vi. Flooring:

Best quality Vitrified tile flooring having min size of 600 mm x 600 mm x 8-10 mm thickness of standard manufacturers as approved by EIC.

vii. Toilet:

Toilet shall be designed for 10 persons; and constructed with following finish

- Floor: Vitrified tiles
- Door and window: made out of aluminum brown anodized sections, 6mm float glass
- Ventilators: Mechanical exhaust facility
- Plumbing fixtures: Jaquar and Kohler make
- Sanitary ware: Hindware, Cera or equivalent make
- EWC: 390 mm high with health facet, toilet paper roll holder and all fittings
- Urinal (430 x 260 x 350 mm size) with all fittings.
- Wash basin (550 x 400 mm) with all fittings.
- Bathroom mirror (600 x 450 x 6 mm thick) hard board backing
- CP brass towel rail (600 x 20 mm) with C.P. brass brackets
- Soap holder and liquid soap dispenser.

vii. Doors and Windows:

Doors and windows shall be made of aluminum sections. All sections shall be 20 microns anodized. Sections of door frame and window frame shall be adopted as per industrial standards. Door shutters shall be made of aluminum sections and combination of compact sheet and clear float/wired glass. All windows of Control cum conference room shall be protected by Sun film protection sheet. The control room shall require a number of windows/louvers to be provided for ventilation/ fresh air circulations. All fixtures for doors and windows shall be of Dorma, Godrej and Kich make.

viii. Water Supply for Toilets:

GI pipes (B class) Tata or equivalent make. Separate Overhead water tank Sintex or equivalent of 2,000 liter capacity.

ix. Drainage for Toilets:

Drainage pipes shall be of CPVC (6 kg/cm2) Supreme, Prince or equivalent make. Gully trap, inspection chambers, septic tank for 10person and soak well to be constructed for abovementioned requirement.

x. Air Conditioner for Control Room:

The control room shall be equipped with appropriate numbers of fans for effective heat dissipation. The SCADA cabin and Conference room shall have split type air conditioning units.

xi. Fire Extinguishers:

Liquefied CO2 fire extinguisher shall be up right type of capacity 10 kg having IS: 2171. 7 IS: 10658 marked. The fire extinguisher shall be suitable for fighting fire of Oils, Solvents, Gases, Paints, Varnishes, Electrical Wiring, Live Machinery Fires, and All Flammable Liquid & Gas. Bidder shall provide Min. 10 no of fire extinguisher is envisaged for main control room.

xii. Sand Bucket:

Sand buckets should be wall mounted, made from at least 24 SWG sheet with bracket fixing on wall conforming to IS 2546. Bucket stands with four buckets on each stand shall be provided in the Transformer Yard – 4 Nos.

xiii. Sign Boards:

The sign board containing brief description of various components of the power plant as well as the complete power plant in general shall be installed at appropriate locations of the power plant.

- For Switchyard and Transformer Yard:

The Sign boards shall be made of steel plate of not less than 3 mm. Letters on the board shall be with appropriate illumination arrangements.

- All Inverter Rooms and Control and Conference Room:

The name boards shall be made of acrylic sheet of 300mm height and fixed at the entry of the all facilities.

The Contractor shall provide to GSECL, detailed specifications of the sign boards.

5.2.19 Module Mounting Structures (MMS):

The Contractor shall design and construct appropriate civil foundations for MMS.

The array structure shall be so designed that it will occupy minimum space without sacrificing the output from Solar PV panels at the same time it will withstand severe cyclonic storm with wind speed **as per IS 875 for calculations of Vz. Bidder shall take basic wind speed value for respective sites as per following.**

Site wise wind speed to be mentioned here as per IS 875.

Pile casting for testing shall be as per IS before approval of drawing &design. Testing of pile by NABL accredited laboratory.

It shall support Solar PV modules at a given orientation, absorb and transfer the mechanical loads to the ground properly. There shall be no requirement of welding or complex machinery at site and is strictly not allowed.

Seismic factors for the site to be considered while making the design of the foundation/ramming etc. or any technology. The design of array structure shall be based on soil test report of the site and shall be approved from GSECL/Consultant.

The Contractor has to plan for pilot test like pull out; lateral and compression of minimum 10,10,3 are required to be conducted for each floor at strategic location, immediately. Based on the results of above-mentioned tests, final approval for design of pile shall be provided.

The material of construction, structural design and workmanship shall be appropriate with a factor of safety of not less than 1.5.

For multiple module mounting structures located in a single row, the alignment of all modules shall be within an error limit of 5 mm in vertical / horizontal line.

The Contractor shall provide to GSECL the detailed design, specifications and calculations of the MMS and take approval from GSECL.

The Contractor shall specify installation details of the Solar PV modules and the support structures with appropriate diagrams and drawings.

The Module Mounting Structure design shall be certified by a chartered structural engineer and it is mandatory.

The Contractor should design the structure height considering highest flood level at the site. The minimum clearance between the lower edge of the module and the ground shall be the higher of (i) above highest flood level at the site and (ii) minimum 500 mm.

The Contractor shall provide to the Company the detailed design, specifications and calculations of the MMS during **detailed engineering**.

Curing of all piles shall be done thrice a day and be maintained for a period of seven days from the date of casting.

The Contractor has to ensure sufficient lighting arrangement for all concreting activities during night time. Sufficient illumination should be ensured in and around areas wherever civil and construction activities take place during night time.

The Contractor shall specify installation details of the Solar PV modules and the support structures with appropriate diagrams and drawings.

The Bidder shall be permitted ramming of the module mounting structure provided that they obtain consent of EIC. EIC shall provide such consent once it is convinced that such ramming shall not in any way deteriorate the strength of the structure and shall not reduce the structure's strength to enjoy a working life of more than 25 years.

Civil foundation design for Module Mounting Structures (MMS) as well as control room, inverters room shall be made in accordance with the Indian Standard Codes and soil conditions, with the help of Chartered Structural Designer having substantial experience in similar work. The Successful Bidder shall submit the detailed structural design analysis along with calculations and bases/ standards in the Bid.

Module Mounting Structures Design is to be certified by Chartered Structure Engineer and certificate to be produced along with the design details for approval by GSECL. Switchyard structures / transmission line structure designs shall be strictly as per GETCO design.

All the civil defects, rectification, repairing, replacement related to civil works shall be in the scope of contractor during the O&M period, the Contactor shall be responsible for rectification of any defect in the civil work and maintain the structure/buildings in good condition with proper maintenance. The Contractor shall be responsible for the maintenance of each civil works carried out as mentioned below.

1. Buildings Control room premises, Underground water tank includes:

I. Water tightness/ leak proof of roof and walls.

II. Painting to the structure either PEB/ RCC Framed structure at regular interval (not more than five years).

III. Plumbing & Sanitation related defects/replacement.

IV. Chalking / overflow of septic tank and soak pit.

V. Replacement / repairing of water tank if major/minor leakage observed.

VI. Leakage of water to be attended by suitable crack filler.

VII. Repairing/replacement of doors, windows, ventilators & rolling shutter.

2. Road WBM or Bitumen:

I. Crack repairing of the road surface.

II. Pot-holes over the top road surface to be rectify.

III. Maintenance of shoulders for the rain cuts or damage due to some external reasons.

IV. Re-carpeting of the road surface at every five years interval.

3. Storm water Drainage:

I. Before and after the monsoon season the storm water drainage shall be maintained & cleaned for smoother flow of storm water.

4. Main Entry gate & Fencing:

I. Maintain the elegance of entry gate with painting as & when required.

II. Repairing & painting of precast boundary wall as & when required.

The above list is not exhaustive but indicative only. Although most of the structures are covered here in, any other system (Civil, Structural and Architectural) required for successful operation and maintenance of the works shall form a part of this contract and shall be deemed to be included in the scope of works. The scope of Bidder/EPC Contractor shall include supply of all

required materials, mobilization of labour, and arrangement of required tools tackles and equipment to carry out all above civil maintenance works.

5.6 **12 MW for 4 Hours (Min. 57 MWH) Battery Energy Storage System (BESS): DETAILED SCOPE OF WORK FOR BESS (CIVIL + ELECTRICAL)**

a) The scope for the Design, Engineering, Supply, Transportation, Unloading, Storage, Construction, Erection, Testing, Commissioning of grid connected Battery Energy Storage System (BESS) with minimum 35 (AC) solar project and 12 MW for 4 Hours (Min. 57 MWH)) rated AC discharge capacity at 11 or 33 kV interconnection point at PV Plant throughout the life of 25 Years and Comprehensive Operation and Maintenance (O&M) works of BESS system for a period of Twelve (12) Years from the date of successful completion of project shall be on turnkey basis completely covering the following activities and services in respect of all the equipment & works specified and covered under the specifications and read in conjunction with "Scope of Supply & Services" elaborated elsewhere. BESS system must be able to communicate with Load Dispatch Centre and Control both Battery System and Solar PV plant system as per Local LDC and as well as SLDC/ALDC requirement.

b) The BESS shall comprises of Battery Storage system, Battery Management System (BMS), Energy Management System (EMS) & Power Conditioning System (PCS), Protection system, Solar Plant Generation Forecasting & scheduling System/Service, Communication System, HT & LT System, Auxiliary Power System, Monitoring & Control System and all other associated materials and accessories necessary for trouble free Operation and Maintenance of the BESS system.

c) As per Tender, The minimum Guarantee for BESS Battery, the life should be for minimum 12 Years. But the BESS System should work for 25 years. Within the Guarantee period, if bidder envisage any replacement, then the cost of replacement shall be in scope of successful bidder.

d) The Bidder shall supply 5% of mandatory spare of all items for the integrated BESS System.

e) The configuration and internal layout of the BESS shall provide suitable safe access to all equipment for installation, operation, maintenance and repair in all weather conditions. Bidder shall be responsible for identifying and providing any and all the

other additional equipment, component and services necessary for its integration with the 35 MW (AC) Solar PV Plant and existing AC grid, as a fully functional grid interactive BESS System. All equipment, materials and services that are necessary for the satisfactory operation of the BESS for entire O&M period of 12 years shall be deemed to be included in the scope of EPC package work and shall not be limited to the following.

f) Out of total solar power generation, 70% power shall be directly injected/evacuated to the grid and 30% power shall be used for the BESS charging purpose. BESS shall be designed such that 12 MW power for 4 hour (Min. 57 MWH) shall be evacuated to the grid separately during grid peak time. Grid peak time shall be as per GUVNL requirement and it is most probably evening peak time i.e. 06:00 PM to 10:00 PM daily.

5.6.1 BATTERY AND BATTERY MANAGEMENT SYSTEM (BMS): GENERAL SCOPE OF WORK

a) The primary application of BESS for the current Project shall be mitigation of intermittent fluctuations of solar power generation (due to cloud, rain, tripping of solar inverter or any other reason) by smoothening of power output from the Solar PV plant and provide energy time shifting. In addition to the above two application requirement, BESS shall also have feature of manual operation, VAR support, anti-islanding operation, black start operation and frequency regulation control mode. The BESS shall remain connected to the grid as per Central Electricity Authority Technical (standards for connectivity to the grid) regulation 2007 with all latest amendments and its components shall be designed accordingly.

b) BMS shall ensure safe operation and mitigate fire risk BESS shall have at least twenty five (25) years of service life i.e. it should have capabilities for providing services as per specification for twenty five (25) years from the date of successful completion of trial run. The BESS shall be configured to perform multiple charge discharge cycles. Any failure in BESS during 12 years of comprehensive O & M, EPC contractor shall have to replace at no extra cost.

1. A. **SOLAR GENERATION SMOOTHENING MODE:-**

i) BESS is required to mitigate the intermittent fluctuations of solar power generation by smoothening the Solar PV plant output and deliver scheduled power (as per CERC regulation) to grid. The BESS shall absorb the short term power variations in Solar PV plant output power by fast charging or discharging the battery and generate a smoother resultant output curve that can be absorbed in the grid in an easier way.

ii) Smoothening action is to be carried out by BESS by estimating target reference power based on 15 minutes moving average algorithm or 15 minutes moving average along with SOC control algorithm. The moving average values is the last 15 minutes average value of Solar PV plant output power.

iii) Bidder can also propose other better suitable control algorithm for this application. If alternate algorithm are proposed, then the Bidder needs to submit the supportive technical document including simulation study report for proving the superiority of the proposed alternate control algorithm over algorithm as mentioned above with respect to application requirement.

iv) The BESS shall also to have suitable control methodology to avoid unwanted charging and discharging of BESS Battery during clear sunny days without intermittency.

v) BESS shall ensure that the combined Solar PV and BESS output to grid (injected grid power) follows the reference target power and shall be within the band of ±5% of reference target power at any time instant for smooth injection power to grid.

vi) The Reference Target Power in this mode shall be the 15 minutes moving average value OR grid reference power set point as generated with 15 minutes moving average along with SOC control algorithm.

vii) The BESS shall operate continuously and Battery SOC needs to be controlled within a certain range to prevent forced shutdown of the BESS due to overcharging OR Over discharging of batteries. For Energy time shifting requirement, the BESS Battery shall be sufficiently charged (subjected to sufficient power generation from solar PV plant) after mitigating intermittency and BESS shall be able to deliver 12 MW for 4 Hour energy at PCC.

2. B. **MANUAL MODE**:-

i) The BESS operator shall be able to provide grid power set point to EMS controller through BESS SCADA HMI. BESS SCADA shall also have the facility to receive the

grid power set point from LDC/Energy Management Centre and provide the same to EMS controller for necessary action.

ii) BESS shall ensure that the combined Solar PV and BESS output to grid (injected grid power) follows the reference target power and shall be within the band of ± 5% of Reference Target Power at any time instant for smooth injection power to grid. The Reference Target Power in this mode shall be the manual grid power set point set through SCADA HMI or set point signal as received from LDC/Energy Management Centre.

iii) BESS operator shall be able to Ramping Up or Down the BESS power (up to maximum BESS MW rating) by providing BESS power set point to EMS controller through BESS SCADA HMI. Once this mode is initiated, the BESS shall remain at the designated output (or input) power level until terminated by BESS SCADA with manual intervention or Battery Charging or Discharge limit is reached.

iv) However, as per grid operator requirement or under special emergency grid condition requirement the same shall be allowed for smoothening of solar PV plant output power intermittency. For this, the details control logic shall be finalized during detail engineering stage.

v) The Bidder must take care all type of intermittency including seasonal at suitable scale in their BESS design.

3. C. **VAR SUPPORT MODE**:-

i) The BESS shall be required to provide VAR support to grid for voltage regulation purpose. BESS operator shall be able to provide reactive power/power factor set point to EMS controller/PCS through BESS SCADA HMI (manual intervention). BESS SCADA shall also have the facility to receive the reactive power set point from LDC/Energy Management Centre and provide the same to EMS controller/PCS for necessary action. The VAR output of the BESS may be limited based on remaining capacity left after providing real power output.

4. D. **ANTI-ISLANDING MODE**:-

i) The BESS shall have anti-islanding protection as per IEC 62116 or equivalent international standard. This can be achieved through incorporating compatible PCS as described in the tender for the grid tied inverters.

5. E. **BLACK START/ISLAND MODE**:-

i) BESS shall have black start operation feature and shall be able to form a micro grid with Solar PV Plant & local loads connected at 66 kV Switchgear. BESS shall set and automatically control the micro-grid voltage & frequency within acceptable limit and shall charge or discharge the battery based on micro-grid requirement. As per requirement BESS shall also control the active and reactive power (or power factor) of Solar PV plant by providing required set point to Solar PV Inverters and also control (close/trip) the 11/33 kV circuit breaker located at Solar PV Plant end for load control purposes. BESS shall have all the required hardware, control and protection feature for safe operation of micro-grid.

6. F. **FREQUENCY REGULATION**:-

i) The BESS shall be able to support grid during very low or high grid frequency by supplying or absorbing power to/from grid. The power support shall be based on power vs frequency droop characteristic for system frequency outside of the predefined frequency dead band (say 49.5 to 50.5). The operation in this mode shall be initiated by detection of low or high grid frequency while the BESS is in any other mode. After normalization of grid frequency to normal operating range, the BESS shall return to the mode in which it was operating at the start of frequency regulation mode. Within the dead band frequency range the BESS do not have to participate for frequency regulation operation.

ii) During detail engineering the actual value of dead band frequency range shall be finalized based on CEA grid regulation. This mode shall be kept disable after commissioning test for the time being and Bidder needs not to consider any additional battery sizing for this application requirement.

7. G. **SOLAR FORECASTING along with BESS topology:-**

i) Bidder also has to provide solar forecasting and scheduling system/service along with BESS topology and software tool as per CERC requirement for forecasting and

scheduling for 35 MW (AC) solar PV project along with 12 MW for 4 hours (Min. 57 MWH) BESS. The forecasting & scheduling service shall provide one day prior data of 90 minutes and 15 minutes advance data for intra-day as per SLDC/ALDC requirements and guidelines time to time. This system must be able to send the forecasting and scheduling data as above with Load Dispatch Centre/ Energy Management Centre through BESS SCADA/EMS system. The weather station input e.g. GHI, Ambient Temperature, Humidity and Wind speed, shall be taken by Bidder from Solar PV Plant SCADA system.

5.6.2 **Factory Acceptance Testing of BESS**

i) The Contractor shall develop and submit to the Employer for its review and approval a comprehensive FAT plan that shall demonstrate that the BESS will meet the requirements of the specification. The Employer shall have the right to request reasonable changes to the test plan.

ii) Where full-scale testing of larger systems at the factory may be difficult or impossible due to the large system, the FAT shall be carried out at a subsystem or module level and shall consist of tests of 100% of the subsystems or modules that comprise the complete BESS, to the extent possible. In the FAT plan, the Contractor shall clearly state what is being tested and shall fully explain any features or functions of the fully assembled BESS that would not be fully tested in the reduced-scale testing proposed. In such a case, the SAT plan shall further describe how the tests that could not be carried out in the factory will instead be carried out at the site.

iii) After the Contractor determines that the BESS is fully operational, the Contractor shall conduct a FAT, witnessed by the Employer and/or the Employer's representative. The FAT shall consist of the Contractor demonstrating to the Employer that the BESS is fully operational and performs as specified. This includes but is not limited to the following:

- Visual inspection of all provided equipment, including dimensions and overall design.
- Verification of proper mechanical construction such as electrical connection torques.
- Verification of sensors, metering, and alarms.

- Verification of all control functions, including remote control and monitoring, and communications interfaces.
- Verification of BESS performance at full and partial power and energy ratings.
- Verification of maintenance and replacement features for unit batteries and other key components.
- Verification of compliance with specifications.

iv) During the FAT, the BESS shall meet the following:

- Be operated and function as specified and designed in all the operating states, use cases, and duty cycles specified herein
- Meet the power and energy requirements specified herein
- Be demonstrated to meet the safety and response to catastrophic failure requirements specified herein
- Have the efficiencies, response capabilities, and other features specified herein and/or proposed by the Contractor

  Note: The methodology for measurement of procurement specifications is provided in this Section.

v) Operation of all control, protective relaying, and instrumentation circuits shall be demonstrated by direct test, if feasible, or by simulating operating states for all parameters that cannot be directly tested. Automatic, local (control console), and remote operation of the controls shall be demonstrated.

vi) Factory testing shall demonstrate operation at expected temperature extremes at the Employer's site. If this is not possible for the full BESS at the manufacturing facility, independent laboratory certification of operation of critical components and subsystems in the battery, PCS, and control systems shall be submitted at the time of the FAT. The Contractor shall submit to the Employer for approval, 90 days before the FAT, a list of components and subsystems for which independent lab testing certification will be sought.

vii) The Contractor shall perform any and all system modifications required during start-up and testing. The testing may be suspended as a result of a BESS malfunction and resumed only on rectification of problem items. Such suspension and resumption will occur at the sole discretion of the Employer.

viii) The BESS will not be accepted for shipment until all FATs have been successfully completed. In addition, the Employer will verify that all provisions of the contract have been met, including verification of all required submittals, any spare parts delivery, and any required system modifications.

5.7 INTEGRATION OF 35 MW (AC) SOLAR PV PLANT & 12 MW FOR 4 HOURS (MIN. 57 MWH) BESS:

i) BESS to take (0.2S class) and (0.2 class) input signals directly from 11/33 kV switchgear located at 35 MW (AC) Solar Plant. Supply of Control & Communication cable and associated cabling work (including termination etc.) shall be in the scope of bidder. SCADA/EMS of BESS system shall have facility for direct control of 35 MW (AC) Solar Plant Inverters for Active and Reactive Power Control and closing and tripping of 11/33 kV circuit breakers for load and generation control purpose at both end i.e. Generating station and GETCO end. SCADA/EMS of BESS system shall also be able to read and write data from/to solar SCADA/EMS server/controller as per BESS requirement.

ii) In this arrangement the solar Inverters system shall be integral part of BESS SCADA/EMS LAN and direct control & monitoring of solar inverters shall be possible from SCADA/EMS of BESS system. For Solar Plant VCBs control and to read and write data from/to solar SCADA server/controller the SCADA/EMS of BESS system shall communicate with Solar SCADA with alternate (Redundant) arrangement over suitable standard protocol with no direct connection with solar SCADA LAN.

iii) Supply of necessary Control & Communication cable, Coupling relay, Ethernet switch etc as applicable shall be in the scope of the EPC Contractor. Detail shall be finalized during details engineering stage.

5.7.1 BESS PARAMETER:

The following minimum parameters must be provided for technical bid evaluation. Bidder also shall submit all technical parameters so that it can be assess for all BESS functionality as mentioned above. Separate table of Functional parameters is to be submitted for each functional requirement.

S. No	Parameter	Value
1	Rated Discharge AC useful Capacity at PCC	12 MW for 4 Hour per day continues for 12 Years
2	BESS Round trip AC/AC Efficiency at PCC including auxiliary consumption	Min. 83% at PCC of 11/33 kV Transformer Level
3	Depth of Discharge (DOD)	85% to 90% at 25°C as per BESS system OEM
4	Rated No. of Cycles	4500-5000
5	Battery Efficiency (DC-DC round trip)	Min. 88% - 90% as per their BESS system OEM
6	Guaranteed Minimum service life for Battery Modules	12 Years
7	Charging Rate	To be specified by EPC contractor as 12 MW for 4 Hour discharge required from BESS system
8	Power factor (Measure at PCC)	Four quadrant capability is required. Operating power factor shall be 0.95 lead or lag.
9	Response time	Response time of BESS system shall not be more than 1 (one) second.
10	Positive and Negative Ramp Rate	BESS shall have suitable positive and negative ramp rate to support smooth injection of Solar PV plant output power into grid.

11	BESS design temperature	0º-50º C ambient

Response Time: The design of BESS system should be such that its response time shall not be more than **1 (one) Sec**. Response time is the time interval between need for response (a command or grid event or Solar Plant power generation event, etc) is detected by the BESS and the time when power as measured at the grid has attained that level. This shall include all intermediate response time of system components.

5.7.2 CODES AND STANDARDS

The BESS shall conform to the all applicable IEC/UL standard. Where an applicable IEC/UL standard is not available, IS/ any applicable international standard shall be referred to as best practice. The BESS shall meet all the CEA/CEIG and local statutory requirements for interconnection with grid at the required Voltage level. As a minimum requirement, the following standards as applicable shall be complied with:

UN 38.3	Contractors may seek the necessary information from Battery OEMs as these are UN guidelines for Li Ion Battery transportation.
UL1973	Energy storage for stationary applications such as for PV. Non-chemistry specific (applicable to all secondary battery types)
IEC 61508	Functional Safety of Electrical/ Electronic/ Programmable Electronic Safety-related Systems: Applicable for all Battery Energy Storage Systems
UL 1642	Standard of Lithium Batteries (Safety of Lithium Ion Batteries)

IEC 62619/ IEC 61427	Safety requirements for large scale industrial applications.
UL9540	Safety of energy storage systems and equipment.
IEC 61850/ DNP3	Communications networks and management systems. (Plant SCADA and the BESS control system communication)
Grid Connectivity	Relevant CEA Regulations (including LVRT/HVRT compliance) and Grid Code as amended and revised from time to time.
Battery management and Handling rules, 2001 Ministry of Environment, Forests and Climate Change.	
E-waste (management) rules-2016 Ministry of Environment, Forest and Climate Change.	

5.7.3 BATTERY STORAGE SYSTEM:

i) The energy storage system may consist of **Lithium-ion Type of Batteries** to meet the application requirement. Battery shall be electrically interconnected in any desirable series and parallel configuration to achieve the overall system storage and power rating requirements. The DC voltage of Battery system shall be selected by the Bidder to suit the PCS and Battery efficient and safe operational requirement.

a. The Battery cells may be supplied as separate, individual units or as group of cells combined into modules. The design, materials, and method of cell construction shall conform to the applicable code and/or standard.

b. Cell/Module terminals and interconnects shall have adequate current carrying capacity. Labelling of the cells/modules shall include manufacturer's name, cell /module type, name plate rating, and date of manufacture, in fully legible characters. All cells/modules shall be traceable to the point of origin for purpose of addressing safety issues. The polarities of cell/module terminal posts shall be embossed on the cover at the terminal.

c. Each electrically series-connected Battery string shall include a means of disconnecting the string from the rest of the system and of providing over-current protection (during a fault). This protection shall be coordinated with the PCS capabilities and battery string protection, and shall take into account switching or other transients and the inductance/resistance (L/R) ratio at the relevant areas of

the DC system. These disconnecting devices should be capable of operating with normal load current and provide physical interruption.

d. The Battery system may be ungrounded or grounded. Grounded configurations may be centre or one-pole-grounded and/or solid or high resistance grounded. However, the Battery System shall include a system to detect and alarm excessive ground leakage current levels. Ground fault detection shall be enabled for each container or, if more than one electrical series string is installed in the container, for each series string. The detection/trip level shall be field adjustable. The cells/modules and Battery system shall be supplied with all required and/or recommended accessories.

e. Cells/Modules, wiring, switch gear, and all dc electrical components shall be insulated for the maximum expected voltages plus a suitable factor of safety. The DC bus work and load-carrying cables within the storage subsystem shall have an enough margin for the actual load current. Also, all other components shall have an enough margin for the actual load current according to applicable code and/or standard.

f. Battery container shall have minimum protection class IP54 with proper roof/shed structure.

g. Suitable ventilation/controlled air conditioning and personnel safety measures in battery room/container must be maintained to minimize health hazards to any exposure to hazardous Battery elements. Automatic fire fighting system should be provided as per NFPA.

h. Fire protection system for BESS shall be simulated and provided as per VESDA, if applicable or as per OEM requirements.

5.7.4 BATTERY MANAGEMENT SYSTEM (BMS):

a. The BMS shall be designed to provide for automatic, unattended operation of the Battery Storage System. The BMS shall provide the necessary Monitoring and Control to Protect the Battery cells/module/string from out of tolerance ambient or unsafe operating conditions.

b. The BMS shall automatically control the charge and discharge of the individual cells/module, balancing between cells/module to optimize energy consumption and range, monitor cell/module heath and provide critical safeguards to protect the Batteries from damage. BMS shall have the following feature.

c. However Bidder to supply the BMS system as per Battery OEM recommendation & requirement and shall be in line with the application requirements:

a. **Cell/Module Protection**:-Protecting the Battery from out of tolerance operating conditions and BMS must provide full cell/module protection to cover almost any eventuality.

b. **Charge Control:** - BMS shall automatically control the charge and discharge of the individual cell/module.

c. **SOC Determination**: - BMS shall automatically determine the State of Charge (SOC) of the individual cell/module.

d. **SOH Determination**: - BMS shall automatically determine the State of Health (SOH) of the individual cell/module.

e. **Cell Balancing**:- BMS shall automatically balancing between cells/modules to optimize energy consumption, range and protecting the battery.

f. **History - (Log Book Function):-** Monitoring and Storing the Battery's parameters and communicating the same to SCADA.

g. Alarm and fault generation and communicating the same to SCADA.

h. Isolating the battery in cases of emergency.

5.7.5 ENERGY MANAGEMENT SYSTEM (EMS)

Energy Management System (EMS) system shall be a computerized system for real time monitoring, operation, control, reliable & efficient operation and optimization of performance of the BESS system. SCADA system shall be part of EMS system. EMS shall be able to acquire real time data of various equipment of BESS system and have in built logic/programming to monitor, control and optimize the performance of BESS as per specification.

Contractor shall provide complete EMS & SCADA system with all accessories, auxiliaries and associated equipment and cables for the safe, efficient and reliable operation of entire BESS and its auxiliary systems. Contractor shall include in his proposal all the Industrial Grade Hardware, Software, Panels, Power Supply, HMI, Laser Printer, Gateway, Networking equipment and associated Cable etc. needed for the completeness even if the same are not specifically appearing in this specifications.

a) EMS shall have provision to control the BESS equipment. EMS shall be able to acquire real time Data, Status and Alarm from following equipment, but not limited to as required or offered under the scope of this specification.
   i. All the LV/MV Switchgear Equipment /panels including solar plant and 66 kV switchgear equipment.
   ii. UPS and Battery charger as approved in detail Engineering
   iii. Energy Meter/MFM/Power Meter/transducer
   iv. Numerical Relay
   v. Power Conditioning System (Solar Plant and BESS)
   vi. Fire Protection System
   vii. GPS Time Synchronisation unit
   viii. BMS system
   ix. Transformer
   x. Any other equipment as offered by contractor.

b) EMS shall perform the following functions,
   i. Real-time acquisition and display of data, status, alarms and trends.
   ii. Display BESS system data suitable for operation and fault finding including diagnostics and self-check functions.
   iii. Operate the BESS as per application requirement
   iv. Display of status of major equipment in Single Line
   v. Logic functions for control, protection and annunciation of the equipment and systems.
   vi. Allow local control of the BESS, such as providing charge and discharge set points and setting of ramp rates.

vii. Allow selection of BESS operation mode.

viii. Control of switchgears and PCS.

ix. Display and storage of measured values.

x. Historical storage of important data.

xi. Display and storage of derived/calculated/integrated values.

xii. Display and Storage of Alarm, Event and Trends

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

xiv. Generate, store and retrieve user configurable periodic Reports. It shall have facility to generate report in MS Excel format.

xv. Generation control and scheduling of Generation as per CEA regulation.

xvi. Remote monitoring of essential parameters on the web authorised with user id and password using standard modem (Internet connection for transferring data to web shall be taken by Contractor in the name of GSECL Site for O & M period).

xvii. Communication with Solar PV SCADA under this project. All necessary software and hardware (both end) including laying of Communication/Fiber optic cable as required for communication solar SCADA shall be provided by the contractor.

xviii. It shall support following standard protocols (included but not limited to) to communicate with different sub system/Devices.

a. Modbus (TCP/IP, RTU, ASCII)

b. Sub Station Protocol such as IEC- 61850, IEC 60870 -5- 101//104System self-supervision and diagnostic functions

xix. Security of Data from authorized access using Hardware Firewall and software access privileges/rights.

xx. Auto logging of all O & M evaluation parameters like availability, daily capacity used etc. in report form.

xxi. Auto generated reports to evaluate the performances of BESS for all functions like smoothening, time shift operations etc. as mentioned elsewhere in this specification.

a. Contractor shall provide a Package/Split AC of suitable capacity decided by load requirement in EMS (SCADA) room.

b. The control system shall provide safe operation under all plant disturbances and on component failure so that under no condition the safety of plant, personnel or equipment is affected.

c. Control system shall be designed to prevent abnormal swings due to loss of Control System power supply, failure of any Control System component, open circuit/short circuit.

d. On any of these failures the controlled equipment/parameter shall either remain in last position before failure or shall come to fully open/close or on/off state as required for the safety of plant/personnel/equipment and as finalized during detailed engineering.

e. The SCADA (including EMS) system shall be provided with two (2) processors (Main processing unit and memories) one for normal operation and one as hot standby. In case of failure of working processor, there shall be an appropriate alarm and simultaneously the hot standby processor shall take over the complete plant operation automatically.

f. The transfer from main processor to standby processor shall be totally bump less and shall not cause any plant disturbance whatsoever. In the event of both processors failing, the system shall revert to fail safe mode. It shall be possible to keep any of the processors as master and other as standby. The standby processor shall be updated in line with the changes made in working processor. The memory shall be field expandable.

g. The memory capacity shall be sufficient for the complete system operation and have a capability for at least 10% expansion in future. Programmed operating sequences and criteria shall be stored in non-volatile semiconductor memories like EPROM. All dynamic memories shall be provided with buffer battery backup for at least 360 hours.

h. The Batteries shall be **lithium- ion type only**.

i. Manual intervention shall be possible at any stage of operation. Protection commands shall have priority over manual commands and manual commands shall prevail over auto commands.

j. A forcing facility shall be provided for changing the states of inputs and outputs, timers and flags to facilitate fault finding and other testing requirements. It shall be possible to display the signal flow during operation of the program.

5.8 DETAILED ELECTRICAL WORK

5.8.1 Photovoltaic modules

In line with OM no 283/54/2018 GRID SOLAR-Part-I dtd 10.03.2021 (Requirment for compulsory registration), Order 2019, PV modles are to be sourced from ALMM Annexure -1 of above OM and amended from time to time.

The Contractor shall employ solar PV module of Crystalline-Si (Poly / Multi or Mono / Single) solar technology only. The Contractor shall provide detail Technical Data Sheets, Certifications of Standard Testing Conditions (STC: defined as Standard Testing Condition with air mass AM1.5, irradiance 1000W/m2, and cell temperature 25°C) as per the latest edition of IEC 61215 and IEC 61730 and as tested by IEC / MNRE recognized test laboratory. The Bidder shall also specify the minimum guaranteed energy output of solar PV module as per the site condition in the RFP. PV module must be registered with BIS.

i. The PV modules to be employed shall be of minimum 72 cell configuration with rated power of module ≥300 Wp as certified for solar PV module power performance test as prescribed by latest edition of IEC 61215 and IEC 61730 and as tested by IEC / MNRE recognized test laboratory. The maximum tolerance in the rated power of solar PV module shall have maximum tolerance up to +3%. No negative tolerance in the rated capacity of solar PV module is allowed.

ii. PV module must be registered with BIS.

iii. All modules shall be certified IEC 61215 2nd Edition (Design qualification and type approval for Crystalline Si modules), IEC 61730 (PV module safety qualification testing @ 1000 V DC or higher). IEC 62804 Certified PV modules should be PID free, documents for the same should be submitted with conditions of the PID test should be for a humidity of 85 % and a cell temperature of 85^0 C at 1000Volts , IEC 62716 , IEC 61701.

iv. The certified Bill of Material (BOM) to be used in the PV Modules should be the same as used during the IEC certification of reference PV Module certified by renowned agency like TUV, UL, etc.

v. Minimum certified module efficiency shall be 15% for crystalline with minimun fill factor of 0.75.The permissible maximum temperature coefficient of power (Pmpp) shall be -0.43%/ ^{0}C or better.

vi. All photovoltaic modules should carry a performance warranty of >90% during the first 10 years, and >80% during the next 15 years.

vii. Further, module shall have performance warranty during the first year of installation as under.

- Mono > 97%
- Poly > 97.5%

viii. The module mismatch losses for modules connected to an inverter should be less than **1%.(Maximum)**

ix. SPV module shall have module safety class-II and should be highly reliable, light weight and must have a service life of more than 25 years.

x. The PV modules shall be equipped with IP67 or higher protection level junction box with min. 3 by pass diodes of appropriate rating and appropriately sized output power cable of symmetric length with twist locking connectors.

xi. The SPV module shall be made up of high transmitivity glass & front surface shall give high encapsulation gain and the module shall consists of impact resistance, low iron and high transmission toughened glass. The module frame shall be made of corrosion resistant material, which shall be electrically compatible with the structural material used for mounting the modules.

xii. The SPV modules shall have suitable encapsulation and sealing arrangements to protect the silicon cells from environment. The encapsulation arrangement shall ensure complete moisture proofing for the entire life of solar modules.

xiii. The module frame should have been made of Aluminium or corrosion resistant material, which shall be electrolytically compatible with the structural material used for mounting the modules with sufficient no. of grounding/installation.

xiv. All materials used for manufacturing solar PV module shall have a proven history of reliability and stable operation in external applications. It shall perform in relevance as per IEC standards.

xv. Modules only with the same rating and manufacturer shall be connected to any single inverter. Modules shall compulsorily bear following information in the form of ID encapsulated with solar cell in the manner so as not to cast shadow on the active area and to be clearly visible from the top.

xvi. The Bidder shall provide to GSECL in the Bid, power performance test data sheets of all modules. The exact power of the module shall be indicated if the data sheet consists of a range of modules with varying output power.

xvii. Only those crystalline modules (above 300Wp) of the same module manufacturer which has supplied for a capacity more than 0.75MW x 35 MW (AC) Solar Project, in other projects in India with minimum 1 project size of 0.075MW x 35 MW (AC) Solar Project. On this account, the Contractor shall provide full information, to the satisfaction of GSECL, before placing final order for the modules. The Contractor shall also submit the proof of original purchase.

xviii. GSECL or its authorized representative reserves the right to inspect the modules at the manufacturer's site prior to dispatch.

xix. The Bidder is advised to check and ensure the availability of modules prior to submitting the Tender Document.

xx. The Contractor would be required to maintain accessibility to the list of module IDs along with the above parametric data for each module.

Table 5-1 Information to be displayed on solar PV module

Sr.	Particulars
1	Name of the manufacturer of the PV module and RFID code
2	Name of the manufacturer of solar cells
3	Month & year of the manufacture (separate for solar cells and modules)
4	Country of origin (separately for solar cells and module)
5	I-V curve for the module at standard test condition (1000 w/m^2 , AM 1.5, 25°C
6	Wattage, Imp, Vmp, Isc, Voc, temperature co-efficient of power and FF for the module
7	Unique Serial No. and Model No. of the module
8	Date and year of obtaining IEC PV module qualification certificate
9	Name of the test lab issuing IEC certificate
10	Other relevant information on traceability of solar cells and module as per ISO 9001 and ISO 14001

5.8.2 Junction Box/ Combiner Box

i. The Contractor shall provide sufficient no. of Array Junction Boxes / PV combiner boxes / DCDBs.

ii. All switch boards shall be provided with adequately rated copper bus-bar, incoming control, outgoing control etc. as a separate compartment inside the panel to meet the requirements of the Chief Electrical Inspector of Government (CEIG). All live terminals and bus bars shall be shrouded. The outgoing terminals shall be suitable for connection to suitable runs and size of cables required for the Inverter/Transformer rating.

iii. The degree of protection for following equipment shall be:

- Indoor Junction box : IP 21
- Outdoor Junction Box: IP 65

iv. All junction/ combiner boxes including the module junction box, string junction box, array junction box and main junction box should be equipped with appropriate functionality, safety (including fuses, grounding, etc.), string monitoring capabilities, and protection.

v. The terminals will be connected to copper bus-bar arrangement of proper sizes to be provided. The junction boxes will have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables. Suitable markings shall be provided on the bus-bars for easy identification and cable ferrules will be fitted at the cable termination points for identification.

Each Array Junction Box shall have suitable Reverse Blocking Diodes / Fuses of maximum DC blocking voltage of 1000 V with suitable arrangement for its connecting. The Array Junction Box shall also have suitable surge protection device. In addition, over voltage protection shall be provided between positive and negative conductor and earth ground such as Surge Protection Device (SPD) or on-load DC dis-connectors with shoes. All incoming & outgoing cables must be terminated with Brass Gland for Cu Cables & Steel Gland for Al Cables. Bidder can also provide polyamide glands and MC4 connector. All Glands must be of Double Compression type for Outdoor duty & Single Compression type for Indoor duty. The rating of the Junction Boxes shall be suitable with adequate safety factor to inter connect the Solar PV array.

vi. The Junction Boxes shall have suitable arrangement for the followings

vii. Combine groups of modules into independent charging sub-arrays that will be wired into the controller.

viii. Provide arrangement for disconnection for each of the groups.

ix. Provide a test point for each sub-group for quick fault location.

x. To provide group array isolation

xi. The rating of the Junction Boxes shall be suitable with adequate safety factor to inter connect the Solar PV array.

xii. The junction boxes shall be dust, vermin, and water proof and made of thermoplastic/ metallic in compliance with IEC 62208, which should be sunlight/ UV resistive as well as fire retardant & must have minimum protection to IP 65(Outdoor)/ IP 21(indoor) and Protection Class II or higher.

xiii. The terminals shall be connected to copper bus-bar arrangement of proper sizes. The junction boxes shall have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables.

xiv. The current carrying rating of the Junction Boxes shall be rated with standard safety factor to interconnect the Solar PV array.

xv. Suitable markings shall be provided on the bus-bars for easy identification and cable ferrules will be fitted at the cable termination points for identification.

xvi. Adequate capacity solar DC fuses & isolating miniature circuit breakers / MCCB should be provided if required. Fuses for string and outgoing DC dis-connector for SMB are allowed. The Junction Box must have space for the maintenance and 10% Spare Install Capacity for future integration.

xvii. Detailed junction box specifications and data sheet shall be provided in the Technical Bid document.

xviii. Other Sub systems and components used in the SPV power plants (Cables, connectors, Junction Boxes, Surge Protection devices, etc.) must also confirm to the relevant international /national standards for electrical safety besides that for quality required for ensuring expected service life and weather resistance. It is recommended that the cables of 600-1800 Volts Dc for outdoor installations should comply with the draft EN 50618 for service life expectancy of 25 years.

5.8.3 Inverter and Power Conditioning Unit (PCU)

Bidder shall consider Central or String Inverters as per specifications mentioned in NIT

(D) <u>Central Inverters</u>

i. Only those PCUs/ Inverters which are commissioned for more than 0.75 MW x 35 MW (AC) Solar Project, capacity in other solar PV projects till date shall be considered for this project. The Contractor has to provide sufficient information to the satisfaction of GSECL before placing the final order for PCUs/Inverters. Power Conditioning Unit (PCU) shall consist of an electronic inverter with latest technology available in the market along with associated control, protection and data logging devices and must be fully communicable to SCADA with OPEN Communication Protocol. If any software required for the communication & SCADA, the same to be made available within the EPC package by the Contractor.

ii. All PCUs should consist of associated control, protection and data logging devices and remote monitoring hardware, software for string level monitoring.

iii. Dimension and weight of the PCU shall be indicated by the Bidder in the Bid.

iv. Capacity of single unit of inverter shall be min. 1,000 kW. This plant shall be divided into 40-50 identical Solar PV arrays "sections", wherein the capacity of each section varies depending upon supplier's product capacity.

v. No. of inverters to be supplied shall be worked out by the Contractor based on DC rating of inverter, Pnom ratio, limit on overloading capacity.

vi. The Bidder shall guarantee average annual power loss due to non-threshold condition to be less than 0.1% and shall support the claim with necessary document / data / graphs in the Bid.

vii. DC Injection into the grid: This shall be avoided by using a step-up transformer at the output of the inverter. DC injection shall be limited to 1% of the rated current of the inverter as per IEC 61727.

viii. Inverters shall be capable of operating at varying power factor preferably between 0.85 lag to 0.85 lead and shall be able to inject or absorb reactive power.

ix. Inverters shall operate at ambient temperature of 50°C without deration.

x. The up-time of Inverters should be of 99% in a year, in case of failing to achieve this due to failure of any component of inverter the Contractor shall either replace the inverter or the component at his own cost.

xi. All inverters shall be tested for IEEE 519 &IEC 62116 standard.

xii. DC input terminals must be in enough numbers so as each terminal is connected to dedicated single input. Two DC inputs can not be connected on the single input DC terminal of the inverter. If adequate number of input are not available in the selected inverter by the Contractor then a DC junction box with protection devices such as fuse, DC disconnects may be incorporated in to design. The Bidder has to indicate the selected parameters in the Bid.

xiii. The minimum European efficiency of the inverter shall not be less than 98% measured at 100% load as per IEC 61683 standards for measuring efficiency. The Bidder shall specify the conversion efficiency at different loads i.e. 25%, 50%, 75% and 100% in the Bid. The Bidder should specify the overload inverter capacity in the Bid.

xiv. The PCU shall be tropicalized and design shall be compatible with conditions prevailing at site. Provision of exhaust fan with proper ducting for cooling of PCU's should be incorporated in the PCU's, keeping in mind the extreme climatic condition of the site.

xv. The inverters shall have Protection Class II or higher and minimum protection of IP as under:
Outdoor : IP 65(Electronics)/ IP 54 (Magnetic)
Indoor : IP 21

xvi. Nuts & bolts and the PCU enclosure shall have to be adequately protected taking into consideration the atmosphere and weather prevailing in the area.

xvii. (Grid Connectivity) Relevant CERC/GERC regulations and grid code as amended and revised from time to time shall be complied. The system shall incorporate a uni-directional inverter and should be designed to supply the AC power to the grid at load end. The power-conditioning unit shall adjust the voltage & frequency levels to suit the Grid.

xviii. All three phases shall be supervised with respect to rise/fall in programmable threshold values of frequency.

xix. The inverter output shall always follow the grid in terms of voltage and frequency. This shall be achieved by sensing the grid voltage and phase and feeding this information to the feedback loop of the inverter. Thus control variable then controls the output voltage and frequency of the inverter, so that inverter is always synchronized with the grid. The inverter shall be self-commutated with Pulse width modulation technology.

xx. This should be capable to synchronize maximum within 1 Minutes.

xxi. The PCU shall be capable of controlling power factor dynamically.

xxii. Maximum power point tracker (MPPT) shall be integrated in the power conditioner unit to maximize energy drawn from the Solar PV array. The MPPT should be microprocessor based to minimize power losses. The details of working mechanism and make of MPPT shall be mentioned by the Bidder in the Bid. The MPPT must have provision for constant voltage operation. The MPPT unit shall confirm to IEC 62093 or **EN50330** for design qualification.

xxiii. The system shall automatically "wake up" in the morning and begin to export power provided there is sufficient solar energy and the grid voltage and frequency is in range.

xxiv. Sleep Mode: Automatic sleep mode shall be provided so that unnecessary losses are minimized at night. The power conditioner must also automatically re-enter standby mode when threshold of standby mode reached.

xxv. Stand – By Mode: The control system shall continuously monitor the output of the solar power plant until pre-set value is exceeded & that value to be indicated.

xxvi. Basic System Operation (Full Auto Mode): The control system shall continuously monitor the output of the solar power plant until pre-set value is exceeded & that value to be indicated.

xxvii. The PCU shall include appropriate self-protective and self-diagnostic feature to protect itself and the PV array from damage in the event of PCU component failure or from parameters beyond the PCU's safe operating range due to internal or external causes. The self-protective features shall not allow signals from the PCU front panel to cause the PCU to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the PCU, including commutation failure, shall be cleared by the PCU protective devices. In addition, it shall have following minimum protection against various possible faults.

a. Earth Leakage Faults: The PCU shall have the required protection arrangements against earth leakage faults and –Ve DC directional protection.

b. Over Voltage & Current: In addition, over voltage protection shall be provided between positive and negative conductor and earth ground such as Surge Protection Devices (SPD).

c. PCU shall have arrangement for adjusting DC input current and should trip against sustainable fault downstream and shall not start till the fault is rectified.

d. Galvanic Isolation: The PCU inverter shall have provision for galvanic isolation. Each solid state electronic device shall have to be protected to ensure long life of the inverter as well as smooth functioning of the inverter.

e. Anti-islanding (Protection against Islanding of grid): The PCU shall have anti islanding protection. (IEEE 1547/UL 1741/ equivalent BIS standard).

f. Unequal Phases: The system shall tend to balance unequal phase voltage.

g. Heat Transfer / Cooling / Built in Ventilation Systems must be provided with 20% Spare capacity. Bidders to Submit Heat Rejection / Transfer calculation for Air Conditioning of Inverter Room.

h. Inverter must be provided with –Ve earthing for protection of PV modules against possible "Potential Induced Degradation".

xxviii. Reactive Power: The output power factor of the PCU should be of suitable range to supply or sink reactive power. The PCU shall have internal protection arrangement against any sustained fault in the feeder line and against lightning in the feeder line.

xxix. Isolation: The PCU shall have provision for input & output isolation. Each solid-state electronic device shall have to be protected to ensure long life as well as smooth functioning of the PCU.

xxx. All inverters/ PCUs shall be three phase using static solid state components. DC lines shall have suitably rated isolators to allow safe start up and shut down of the system. Circuit breakers used in the DC lines must be rated suitably.

a. Sinusoidal current modulation with excellent dynamic response.

b. Compact and weather proof housing.

c. Direct use in the outdoors with outdoor housing.

d. Comprehensive network management functions (including the LVRT and capability to inject reactive power to the grid).

e. No load loss < 1% of rated power and maximum loss in sleep mode shall be less than 0.05%.

f. Unit wise & integrated Data logging