communication module failure ...etc.
	PPC Internal Minor Alarm	PPC, DEWA CONTROL CENTRES	General alarm for any minor internal alarm of PPC such as, communication channel Fail...etc.
	Battery Charger Alarm	PPC, DEWA CONTROL CENTRES	DC system Alarm
	AC supply Fail	PPC, DEWA CONTROL CENTRES	DC system Alarm
	PPC Panel High Temperature Alarm	PPC, DEWA CONTROL CENTRES	
	PPC MCB Trip	PPC, DEWA CONTROL CENTRES	

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5. Communication

160. DEWA's Communication Process in order to comply with the communication requirements will be as follows:

i. Upon receiving the application for the PV system connection, DEWA communication team will schedule a site visit to assess the communication options for the D33 customer.

ii. DEWA will conduct a site assessment to determine the needed equipment and infrastructure based on the site's characteristics.

a. DEWA's preferred communication option is fiber optics.

b. If option (a) is not possible to be used, then other options will be explored, incl. RF Mesh or 3G/4G communication.

iii. Due to the sensitivity of the telecommunication equipment, the selection of equipment shall be based on DEWA's approval. In case it is agreed that DEWA will supply, install and configure the communication equipment, the customer shall bear the costs.

161. Any decision regarding the communication methods and cyber-security requirements to secure the connection between the PV system and the DEWA interface remains at DEWA's discretion and corresponding technical specifications related to these requirements will be shared with interested producers accordingly.

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6. Appendices

6.1 DC System Technical Particulars & Guarantees

6.1.1 Battery (Maintenance Free -dry Type)

Table 6-1 Technical particulars and guarantees for the battery.

Technical Particulars & Guarantees for Battery			
#	**Description**	**DEWA Specs**	**D33 application specs**
1	Manufacturer	Subject to approval	
2	Country of Manufacturer	Subject to approval	
3	Battery Type	Dry type	
4	Battery Model No.	Subject to approval	
5	Battery system nominal voltage rating V	24Vdc	
6	Battery Capacity in Ampere Hour (Ah) at C5	Subject to approval	
7	Battery life span at ambient temperature- 25 °C	15 years	
8	Overall Dimensions of Battery (LXWXH) mm		
9	Total weight of Battery -Kg		
10	Maximum temperature rise within charger enclosure when operating under Site ambient conditions - °C	Subject to approval	
11	Protections provided for the Battery (Yes / No)	Yes	
12	Battery DC load calculations provided (Yes / No)	Yes	
13	Temperature de-rating curve of service life for proposed batteries are provided (Yes / No)	Yes	
14	No. of years of battery in service in GCC & utilities are provided (Yes / No)		
15	Details of Compliance with safety standards and Certification		
16	Specify the type of mounting of Battery in the panel		
17	Material specification datasheet (MSDC) is provided		
18	Legal recommendation, environmental/safety approval for the batteries		
19	Accreditation /certificates received from the authorities		
20	Safety measures of the battery		
21	Previous supply records and contact details of end user		
22	Battery country of origin details		
23	Type of battery container		
24	Applicable IEC standard	IEC 60623/60896 /60086/61436	
25	Number of batteries connected in series to make the 24V system		
26	Battery capacity at C5 hour	Subject to approval	

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27	Battery nominal charging current A	As per Battery data sheet	
28	Battery Nominal Voltage per cell V	Subject to approval	
29	Battery design life at 25 °C Ambient	15 years	
30	Battery service life at 55 °C Ambient	8 years	
31	Material of container		
32	Battery efficiency - %	> 90 %	
33	Battery intercell connection type provided		
34	Battery charging modes profiles: Float/boost/absorption/commissioning.	Yes	
35	Max storage period before first initial charging- months		
36	Max. Battery storage temperature – Deg. C		
37	Recommended (by manufacturer) initial charging current - A	Subject to approval	
38	Recommended (by manufacturer) initial charging voltage - V	Subject to approval	
39	Recommended (by manufacturer) initial charging time - hours	Subject to approval	
40	Open circuit cell voltage at the end of initial charge cycle - V	Subject to approval	
41	Max. Boost voltage for fully charged battery V	Subject to approval	
42	Open circuit cell voltage at the end of Boost charge cycle V	Subject to approval	
43	Trickle (float) charging voltage (V/cell)		
44	Trickle (float) charging current of charged cell (A)		
45	Ampere-hour efficiency at 5-hours rate discharge	Subject to approval	
46	Ampere-hour efficiency at 1-hour rate discharge	Subject to approval	
47	Internal resistance per cell when fully charged - mΩ		
48	Battery life terminals shall be covered/shrouded	Yes	
49	Internal resistance per cell when fully discharged - mΩ		
50	Battery voltage at the end of the duty cycle specified - V		
51	Maximum short circuit Current at battery terminals (when fully charged)- KA		
52	Battery performance Standard		
53	Quality Management Standard	ISO 9001	
54	Environmental Management Standard	ISO 14001	

6.1.2 Battery (Ni-cd Type)

Table 6-2 Technical particulars and guarantees for the battery.

Technical Particulars & Guarantees for Battery			
#	**Description**	**DEWA Specs**	**D33 applicant specs**
1	Manufacturer	Subject to approval	
2	Country of Manufacturer	Subject to approval	
3	Battery Type	Ni-Cd low maintenance	
4	Battery Model No.	Subject to approval	
5	Battery system nominal voltage rating V	24Vdc	
6	Battery Capacity in Ampere Hour (Ah)	Subject to approval	

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7	Battery life span at ambient temperature 25°C	20 years	
8	Overall Dimensions of Battery (LXWXH) mm		
9	Total weight of Battery –Kg		
10	Maximum temperature rise within charger enclosure when operating under Site ambient conditions - °C	Subject to approval	
11	Protections provided for the Battery (Yes / No)	Yes	
12	Battery DC load calculations provided (Yes / No)	Yes	
13	Temperature de-rating curve of service life for the proposed batteries are provided (Yes / No)	Yes	
14	No. of years of battery in service in GCC & utilities are provided (Yes / No)		
15	Details of Compliance with safety standards and Certification		
16	Specify the type of mounting of Battery in the panel		
17	Material specification datasheet (MSDC) is provided		
18	Legal recommendation, environmental/safety approval for the batteries		
19	Accreditation /certificates received from the authorities		
20	Safety measures of the battery.		
21	Previous supply records and contact details of end user		
22	Battery country of origin details.		
23	Type of battery container		
24	Applicable IEC standard	IEC 60623/60896 /60086/61436	
25	Number of batteries connected in series to make the 24V system		
26	Battery capacity at C5 hour	Subject to approval	
27	Battery nominal charging current A	0.2C5 (20%)	
28	Battery Nominal Voltage per cell V	Subject to approval	
29	Battery design life at 25 °C Ambient	20 years	
30	Battery service life at 55 °C Ambient	10 years	
31	Material of container		
32	Battery efficiency - %	> 90 %	
33	Battery intercell connection type provided		
34	Battery charging modes profiles: Float/boost/absorption/commissioning	Yes	
35	Max storage period before first initial charging-months		
36	Max. Battery storage temperature – Deg. C		
37	Recommended (by manufacturer) initial charging current- A	Subject to approval	
38	Recommended (by manufacturer) initial charging voltage- V	Subject to approval	
39	Recommended (by manufacturer) initial charging time- hours	Subject to approval	
40	Open circuit cell voltage at the end of initial charge cycle- V	Subject to approval	
41	Max. Boost voltage for fully charged battery V	Subject to approval	
42	Open circuit cell voltage at the end of Boost charge cycle V	Subject to approval	
43	Trickle (float) charging voltage (V/cell)		
44	Trickle (float) charging current of charged cell (A)		
45	Ampere-hour efficiency at 5-hours rate discharge	Subject to approval	

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46	Ampere-hour efficiency at 1-hour rate discharge	Subject to approval	
47	Internal resistance per cell when fully charged - mΩ		
48	Internal resistance per cell when fully discharged- mΩ		
49	Battery voltage at the end of the duty cycle specified- V		
50	Maximum short circuit Current at battery terminals (when fully charged)- KA		
51	Battery performance Standard		
52	Quality Management Standard	ISO 9001	
53	Environmental Management Standard	ISO 14001	

6.1.3 Battery Charger

Table 6-3 Technical particulars and guarantees for battery charger.

Technical Particulars & Guarantees for Battery Charger			
#	**Description**	**DEWA Specs**	**D33 applicant specs**
1	Manufacturer	Subject to approval	
2	Country of Manufacturer	Subject to approval	
3	Battery Charger Type	SMPS Type (Switch mode type)	
4	Battery Charger Model No.		
5	Battery Charger complying to IEC Standard	IEC 61000,60950 & 60068	
6	Battery Charger nominal Voltage rating Vdc	24Vdc	
7	Battery charger Current rating A		
8	Battery charger rated AC input voltage V	230Vac	
9	Battery charger rated frequency Hz	50Hz	
10	Type of Battery Charger Controller (Analogue/ Digital Microprocessor)	Subject to approval	
11	IP rating of battery charger	IP 20	
12	AC input voltage range (Min/Nominal/Max) Volts	+/- 6%	
13	Input frequency range (Min/Max) Hz	+/-5%	
14	Battery Charger suitable for 55°C average ambient temperature (Yes/No)	Yes	
15	Charger Efficiency %	> 85% at nominal input voltage	
16	Efficiency at 216V AC input voltage %	90%	
17	Load Regulation %	1 %	
18	Line Regulation %	< .01% Vo	
19	Type of charging modes	Float, boost, absorption & purification	
20	No. of Charging profile stages	Four	
21	Temperature compensation provided (Yes / No)	Yes	
22	AC Fuse rating	Subject to approval	
23	Charger output ripple without battery connected & with battery connected	2.5% & 1 %	

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24	Method of charging voltage control when: -		
25	(a) on float charge	Constant Voltage & Constant current	
26	(b) on boost charge	Constant Voltage & Constant current	
27	Variation in DC output voltage at rated output, resulting from supply voltage variation of input AC power supply: - (a) + 6% (b) - 6%	+/-1%	
28	Maximum ripple content of DC supply voltage as a percentage of nominal output voltage (a) at full rated output with battery connected (b) with battery disconnected	1% 2.5%	
29	Maximum current under `dead battery' condition and normal AC supply Voltage		
30	Can charger operate with battery disconnected?		
31	Overall Dimensions of charger (LXWXH) mm		
32	Maximum size of ventilation openings in enclosure mm		
33	Total weight of charger including enclosure Kg		
34	Maximum temperature rise within charger enclosure when operating under Site ambient conditions 55 °C		
35	Battery charger meter display device provided (Yes/No)		
36	Service Life of Battery Charger in Years	20 Years	
37	Battery charger provided with short circuit, over current protection (Yes / No)	Yes	
38	Communication port provided (Yes / No)	(Modbus/RS485)	
39	Battery and charger Alarms Provided a. Under Voltage (Yes / No) b. Over Voltage (Yes / No) c. Over Current (Yes / No) d. low battery e. Charger failure f. Charger AC mains failure g. Charger shutdown	Yes for all items	
40	Battery Charger Protection Provided for the below: a. Short Circuit (Yes / No) b. Over current (Yes / No) c. Over current (Yes / No) d. Reverse Polarity (Yes / No) e. Over Current (Yes / No) f. Over Voltage (Yes / No) g. Under Voltage (Yes / No) h. Battery temperature (Yes/No) Compensation using PT1000 temperature sensor with over temperature protection	Yes, for all items	
41	For AC input, under voltage and over voltage protection provided (Yes/No)	Yes	

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42	Self-test / diagnosis function available in battery charger (Yes/ No)	Yes	
43	Mean time between Failures of charger (MTBF) in hours		
44	AC Input current at full load in Amps A		
45	Rated output voltage at float charger mode V	27.4Vdc	
46	Nominal charger Voltage V	24Vdc	
47	Rated output voltage at boost charger mode V	29.5Vdc	
48	Type of charging control (Constant current, constant voltage)		
49	Battery charger operating temperature range	-25°C to 80°C	
50	Specify the type of mounting of Battery charger in the panel?	Subject to approval	
51	Charger continuous rated output float charge current A	Subject to approval	
52	Charger continuous rated output boost charge current A	Subject to approval	
53	Float charging voltage setting range V	Subject to approval	
54	Voltage Regulation	+ 1%/-1%	
55	Charger output current setting range for float mode	Subject to approval	
56	Boost charging voltage setting range	Subject to approval	
57	Charger output current setting range for boost mode	Subject to approval	
58	Manual voltage regulator (float/boost)		
59	Max. Battery Current Limit	As per battery data sheet	
60	Maximum ripple current at full load with battery disconnected	< 2.5%	
61	Maximum ripple current at full load with battery connected	< 1%	
62	Time for charger to recharge 90% of the battery capacity after full discharge	4-5 hours	
63	Timing range for auto and manual timer	0-24 hours	
64	Variation in DC output voltage at rated output resulting from AC supply variation.	+/-1%	
65	Material of Enclosure	Subject to approval	
66	Colour of battery charger enclosure	RAL 7035	
67	Battery charger rating is adequate for the battery capacity Ah rating	Yes	
68	Battery charger sizing calculation submitted	Yes	
69	Upon DEWA request, Charger Type Test conducted for the proposed maker & type of Battery charger shall be provided as per IEC 61000-6-4, IEC-60068-2-6, IEC 60068-2-27, IEC 60068-2-1, IEC 60068-2-78, IEC 60950-1, IEC 60529	Yes	
70	Type tests are conducted in independent, external, accredited & approved labs	Yes	
71	Battery Charger alarm contact provided to SCADA (Yes/No)	Yes	
72	AC supply fail alarm contact provided to SCADA (Yes/No)	Yes	

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73	Battery charger temperature sensor alarm provided to SCADA (Yes/No)	Yes	
74	AC MCB for incomer AC supply protection provided (Yes/No)	Yes	
75	DC MCB for battery & load protection provided (Yes/No)	Yes	
76	DC MCB between charger & battery for protection provided (Yes/No)	Yes	
77	Battery Charger shall be designed & operational for battery output MCB/terminal & load output MCB/terminal shall be separately (YES/No)	Yes	
78	Past Supply records, performance of the proposed maker, type of the battery charger in UAE/ GCC preferably in utility submitted (Yes/No)		

6.1.4 Singe Line Diagram (SLD) of the proposed 24V_{DC} System.

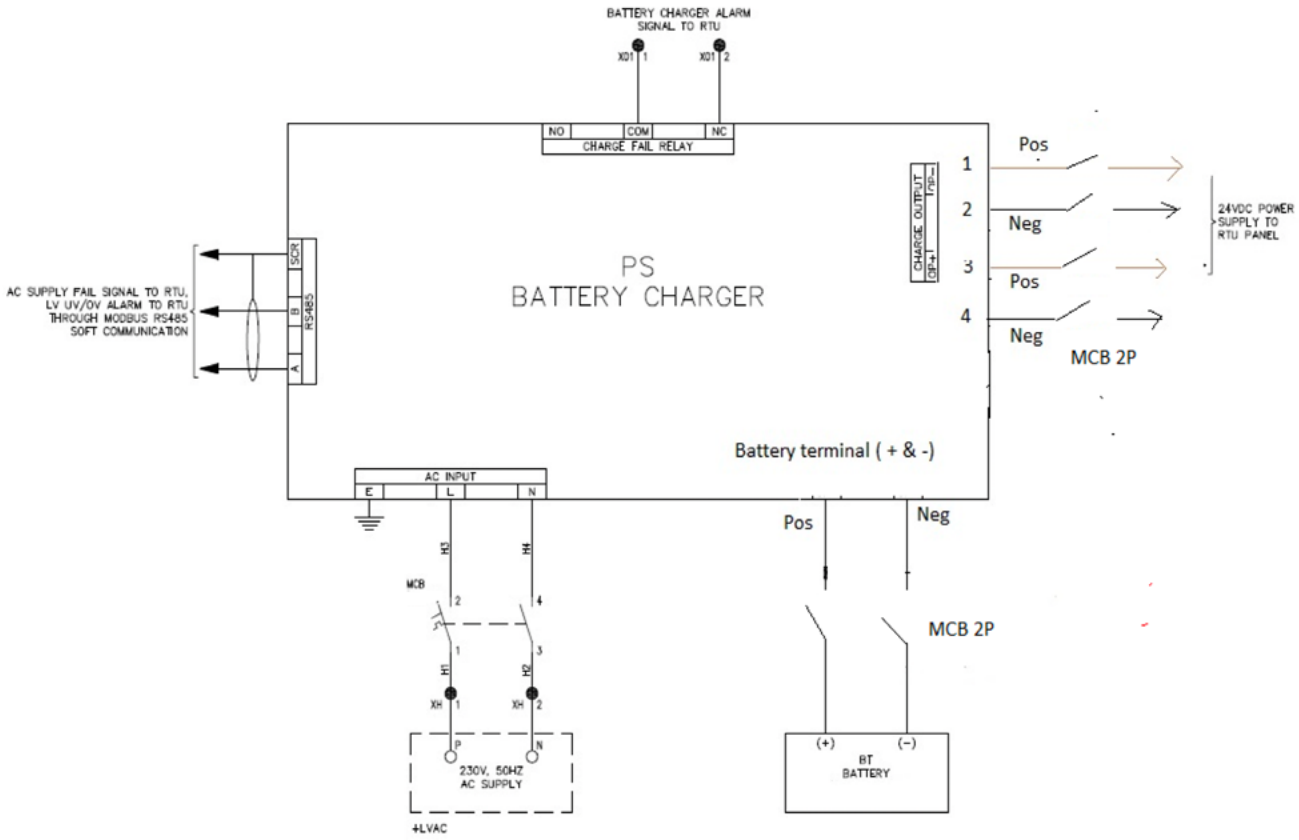

Figure 6-1 SLD of proposed 24VDC System

6.2 Power Plan Controller Cyber-Security Technical Particulars and Guarantees

Table 6-4 Cyber-security functionality requirements for PPC.

#	Cyber Security Requirements Description	DEWA Requirement			D33 applicant specs	
		Unit	Requirement	Compliance	Compliant? (Y/N)	Detailed Response (mark N/A if not applicable)
A	GENERAL BASELINE SYSTEM FUNCTIONALITY					
1	Proposed logical network topology (Ring/ Star/Dual Ring/Dual Star/ Mesh or Others).			Yes/No		
2	Event log generation in Syslog format for all equipment/ software.		RFC5424	Yes/No		
3	Processing one or more equipment/ system events/ logs and allowing for all combinations of the following:			Yes/No		
	a) Storing events locally on the equipment memory buffer.			Yes/No		
	b) Storing locally and forwarding to remote location (LAN) based on configured filters.			Yes/No		
	c) Forwarding to remote location over WAN.			Yes/No		
4	List of supported Syslog messages for all equipment/ system.			Yes/No		
5	Availability of physical equipment redundancy and related software service redundancy for all devices/ except where explicitly stated otherwise. This includes physical and virtualized networks.			Yes/No		
6	Unified time synchronization for all equipment/ software.			Yes/No		
7	Watchdog is standard or factory-installed for all equipment and supports alarms for minimum of device status, CPU utilization, power supply status, storage buffer and network status.			Yes/No		
8	All equipment supports for SNMP and provide individual equipment MIBs/ message details that are available OEM for device monitoring and/or control.			Yes/No		
9	Integration of equipment alarms with local and remote SNMP Manager via SNMP for monitoring only.			Yes/No		

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#	Cyber Security Requirements Description	DEWA Requirement			D33 applicant specs	
		Unit	Requirement	Compliance	Compliant? (Y/N)	Detailed Response (mark N/A if not applicable)
10	SNMP support as standard for all equipment.		Version 3	Yes/No		
11	Centralized identity and access management services for all equipment/ systems using local (Station DMZ) Active Directory.			Yes/No		
12	Role Based Access Control (RBAC) with custom role definitions capability for all equipment/ systems.			Yes/No		
13	Built-in support for RADIUS, LDAP protocol (prevailing IETF RFCs) for authentication, authorization and accounting services for all equipment that cannot natively communicate to Active Directory.			Yes/No		
14	Where use of digital certificates is required (for multi-factor authentication or secure transport):			Yes/No		
	a) Only DEWA OT PKI signed certificate.		a) x.509 v3	Yes/No		
	b) the minimum key length for symmetric crypto algorithm.		b) 256 bits	Yes/No		
	c) hash algorithm.		c) SHA 256 or above	Yes/No		
	d) the minimum key length for asymmetric crypto algorithm.		d) 2048 bits or higher key length	Yes/No		
15	20% spare capacity for future scalability requirements for all equipment.			Yes/No		
16	Included OEM warranty/ support period for software/ system after TOC for the all the systems/software proposed as part of solution.	Years	Minimum 2 Years	Yes/No		
17	Proposed virtualization technologies and associated equipment/ systems (list details).			Yes/No		

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#	Cyber Security Requirements Description	DEWA Requirement			D33 applicant specs	
		Unit	Requirement	Compliance	Compliant? (Y/N)	Detailed Response (mark N/A if not applicable)
B.1	ACCESS CONTROL					
1	Access to equipment for engineering, commissioning, or maintenance purposes - over Ethernet or serial interfaces - by authorized DEWA personnel shall require individual user account for authentication purposes. Each user account shall be protected by a password that can be updated upon request by the authorized user.			Yes/No		
2	Support for authentication using RADIUS, LDAP and Active Directory.			Yes/No		
3	Role Based Access Control (RBAC) with custom role definitions capability for all equipment/ systems.			Yes/No		
4	The authorized user shall have the capability to by-pass configured authorization requirements for an object for a configurable period. Example of such situations include when a privileged account is locked out if the role holder has forgotten the password.			Yes/No		
5	PPC/RTU shall be configured to protect user credentials from unauthorized access and modification by ensuring that passwords are not stored in clear text. The system shall also be configured to prevent transmitting/ sharing passwords in clear text. Where this is not possible, mutually agreed compensating controls shall be implemented to mitigate the identified risk.			Yes/No		
6	Use of passwords shall comply with the following requirements that shall be referred to as password 'complexity' requirements:			Yes/No		
	a) Use of unique password for each system.			Yes/No		
	b) Passwords shall not match any personally identifiable attributes of the end-user, system or substation location and any other related attributes.			Yes/No		
	c) Capability to update passwords based on a configurable frequency or on-demand request initiated by authorized DEWA user.			Yes/No		

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#	Cyber Security Requirements Description	DEWA Requirement			D33 applicant specs	
		Unit	Requirement	Compliance	Compliant? (Y/N)	Detailed Response (mark N/A if not applicable)
6	d) Passwords length shall not be shorter than eight (8) characters.			Yes/No		
	e) A combination of upper- and lower-case letters along with numbers and symbols shall be used for a configured password.			Yes/No		
	f) The capability to prevent users from reusing the previously utilized passwords for a configurable period of time.			Yes/No		
7	PPC/RTU shall allow users to operate with the least privileges and therefore all users shall be authenticated, and user accounts /administrator accounts shall be separated in terms privileges and roles (e.g. administrator, operator, viewer, etc.). A user account that belongs to a staff member assigned with Viewer role shall not have the ability to issue control commands.			Yes/No		
8	PPC/RTU shall be configured to display recorded audit logs/events only for authorized users as per privileges on read only basis.			Yes/No		
B.2	SYSTEM INTEGRITY					
1	Portable and non-portable devices (e.g. configuration ports, unused ports, spare ports) shall be disabled by default. Where explicitly enabled, the system shall be configured to restrict use of the portable devices to authorized users only. All authorized use of such devices shall only be permitted after these are scanned and approved by OT Security department.			Yes/No		
2	PPC/RTU shall reject any attempts to inject unauthorized session identifiers to hijack established communication sessions.			Yes/No		
3	Tool shall have the capability to recover the backup of the PPC/RTU and reconstitute to PPC/RTU in case of any disruption or failure.			Yes/No		

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#	Cyber Security Requirements Description	DEWA Requirement			D33 applicant specs	
		Unit	Requirement	Compliance	Compliant? (Y/N)	Detailed Response (mark N/A if not applicable)
4	All unused interfaces on the field / network devices shall be blocked or disabled and principle of least privilege shall be applied for any given user (human, software, or device) to limit or prevent unauthorized use. Moreover, all non-essential software services, operational protocols, physical ports/ interfaces shall be disabled, blocked, or removed. Where possible, the configuration ports shall be blocked/ disabled after initialization of the device.			Yes/No		
5	The update firmware, bug fixes and such fixes shall not void the warranty post-handover of system to DEWA. The tool shall have the capability to update the PPC/RTU either over network or though PPC/RTU management interface.			Yes/No		
6	The system shall be configured to restrict use of the portable devices (prevent data transmission to or from portable or mobile devices) to authorized named users. Authorized administrative usage of any portable media shall be scanned and approved by OT Security department before usage by named users.			Yes/No		
7	PPC/RTU shall be capable to display security configuration settings (such as lock-out time period for failed authentication attempts, security logging server IP address, etc.,) to authorized DEWA users only when required.			Yes/No		
B.3	OT SYSTEM ASSET DATABASE					
1	Capability to share the following PPC/ RTU asset details over IEC protocol (or manual if not applicable) at minimum:			Yes/No		
	1. Manufacturer name and equipment series/model.			Yes/No		
	2. Name of physical equipment/device.			Yes/No		
	3. Operating software/ firmware.			Yes/No		
	4. Operating software/ firmware patches/ supplemental software.			Yes/No		

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#	Cyber Security Requirements Description	DEWA Requirement			D33 applicant specs	
		Unit	Requirement	Compliance	Compliant? (Y/N)	Detailed Response (mark N/A if not applicable)
2	The PPC/RTU shall be configured to synchronize its system clocks from substation GPS time server over NTP/ SNTP.			Yes/No		
3	PPC/RTU shall initiate time sync over NTP, and in case of time sync failure RTU shall retry to sync with GPS server (3 times) before generating a time sync failure alarm. The time sync failure alarm shall be sent to OT CSOC and OT NOC.			Yes/No		
B.4	**OT SECURITY MONITORING & RESILIENCE**					
1	PPC/RTU shall be configured to forward all logs to OT CSOC over RFC syslog format. In case if any log server failure the relay shall store the logs locally and forward them once communication with log server is reestablished.			Yes/No		
	Following categories of logs shall be generated at minimum:			Yes/No		
	1. Authentication attempts (successful or failed after defined number of attempts - default 3).			Yes/No		
	2. User actions in the system.			Yes/No		
	3. Use of privileged accounts.			Yes/No		
	4. Network connection attempts.			Yes/No		
	5. Enabling, disabling, or modifying the behaviour or configuration of security mechanisms (e.g. authentication, audit generation).			Yes/No		
	6. Actions undertaken due to audit storage failure or reaching storage threshold.			Yes/No		
	7. Any attempt to export data.			Yes/No		
	8. Modification of a group of users with a given role.			Yes/No		
	9. Detection of a physical security measures (e.g. tamper switch signal, use of I/O interface, etc.).			Yes/No		
	10. Any attempt to establish a user session.			Yes/No		
	11. Attempts to load, modify or collect software (utility or otherwise) or firmware.			Yes/No		

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#	Cyber Security Requirements Description	DEWA Requirement			D33 applicant specs	
		Unit	Requirement	Compliance	Compliant? (Y/N)	Detailed Response (mark N/A if not applicable)
	12. Modifications to system parameters (e.g. IP or non-IP address, cycle time, watchdog timer).			Yes/No		
	13. Modification or forcing of application data.			Yes/No		
	14. Change of device status to stop, run, standby or restart modes.			Yes/No		
	15. Manual alteration in time synchronization cycle.			Yes/No		
	16. Removal and interfacing of hardware components such as expansion cards.			Yes/No		
	17. Modifications to system files or select file system locations.			Yes/No		
	18. Backup and restore events.			Yes/No		
2	Each audit record generated by the system shall include the following information to track the event:			Yes/No		
	1. Timestamp (which an event occurred).			Yes/No		
	2. Source (from where the event was generated/ information about originating device, software process or user account, category).			Yes/No		
	3. Event ID and event results.			Yes/No		
3	PPC/RTU shall record all activities/ operational functions carried out either by operator or by software process to recognize the sequence of actions.			Yes/No		
4	Warning notification shall be issued for all applicable equipment/ systems whenever the allocated audit record storage volume reaches 80% of useable audit record storage capacity.			Yes/No		
B.5	**COMMUNICATION INTEGRITY**					
1	Relay shall have the capability to protect the transmitted information		TLS (optional)	Yes/No		
2	Relay shall reject any attempts to inject unauthorized session identifiers to hijack established			Yes/No		