ANNEXURE-I TO AMENDMENT-1

16 SCADA

16.1 General Requirements

16.1.1 The Contractor shall provide complete SCADA system with all accessories, auxiliaries and associated equipment and cables for the safe, efficient and reliable operation and monitoring of entire solar plant and its auxiliary systems.

16.1.2 The Contractor shall provide all the components including, but not limited to, Hardware, Software, Panels, Power Supply, HMI, Laser Printer, Gateway, Networking equipment and associated Cables, firewall etc. needed for the completeness.

16.1.3 SCADA System shall have the provision to perform the following features and/or functions:

(i) Web enabled Operator Dashboards: Showing key information on Generation, Performance and Current Status of various equipment in Single Line Diagram (SLD) format with capability to monitor PV array string level parameters.

(ii) Real time Data Logging with Integrated Analytics & Reporting: Logging of all parameters - AC, DC, Weather, System Run Hours, Equipment Status and Alarms as well as derived/ calculated/ integrated values. The SCADA User interface shall be customizable and enable Report Generation and Graphical Analysis.

(iii) Fault and System Diagnostics with time stamped event logging.

(iv) Support for O&M Activities: The interface shall allow integration with Surveillance System(s), Module Cleaning System and various other O&M support systems to provide a Data Analysis and Decision Support System for smooth and efficient Plant Operations.

(v) AI based Distributed Analytics for Predictive Maintenance, trend analysis and Alerts.

(vi) Generate, store and retrieve user configurable Sequence of Event (SOE) Reports.

(vii) Interface with different field equipment in the plant and work seamlessly with field equipment supplied by different companies.

(viii) Transfer of plant data reliably, to an Owner designated server or Cloud (Option: check with client) on any kind of remote network including low bandwidth and wireless links such as 2G/3G/VSAT

(Note: Telecom Lease line connection, if required for transferring data from Plant over internet shall be taken by Contractor in the name of Employer for O&M period)

16.1.4 The Control system shall be designed to operate in non-air-conditioned area. However,

the Contractor shall provide a Package/ Split AC of suitable capacity decided by heat load requirement in SCADA room at Main Control Room.

16.2 Architecture

16.2.1 The SCADA System shall be built over Industrial IoT architecture with integrated Analytics, secure web access, enterprise software and Database.

16.2.2 Data acquisition shall be distributed across MCR and LCRs while plant level data aggregation shall be done in both local and remote server (as specified by Owner).

16.2.3 Analog and Digital IO modules shall have integrated processor for distributed IO processing and control.

16.2.4 Data communication system shall be built over fibre optic cables/ wireless network with high bandwidth TCP/IP communication (Fast Ethernet or 802.11a/b/g/n) across all Inverter and Control Rooms with Internet/Intranet access at Main Control Room. Firewall shall be provided for network security.

16.2.5 Plant SCADA Server shall have Industrial Grade server hardware running SCADA & Monitoring Software with data storage (complete plant data) space for 2 years.

16.2.6 Plant data for monitoring and control operations should be accessible without dependence on external network.

16.2.7 A server running SCADA & Monitoring Software shall be configured at the Owner's office in Leh (HQ Server/Remote Server) having the same specifications as the Plant Server, in parallel with Plant Server to enable easy access to plant data from outside the plant without having to login to plant server. Effectively, the plant data shall be replicated in both places i.e. between systems at the Plant Server and Remote Server to provide data redundancy for critical plant data.

16.2.8 Operator Workstation/PC shall be of Industrial Grade for browser-based access to plant data from Plant or remote server. Plant control & SLDC/Utility related operations shall only be initiated through browser-based interface requiring no client software or database to be installed on the Workstation. All critical software and Plant Data shall be installed/stored on local and remote servers only with user access control for protecting the software and data assets from accidental deletion or corruption.

16.2.9 Internet/Intranet at Plant: Public or private network access shall be provided at the plant through any broadband/VSAT connectivity of 2Mbps or higher bandwidth. In case no broadband/VSAT connectivity can be provided at the plant, a 3G/4G data card from any Internet Service Provider (ISP) may be provided. SCADA system shall be capable of sending all plant data in real time to the Remote Server.

16.2.10 GPS based Time Synchronization System: The SCADA system shall have a Master/Slave Clock system along with antenna, receiver, cabinet and internal interconnection cables. All SCADA controllers, servers, OWS and communicating equipment shall be synchronized to the GPS clock.

16.3 Industrial IoT Controllers & Data Acquisition

The Plant SCADA and Monitoring System may use one or more IIoT Controllers at each Inverter Control Room and MCR for the purpose of data acquisition and data forwarding to the Local and Remote SCADA Servers. The IIoT Controllers shall meet the following minimum requirements:

16.3.1 The IIoT Controllers shall be distributed in nature and work independently of other IIoT Controllers or any central controller in the system.

16.3.2 Shall be capable of supporting wide range of field protocols to communicate with different field equipment (Modbus over RS485/Ethernet, etc.)

16.3.3 Shall have local storage for a minimum of 2 weeks (in case of network failure).

16.3.4 Provide web-based interface to configure the controller for various equipment in the field.

16.3.5 IO Functionality: Shall support status monitoring of VCBs & Trip relays on RMU/HT & Transformer panels through distributed DI/AI modules.

16.3.6 Controls: Shall be capable of Controlling breakers (ON/OFF). Both ON/OFF and Parameter control of inverters shall be supported.

16.3.7 Data Communication with Servers: Shall send the data collected, from all the equipment at Inverter Control Room and/or Main Control Room, to the Monitoring & Control Server.

16.3.8 Controllers shall be capable of sending data over Internet connections USB data cards.

16.3.9 Shall not require a static public IP address, at the plant for the purpose of remote access.

16.4 Functionalities

16.4.1 The SCADA system shall monitor instantaneous and cumulative electrical parameters from all DC& AC Equipment including inverters, string combiner boxes, weather station, MFM, Transformer and Switchgear (LT & HT Panels) at regular intervals not greater than one minute.

16.4.2 The SCADA system shall monitor Instantaneous and cumulative environment parameters from weather sensors or data loggers at same interval as electrical parameters and provide PR, CUF on the fly.

16.4.3 The SCADA system shall provide Alarms and Alerts on equipment faults and failure in less than 5 seconds. Alarms on status change of hardwired DI shall also be provided.

16.4.4 The SCADA system shall provide configurable alerts on any parameter crossing settable thresholds. The list of such parameters shall be finalised in consultation with the Owner.

16.4.5 The SCADA system shall enable integration with other sub-systems at the plant for supporting O&M activities. The list shall include but not limited to:

(ix) Surveillance Cameras,

(x) Module Cleaning System – For monitoring of water usage and efficacy of cleaning process.

16.4.6 The SCADA system shall have user-friendly browser-based User Interface for secure access from anywhere, for minimum ten concurrent connections from the Operator PC or other securely connected laptop/mobile, for plant monitoring, O&M, daily reporting, and analysis. A dashboard providing summary details of total plant generation, day's export, irradiance, Inverter Control Room level generation and performance indicators like PR and CUF.

16.4.7 Reporting: The SCADA system shall provide downloadable reports in Excel/PDF, configurable for equipment parameters across the plant.

16.4.8 The system shall have Configurable Analysis page for self-configured as well as on demand Analytics charts.

16.4.9 The SCADA system shall be extensible to include maintenance of O&M schedules and related activities for plant equipment as per the O&M Manual.

16.4.10 Connectivity shall be provided to Owner's Data Monitoring Centre. Data collected by Plant SCADA shall be replicated in real-time, using industry standard interfaces such as Web Services, OPC-UA, data files, as required – with Owner's Central Monitoring System in Delhi. The data recording intervals for different parameters from different devices in the solar plant shall be considered when creating schedules to "push" the data from Plant SCADA to data receivers stationed at Owner's Data Monitoring Centre.

16.4.11 Mobile User Interface: summary of plant performance and issues should be accessible in a mobile Native UI or browser UI.

16.4.12 Data Communication to SLDC: SCADA system shall provide required interface to integrate with DISCOM-SLDC, in compliance with grid code, to send any parameters specified by SLDC.

Note: The methodology and specification of SLDC interface will be provided separately by SLDC/DISCOM and it shall be the responsibility of the Contractor to determine the same.

16.4.13 Power Plant Control: SCADA system shall provide required interface to the local SCADA operator to set various power control modes (active/reactive power/frequency/PF) through the inverters over industry standard communication protocols like Modbus over TCP/IP.

16.4.14 Forecasting and Scheduling: SCADA shall provide day ahead and week ahead forecasting and scheduling for power generation at the plant as per SLDC/Utility stipulations.

16.4.15 Predictive Maintenance: SCADA system shall have in-built or pluggable frameworks to support AI based Predictive Maintenance for all key equipment including inverters, transformers and switchgear at the plant.

16.4.16 All programming functionalities shall be password protected to avoid unauthorized modification.

16.4.17 The Contractor shall provide software locks and passwords to Employer for all operating & application software. Also, the Contractor shall provide sufficient documentation and program listing so that it is possible for the Employer to carry out modification at a later date.

16.5 Cable Specifications

16.5.1 RS485 & IO Cables shall meet the following minimum specifications:

- For RS485: 0.5sq.mm ATC multi-strand (class-5), insulated core, twisted pair, overall screened with ATC drainwire, GI wire Armored, PVC sheathed, DIN47100 color standard, FRLS, 1.1KV grade
- For IO cabling (between HT/RMU panels and SCADA panel) – 1.0 sq.mm multi-strand, 4/8/12 core screened, armored, FRLS cable, 1.1KV grade.
- For Optical Cabling: 6F, Armored, Single/Multi mode laid through HDPE conduits to minimize cable breaks.

16.6 Earthing

16.6.1 Two isolated electronic earth pits near to SCADA panel at every Inverter and Control Room with < 1 Ohm resistance shall be provided. One earth pit shall be used for protective/body earth and the other to be used for Signal Earth.

16.6.2 Apart from providing separate earth pits, manufacturer specified earthing recommendations shall be followed for all communicating equipment connected to SCADA. This includes but is not limited to SMBs, Inverters, WMS and Switchgear panels.

16.7 Communication Cable Laying

16.7.1 All RS485, IO and CAT6 cables shall be laid in separate conduits with a minimum separation of 1.5ft from AC/DC power cables all along.

16.7.2 Power cables shall be laid deep in the trenches first. Data cables shall be laid in separate conduits after partially filling the trenches to ensure minimum 1.5 ft separation between power and communication cables all along the trench.

16.7.3 IO Cables between switch gear panels and SCADA panel shall be laid on separate cable trays, with a minimum of 1.5ft separation from trays carrying AC Power cables.

16.7.4 RS485 & CAT6 cables between switch gear panels or Inverters and SCADA panel shall be laid on separate cable trays, with a minimum of 1.5ft separation from trays carrying AC Power cables.

16.8 Control Cabinets / Panels / Desks at Main Control Room

16.8.1 The cabinets shall be IP-22 protection class. The Contractor shall ensure that the temperature rise is well within the safe limits for system components even under the worst condition and specification requirements for remote I/O cabinets.

16.8.2 The cabinets shall be totally enclosed, free standing type and shall be constructed with minimum 2 mm thick steel plate frame and 1.6 mm thick CRCA steel sheet or as per supplier's standard practice for similar applications.

16.9 Software Licences

The Contractor shall provide software license for all software being used in Contractor's System. The software licenses shall be provided for the project and shall not be hardware/ machine-specific.

16.10 Hardware at Main Control Room

16.10.1 The Hardware as specified shall be based on latest state of the art Workstations and Servers and technology suitable for industrial application & power plant environment.

16.10.2 The Local Monitoring & Control Server and the Operating Work station, to be deployed in the Plant Control Room, shall have the following server hardware and operating system along with accessories:

Plant Server	
Server Hardware	Hex/Octal Core Xeon, 32GB RAM (expandable to 64 GB RAM), 4 X 2TB SATA hard discs in RAID 5 configuration, 2TB external USB hard disc (for backup), dual power supplies, 2 LAN ports, LCD console, keyboard & mouse.

	The Server hardware shall be housed in a rugged fan-cooled, and rodent-proof Server Rack.
Operating System	Operating System and Database shall be of enterprise scale (RedHat Linux or equivalent Linux OS, Oracle/MySQL or equivalent DB), with required AMC for 5 years.
Accessories	1. Monitor: Min 22" LED Flat Monitor with non-interfaced refresh rate min. 75 Hz. 2. Keyboard: ASCII type 3. Pointing Device: Mouse 4. Intelligent UPS (on line): Minimum 2 hour battery backup.
Operator Workstation	
Hardware	i7 CPU running at 3.0 GHz or faster with 8GB RAM, 500GB hard disk, 25" LED monitor, keyboard and mouse, 4 USB ports, LAN port
Operating System	Windows operating system with necessary tools, anti-virus software.
Accessories	1. Screen Display Unit: Min 50" LED Flat Monitor with wall mounted arrangement for the display of SCADA screen 2. A4 size monochrome laser printer. 3. UPS of required capacity with 2 hour battery backup.

16.10.3 All network components of LAN and Workstations shall be compatible to the LAN, without degrading its performance.

16.11 <u>Factory Acceptance Test (FAT)</u>

FAT procedure shall be submitted by bidder for approval. SCADA shall communicate with all third devices which are part of solar plant and same shall be demonstrated during the FAT.

ANNEXURE-II TO AMENDMENT-1

17.4.1 LED luminaires shall meet the following parameters:

Parameter	**Specified Value**
Input voltage	170-260 V
Input Frequency	50 Hz +/-1 Hz
Power Factor	0.90 (Minimum)
Luminous efficacy	> 90 lumens per watt
Beam Angle	Minimum 120°
Total Harmonic Distortion	< 10 %
Working Humidity	10% - 90% RH (Preferably Hermetically sealed unit)
Degree of Protection	Minimum IP 65 (for Outdoor fixtures)
Luminaire Casing	Powder coated metal / Aluminium.
Color Temperature	5700 K (cool day light)
Color Rendering Index	> 65
Moisture protection in case of casing damage	IP 65 (driver unit shall preferably be totally encapsulated)

ANNEXURE-III TO AMENDMENT-1

SCC Clause 8(2)

During the demonstration of yearly CUF, any shortfall from committed CUF will be penalized @ INR 7.37/unit for each unit shortfall. The CUF shall be evaluated as per the formula mentioned in Section VII, Scope of Work and Technical Specifications. Shortfall in CUF during any year may be compensated against excess CUF during previous or subsequent years subject to total CUF over the O&M Period being in accordance with the committed CUF. LD levied, if any, on account of shortfall in CUF in any year shall be refunded when the same is compensated through excess CUF in subsequent years. Determination of penalties on account of shortfall, if any, shall be made after such adjustment, up to adjusted CUF not already accounted in an earlier year.

If the Contractor fails to achieve 5 year cumulative CUF at the end of O&M period, then the Contractor will pay compensation to Owner an amount equal to the Net Present Value (NPV) of the estimated revenue loss due to shortfall in CUF for 6th to 25th year calculated at a discount factor of 9.08% as below.

$$COM = \sum_{n=1}^{20} \left[\frac{\left(\frac{Eg - Ea}{5}\right) \times C}{(1 + 0.0908)^n} \right]$$

Where, COM is the compensation payable to Owner in INR

Eg is 5 year cumulative guaranteed generation with reference to the committed CUF in kWh

Ea is 5 year cumulative actual generation in kWh

C is tariff of INR 7.37/unit

ANNEXURE-IV TO AMENDMENT-1

S. No.	Stage	Reference from D
3.1.1	Issue of NOA/ LOI/ LOA	Zero Date (D)
3.1.2	Detailed Engineering Design and Drawing Approvals & Procurement Planning and Approval	D + 2 Months
3.1.3	Completion of supply of major equipment like SPV Modules (including structure for the above), Power Conditioning Units, transformers etc.	D + 6 Months
3.1.4	Installation of all Major Equipment	D + 12 Months
3.1.5	Interconnection of all Major Equipments and Completion of Installation	D + 17 Months
3.1.6	Completion, Testing and Pre-Commissioning of Solar PV Power Plant	

3.1.7	Commissioning of Plant along with Completion of Facilities in line with Technical/ Functional/ Performance Requirement stated under this Tender Document along with demonstration of PG Tests as mentioned in the SCC	**D + 18 Months**