SECTION - VII

SCOPE OF WORK

&

TECHNICAL SPECIFICATIONS

Contents

DISCLAMIER:

1. Though adequate care has been taken while preparing the Bidding documents, the Bidders/Applicants shall satisfy themselves that the document is complete in all respects. Intimation of any discrepancy shall be given to this office immediately. If no intimation is received from any Bidder within twenty (20) days from the date of notification of IFB/Issue of the IFB documents, it shall be considered that the IFB documents are complete in all respects has been received by the Bidder.
2. Solar Energy Corporation of India (SECI) Limited on behalf of Banaras Hindu University, The Owner, reserves the right to modify, amend or supplement this IFB documents including all formats and Annexures.
3. While this bidding documents have been prepared in good faith, neither Employer/Owner or its authorized representatives nor their employees or advisors make any representation or warranty, express or implied, or accept any responsibility or liability, whatsoever, in respect of any statements or omissions herein, or the accuracy, completeness or reliability of information, and shall incur no liability under any law, staftute, rules or regulations as to the accuracy, reliability or completeness of this bidding documents, even if any loss or damage is caused by any act or omission on their part.
4. The specification mentioned for all the equipment which include Solar modules, PCU/Inverter, combiner boxes (if required), DC cables, module mounting structures, transformer, CT, PT, LT/ HT cables, interfacing panels, switch gears & other associated equipment etc., to complete the power generation and evacuation to the nearest substation, LT panel or HT panel of BHU, in the present bidding documents is for the **reference** only. It is subject to revise/ alter as per the design/ planning/Good engineering practices etc., to be carried out by the selected bidder, to the satisfaction of the Employer/Owner or its authorized representatives. It is advised that the bidders must satisfy himself with the prevailing site conditions before design/ plan. The design must be optimized for the site conditions and directed to achieve the maximum output form the installed capacity at all times. Moreover, the components not separately mentioned, but are required to complete the plant for operation is also included in the scope of bidder and shall be vetted by the Employer or its authorised representatives.

Place:

(Signature)

Date: Name and Designation of bidder

A. INTRODUCTION

1. Site Description

Particulars	Description
Details of proposed capacity of the solar power plant	8 MWp (DC) SPV (Multi crystalline) Grid Connected Rooftop SPV Power Plant
site	Banaras Hindu university (BHU)
District	Varanasi
State	Uttar Pradesh
Location/Building Name (Project site)	Building's/ Roof details as attached at Annexure-1, Mostly project sites are located inside the BHU premises
Nearest Substation Details	Sub Station
Evacuation system	As per state DISCOM regulations & load Requirement of Respective building
Latitude	25.2677° N
Longitude	82.9913° E
Elevation above mean sea level, m	87 m
Estimated life of PV Power plant	25 Years
Vacant Rooftop Available	Refer Roof Plan as attached at Annexure I
Type of Roof	RCC
Nearest Highway	Highway
Nearest Railway Station	BHU Campus is about 20 km. from Mughalsarai Railway Station.
Nearest Domestic Airport	BHU Campus is about 35 kms. from Varanasi (Babatpur) Airport
Minimum values of PR and CUF of the plant after netting off the auxiliary consumption.	Performance Ratio (PR): 0.75 & Minimum Annual CUF : 15% (against installed DC capacity at STC)
Water and Power for Construction	Owner will provide the construction water free of cost as per the requirement of the Bidder during construction/ execution and O&M period. However, the Bidder is advised to avoid Wastage of Water. Power shall be also be provided free of cost as per the requirement of the bidder at single point. However, contractor shall mobilise their DG sets in sufficient quantity for execution of their construction works smoothly, if BHU is unable to provide power supply at all the places.

Note: The total generated solar power from Cumulative capacity 8 MWp DC at different rooftops shall be fed into Substations SS-1, at 11 kV (as per site conditions).

2. Site Visit

2.1 Bidder shall satisfy himself of the site conditions and shall apprise himself of the procedure for engagement of agencies / labour and shall collect other relevant information that may be required before submitting the bid. Claims and objections due to ignorance of site condition will not be considered after submission of the bid.

2.2 Bidder shall fully acquaint himself as to all conditions and matters, which may in any way affect the work or the cost thereof. The bidder shall be deemed to have independently obtained all necessary information especially regarding energy consumption and availability of shadow free space on roofs and load details etc. for the purpose of preparing the bid and his bid as accepted shall be deemed to have taken in to account all contingencies as may arise due to such information or lack of the same.

2.3 Bidder shall be deemed to have visited and carefully examine the site and surroundings to have satisfied himself about the nature of all existing facilities, infrastructure available for transport and communications and the access to the site for developing Solar PV project.

2.4 Bidder is deemed to have acquainted himself of government taxes, laws structure, regulations, levies and other charges relating to the tendered work at site.

2.5 Bidder shall obtain all necessary clearances/ permission/ NOCs etc. for execution of Solar PV project at site.

2.6 Any neglect or omission or failure on the part of the bidder in obtaining necessary clearances and reliable information upon the forgoing or any other matter affecting the bid shall not relieve him from any risks or liabilities or the entire responsibility for completion of the work in accordance with the bid.

2.7 Contact person for site visit:

Registrar, Banaras Hindu University, Varanasi

SE (Electrical), Banaras Hindu University

B. CONTRACTOR SUPPLIED MATERIAL

3. Contractor Supplied Material

3.1 All materials required for the civil works including cement, reinforcement, structural steel, sheeting, consumables, testing appliances, tools and tackles necessary for completing the work shall be supplied by the contractor at his own cost and shall conform to the technical specifications/ Bill of Material and Schedule of Rates.

3.2 All expenses towards mobilization at site and demobilization including bringing in equipment, work force, materials, dismantling the equipment, clearing the site after completion of work and Liasoning with BHU for interconnection of Solar Plant with existing HT, LT panel of BHU buildings or designated Substation (as per requirement) etc. shall be deemed to be included in the prices quoted and no separate payments on account of such expenses shall be entertained. Contractor may have to work in energized or partly energized conditions. In such cases, it shall be the responsibility of the Contractor to arrange for necessary permits or shut downs and provide skilled and responsible persons for the execution of works. Contractor shall organize his works during the shutdown periods properly and complete the programmed works within the time given. Contractor shall not be paid any extra payments for working under the above said circumstances.

3.3 It shall be entirely the Contractor's responsibility to provide, operate and maintain all necessary construction equipment’s, scaffoldings and safety gadgets, cranes and other lifting tackles, tools and appliances to perform the work in a workman like safe and efficient manner and complete all the jobs as per time schedules. However, if any equipment/ facility which are provided by Owner (BHU), the same shall be on chargeable basis.

3.4 Procurement and supply of all materials and consumables in sequence and at the appropriate time shall be entirely the Contractor's responsibility and his rates for execution of work will be inclusive of supply of all these items.

3.5 In case any material/equipment is issued by the Owner, then it will be properly used and maintained by contractor. Subsequent to completion of its use, it will be returned to Owner in good condition. In case of damage or misuse of such material/equipment, Owner will recover the cost from the Contractor from the payments due to the Contractor.

4. Expected Timeline

4.1 Expected timeline for delivering the project activities shall be as defined under SCC.

4.2 The contractor shall submit a detailed PERT chart in line with the proposed time schedule as per SCC clause covering all activities with various key phases of supply and service obligations under the contract such as supply schedule and field erection activities within 30 days of the date of Notification of Award (NoA).

4.3 The time of commissioning /completion shall be inclusive of time for mobilisation, engineering, approval of the design & other materials and intervening monsoon, if any.

4.4 The contractor shall furnish the signed & stamped copy of Daily Progress Report (DPR) / Monthly Progress Report on letter head of company to the Employer /Owner

C. SYSTEM DESIGN AND PHILOSOPHY

5. Design Philosophy

5.1 The main objective of the design philosophy is to construct the plant with in-built Quality and appropriate redundancy to achieve high availability and reliability with minimum maintenance efforts, to minimize the lifecycle cost. In order to achieve this, the following principles shall be adopted while designing system.

5.2 The rooftop SPV power plant should be designed to operate satisfactorily in parallel with the internal grid of BHU within permissible limits of high voltage and frequency fluctuation conditions, so as to generate the maximum possible units. It is also extremely important to safeguard the system during major disturbances, like tripping / pulling out of existing generating stations of BHU and sudden overloading during falling of portion of the loads on the power plant unit in island mode, under fault / feeder tripping conditions.

5.3 Any faults not taken care will result in damage of rooftop SPV power plant or existing power systems/arrangement of BHU. Thus suitable protective measure is to be in- built in the system design so that any disturbance of the internal grid of the BHU will not cause any damage of the equipment's of the Solar Power Plant and vice versa.

5.4 The bidder shall carry out the fault level calculation using state-of-art software such as ETAP etc. The calculations shall be vetted by the organisations (BHU /SECI).

5.5 Very fast responsive microprocessor based Directional and Reverse power flow protection should be provided to ensure isolation of the rooftop solar power plant from

the internal grid at the time of any fault or/and any additional suitable protection.

5.6 Inverter output voltage of 415V has to be stepped up to 11 or 33 kV to connect it to the internal substations (if required as per the state regulations or internal load of buildings are less the generation of plant) at the point of interconnection.

5.7 Based on the SOLAR INSOLATION data (for BHU) from reliable sources, the solar PV system should be so designed that it shall take into account the mean energy output after allowing for various losses, temperature corrections, on an average day for each month of the year.

5.8 The contractor shall keep the adequate provision for measurement of solar isolation by means of placing of 1 nos. Pyranometer as per the various tilt angle of the rooftop space and Modules in order to analysis the actual plant performance. Pyranometers shall be provided as follows:

a. One Pyranometer shall be fixed on horizontal plane to the earth.

5.9 The Pyranometer on module plane to be fixed to the module mounting structure (MMS) only in order to follow the module plane.

5.10 The Contractor is required to measure the Solar Radiation and other climatic conditions relevant to measure the Plant performance. This is necessary to study Solar Level and Guaranteed Performance of the Solar Power Plant. The satellite based analysis is to be combined with direct ground based measurement equipment in order to achieve the necessary accuracy and level of detail in the assessment of solar radiation levels and climatic conditions.

5.11 Roof Condition: As the available roofs are RCC roofs. The contractor is required to consider the entire available rooftop space while designing the SPV systems. The bidders are required to design the layout to ensure optimum availability according to the roof conditions and shadow of the nearby/adjacent buildings etc., and optimise the system design such that the best yield (i.e. 75% PR and Minimum 15% CUF) from the rooftop Solar PV power plant will be achieved.

5.12 Bidder shall carryout the structure analysis of the roof (in the existing condition and after implementation of Rooftop Solar PV system). The structure analysis shall be vetted by an independent certified structure engineer/consultant

5.13 **Technology:** Solar PV multi/poly/Mono-crystalline modules of high efficiency (>16%). As per the requirement of MNRE the modules shall be made in India however, the cells may be imported.

5.14 Adequate capacity of SPV module, PCUs/Inverters, Junction boxes etc. to ensure generation of power as per design estimates. This is to be done by applying liberal de-rating factors for the array and recognizing the efficiency parameters of PCUs, transformers, conductor loss etc. Minimum Size of the DC Cable from PV to SMU to be of 6 and may be use 10 sq.mm. to minimize the cable loss also .

5.15 Selection of the equipment's and adoption of a plant layout to ensure ease of maintenance. Selection of PCUs/ Inverters with proven reliability and minimum downtime. Ready availability of requisite spares. Similarly, only short circuit tested inverter transformer matching with inverter output voltage to be supplied for reliability.

5.16 Strict compliance with the approved and proven & established quality assurance systems and procedures during the different stages of the project starting from sizing, selection of make, shipment, storage (at site) , during erection, testing and commissioning.

5.17 High DC system voltage and low current handling requirements

5.18 The plant instrumentation and control system should be designed to ensure high availability and reliability of the plant to facilitate the operators in the safe and efficient operation of the plant with minimum effort.

5.19 Careful logging of operational data / historical information from the Data Monitoring Systems, and periodically processing it to determine abnormal or slowly deteriorating conditions.

5.20 The specifications provided with this bid document are a functional ones; any design provided in this document is only meant as an example. The Bidder must submit a proposal based upon their design. Bidder must optimize their own design for Rooftop Solar Photovoltaic (SPV) system with proven technology so that it shall best meet to guarantee the performance factors as it is a part of the acceptance criteria given in this bid document. The bidders are advised to visit the site before designing the plant.

5.21 The minimum array capacity at STC shall be determined to have 8 MWp (DC) output at STC condition the time of installation. If the bidder anticipates any degradation of the modules more than 3 % of the module output during the first year, it shall be taken care of to meet guaranteed generation to avoid Penalty/ compensation on account of Generation Performance Guarantees.

5.22 This Bid document specifically cover the rest of the requirements for Grid Connected 8 MWp (DC) for Rooftop Solar Power Plant along with their associated equipment.

5.23 Successful Bidder (Contractor) shall prepare the detailed project report & design basis

report and submit a copy to Employer for evaluation within 4 weeks from the date of issue of LOA.

5.24 **Component and Equipment Reliability**: Each component offered by the bidder shall be of established reliability. The minimum target reliability of each equipment shall be established by the bidder considering its failure, mean time between failures and mean time to restore, such that the availability of complete system is assured. The guaranteed annual system availability shall not be less than 99%. Bidder recommendation of the spares shall be on the basis of established reliability, mean time between failures, mean time to restore. Bidder shall design the equipment and plant in order to have sustained life of 25 years with minimum maintenance efforts.

5.25 The supply, erection, testing, commissioning and all other allied works for 8 MWp (DC) Rooftop Solar PV Power Plant at BHU, Varanasi Uttar Pradesh shall shall follow the timelines as mentioned under SCC.

5.26 Installation methods and procedure for equipment supplied by the contractor shall conform to standard design and shall be uniform.

5.27 **Workmanship (General)**

Electrical equipment installation and electrical work shall be undertaken by qualified and competent tradesman. Manufacturer's installation instruction and recommendations shall be closely followed at all times. Particular care shall be taken with transformer, switchgears and other equipment to ensure that the metal joints are clean and that safe gaps are maintained. Adequate weather protection during installation shall be provided by contractor at all the times.

5.28 **Additional Protection System to Ensure No Power Tripping at BHU Substation Due To Solar System**

The scope of contractor shall be including but not limited to the following,

i. Additional CTs, Relays, cables and all required material and modification to be considered and installed for the implementation of cable differential scheme at identified feeder.

ii. Suitable modification, testing and stability checking to be considered at feeder in accordance with incoming feeder.

iii. Suitable alarm / monitoring facility to be provided at proposed Sub-stations end regarding status of solar system.

iv. Transformer incipient protection feature to be considered and taken care at new

HT panel installed.

v. Inter tripping to be provided between the upstream & downstream power supply feeders.

vi. The contractor shall submit the detailed design of this additional protection system for the approval of Employer.

Spare Parts

Bidder shall recommend and furnish details for essential spare parts required for the plant operation after completion of O&M period and provide the details of nearest source of availability.

D. SCOPE OF SUPPLY AND WORK

6. Detailed Scope of work

6.1 The Scope of Work, includes all design & engineering, procurement & supply of equipment and materials, testing at manufacturers works, inspection, packing and forwarding, supply, receipt, unloading and storage at site, associated civil works, services, permits, licences, installation and incidentals, insurance at all stages, erection, testing and commissioning of 8 MWp (DC) with indigenous modules as per (i.e. the modules to be used in the rooftop solar PV power plants must be made in India, however, the cells may be imported), Grid Interactive Solar PV Power Plant and performance demonstration with associated equipment and materials along with associated transmission system (By means of cables using the existing route wherever possible otherwise, similar cabling arrangement should be made in the missing portion of the cable route. up to the HT panel or designated substation(11 kV) on turnkey basis in the BHU Complex, in the state of Uttar Pradesh, India and 5 (Five) years of comprehensive operation and maintenance from the date of Commissioning or Operational Acceptance, whichever is later.

6.2 Bidder shall extend necessary documentation and technical help including presentations to MNRE, if required

7. Designing of complete plant and subsystems

7.1 The scope of the bidder includes complete system design and engineering, finalization of drawings/ documents, submission of engineering drawing / documents and processing of their approvals by Employer/Owner. The system design shall be based on analysis of actual power consumption of the premises and individual building

peak demand and available space available. Initially contractor shall submit design basis report along with preliminary design showing general system layout within 30 days from LOA for in principle approval of EIC. The detailed design shall be submitted by contractor within one month from LOA.

7.2 The scope shall include submission in proper shape & format, all the Drawings including engineering drawings, sizing calculation, data, test procedures, Equipment layout, Drawings/Data sheets of all the equipment/materials under scope of supply, Civil structural/architectural drawings prepared by structural engineer, Load bearing capacity details, detailed design drawings of Earthing system, Lightning system, Fire fighting system, risk analysis, Lighting system, Inverter and control room (if required) etc, Manuals including O&M Manuals, Control System Manuals with details of error/ fault code, Handbooks/user /O&M manual of equipment like Inverter, Transformer, LT/HT Switchgear etc and any other required design documents covered under technical specifications in requisite numbers to the Owner at different phases of the project as per the requirement of BHU.

7.3 Contractor shall design their SPV panel structure according to wind load (200 km/hour). Load bearing strength of roof top and its suitability for installing solar PV plant, design of SPV structure and distribution of load on roof top beam shall be inspected by structural engineer and structural design need to be vetted by structure engineer/consultant. Any changes in structural design suggested by Employer EIC/Owner shall be binding on the contractor.

7.4 Short circuit calculation and coordination relay settings and detailed protection philosophy, Complete load flow study, transient study and under frequency study to be carried out by contractor for power to be fed to proposed LT/HT panel or Substation (S/S).

7.5 Bidder shall obtain approval from relevant statutory authorities in respect of design, single line drawing, plan etc as mandatorily required by respective authorities in respect of such works.

7.6 Technical coordination (including participation and arranging technical Co-ordination meetings with Employer/suppliers) shall be under the scope of bidder.

8. Scope of Material Supply

8.1 The equipment and materials for Rooftop Solar PV Power Plant with associated system shall be including but not limited to the supply of the following:

8.2 Only Indigenous Solar PV modules shall be used by the contractor. All the module components used in the solar PV power plant must be made in India however imported solar cells may be used

8.3 Module Mounting Structures (MMS)

8.4 Power Conditioning Units/ Inverters including Maximum Power Point Tracker (MPPT)

8.5 Cables including power and control cables and accessories Protection equipment like Circuit Breakers, Relays, Solar Array Fuses, Earthing and Surge Protection System, Lightning protection etc.

8.6 Adequate provisions shall be kept for Cable placement with appropriate cable ties for holding the cable in place during the windy condition, including selection of correct size of fuse to avoid fire risk.

8.7 All earthing requirement of the PV installation is to be integrated with the wire house earthing. Design of earthing systems should avoid breaching the building envelope and damaging either the water proofing system or building electrical system.

8.8 Junction boxes

8.9 Transformers and allied accessories

8.10 LT and HT Switchgear,

8.11 DAS, Data Logger with Power generated details along with other parameters like Voltage, Current, Frequency etc

8.12 Mandatory spares shall be supplied as per list of Mandatory spares provided in the Schedule of Rates (SOR) of the tender document.

8.13 Equipment like Pyranometer, Ambient temperature sensor, Module temperature sensor, wind speed, Energy meters shall be installed at suitable locations to measure the following details,

i) Solar radiation/ Insolation Data

ii) Ambient temperature, Module temperature

iii) DC power

iv) AC power, Frequency, Power Factor

8.14 Tools and Tackles, Caution Boards

8.15 Applicable Type Test Certificates of all the equipment which are under the scope of material supply

8.16 Adequate space on the rooftop so that technicians, can visit the rooftop Solar PV plant for the purpose cleaning, routine checkups etc.

8.17 Water supply Arrangements on the rooftop for Module cleaning etc.

8.18 All meters with all necessary metering rated CT's and PT's at the plant take off point as well as at the substation as per CEA Metering Regulation 2006 as amended time to time and state metering code.

8.19 Fire protection systems for rooftop solar PV power plant (control room (if required), inverter room, instrument room) and fire extinguishers.

8.20 All safety gadgets during Construction and O&M period including but not limited to, rubber mats of appropriate grade, PPE, rubber gloves and shoes etc.

8.21 Adequate and seamless insurance coverage during EPC and O&M period to cater all risks related to construction and O&M of plant to indemnify the Employer//Owner.

8.22 Any other equipment / material required to complete the Rooftop Solar Power Plant on turnkey Basis.

9. Factory acceptance tests

9.1 All acceptance and routine tests of equipment as per the specification and relevant standards shall be carried out. Charges for these tests shall be deemed to be included in the equipment price.

9.2 All major/critical items (Modules, Inverters, ACDB, HT Switchgear, LT Switchgear, Transformer, AC & DC cables, structure) shall be inspected and tested through Employer or its authorised agency/consultant/ representative during manufacture and in assembled condition prior to dispatch in accordance with the standard practice/ pre-approved QAP of the manufacturer and applicable Standards and charges for the same shall be included in the Lump sum cost as quoted by the bidder all the equipment under scope of supply for 8 MWp (DC) Rooftop Solar PV power project". No separate payment shall be done for inspection and testing. BHU representatives may also be present during such Inspection. However, it is not binding upon the Employer//Owner to always send the BHU representatives for witnessing Inspection.

9.3 Employer//Owner at its own discretion may undertake the quality checks during their manufacturing stages also.

9.4 Copies of test certificates for such inspections in triplicate shall be supplied to Employer / Owner before despatch of the equipment.

10. Transportation of equipment from works to site, unloading and storage

10.1 Transportation of equipment from works to site, receipt, unloading, Transit insurance and safe storage of all supplied equipment inside BHU premises shall be under the scope of contractor. The storage space would be provided by the Owner.

10.2 The Contractor shall at his own cost and initiative arrange for and obtain all necessary permissions, permits, consents and licenses, as may be necessary, to transport the equipment/ material, machinery, and labour along or across highway, roadway, railway, bridge, dike, dam, river or through posts of toll collection, Octroi checks or other line border or barrier.

10.3 BHU will not issue any road permits to the bidder. The same shall be organised by the contractor himself for smooth transportation of the equipment/materials pertaining to the project

11. Installation and Commissioning

11.1 Installation (including civil works)

The scope of the contractor shall be, including but not limited to the following

i) Installation of suitable nos. of Solar Photo Voltaic (SPV) modules with power rating of 300 Wp and above.

ii) Installation of Module mounting structure (MMS) for mounting of Solar PV module at roof top of buildings

iii) Installation of Junction Boxes.

iv) Installation of Power Conditioning Unit (PCU)/ Inverters.

v) Installation of String level monitoring (SMUs) system (if required)

vi) Installation of LT and HT switchgears as per system requirement. Necessary HT switch gears (as per system requirement) including VCBs are required for HT isolation and protection.

vii) Installation of transformers and allied accessories.

viii) Laying of cables on prefabricated GI cable trays and / or within suspended ceiling spaces including cable trays, hangers, supports, cable terminations, all fixing accessories wherever required. Parallel top to existing cable trays in the area may be used mostly. However at some places new cable trays would be required which shall also require additional cable tray supports on the existing cable tray structure by contractor as per standard

specifications.

ix) Laying of cables in cable trenches including providing MS cable markers, backfilling the trenches, Making straight through joints using heat shrinkable sleeves for cables or as per applicable norms, connection, termination and testing of cables to distribution boards, Proper sand bedding must be provided. Existing cable trenches in the area would be used mostly where control and power cables to be laid. However at some places new cable trenches would be required which is to be made by contractor as per standard specifications. Road crossings, if require, shall be made by trenchless methods and open cutting shall be avoided. Suitable protection i.e Hume pipe of suitable grade.

x) Interconnection of Solar PV power plant with the HT panel of substation, this includes installation of cables as evacuation line with associated equipment and materials so as to export power from Solar PV power plant to HT panel of BHU'S substation.

xi) Installation of DAS System as required to enable remote access of data from the SPV plant this includes provision of the port in DAS, all internal OFC/ telephone/ LAN cabling from modules arrays to PCUs to DAS and to external OFC connection, as applicable. All electrical, civil, mechanical works related to the said job shall be under the scope of Contractor.

xii) In addition to Control Room DAS system, additional remote monitoring systems would be provided at corresponding hookup substation.

xiii) Installation of Earthing system with testing joint for every pit (grounding) system including cutting of roads / paved areas / PCC floor etc. and making as good as in original shape.

xiv) Installation of lightning arrester and all other protection equipment.

xv) Installation of PV Module cleaning system with necessary pump & piping arrangement.

xvi) Construction of Inverter Room, Control Room (if required), Instrument (DAS etc.) Room, Transformer Yard, requisite testing facilities at site, safety and security requirements and provision for other things that may require for successful operation and maintenance of plants and equipment.

xvii) All civil works required for proper installation of complete SPV system shall be in the scope of contractor. An adequate clean area would be provided to the

contractor at BHU Campus for establishing temporary site office & construction yard.

xviii) Installation of metering equipment, synchronization of solar system with HT/LT panel of substation etc. and carry out the inter connection prior to the final commissioning of the Solar PV power plant.

xix) Danger notice plates shall be provided at prominent locations.

xx) In addition to these works, bidder shall also be responsible for the arrangement of accommodation facilities for the workforce required for construction, arrangement of Diesel generators, power requirement during construction phase of the project etc.

11.2 Commissioning

i) After installation of all equipment, Contractor shall perform commissioning checks to verify the correctness and proper operation of all equipment in all respects. In addition the Contractor shall carry out all other checks and tests recommended by the manufacturers. During the trial operation, SPV plant shall perform trouble-free operation for cumulative 24 hours during which functionality of all plant components shall be demonstrated by the bidder and the system shall be in Generating Mode.

ii) The Contractor shall make all required Liaisoning with BHU for interconnection/synchronization of the solar power plant with HT/LT panel of BHU Substation, so as to commence the utilization of generated solar power from solar power plant after its commissioning. The contractor shall synchronize the SPV system with HT/LT panel of BHU Substation after getting necessary approvals if required for synchronization.

11.3 Approvals

i) Obtaining statutory approvals /clearances on behalf of the Owner from various Government Departments, not limited to, the following-

ii) Pollution control board clearance, if required

iii) All other approval, as necessary for setting up of a solar power plant including, CEA ,CEIG, grid connectivity, power evacuation, etc. as per the suggested guidelines

iv) All other statutory approvals and permissions, not mentioned specifically but are required to carry out hassle free Construction and O&M of the rooftop SPV plant prevailing at Site.

11.4 Norms Related to Penalty against Violation of Safety, Health And Environment: Annual health check-up for the deployed workers is mandatory and its report to be submitted to Employer/Owner. Against violation of applicable Safety, Health and Environment related norms, a penalty of Rs. 10,000.00 per occasion shall be levied on the contractor. Guidelines for imposition of penalty against Safety, Health and Environment related norms:-

i. For first time violation of safety rules & regulation by any contractor, a warning letter to contractor shall be issued by Owner / Safety officer of BHU.

ii. In case of second time violation of safety rules & regulations by same contractor, Owner will call contractor in person and will have a meeting to discuss reason for repetitive violation along with Employer. A warning letter will also be issued by Employer//Owner to contractor.

iii. In case of further violation, punitive fines will be imposed on contractor. Amount of fine will be decided as per severity of violation of safety. However, minimum fine would be Rs.10,000/- and in multiple of Rs.10,000/-, thereafter. This will be limited to 5% of contract value, as maximum cumulative penalty. Violation as above resulting in:

Any physical injury, a penalty of 0.5% of the contract value (Maximum of Rs. 2,00,000.00 per injury in addition to Rs. 10,000.00, Fatal accident, a penalty of 1% of the contract value (maximum of Rs 10,00,000.00) per fatality in addition to Rs. 10,000.00.

12. Operation & Maintenance (O&M)

The contractor shall be responsible for all the required activities for the successful running, optimum energy generation as well as maintenance of associated facilities of the solar PV plant for a period of five (5) year form date of successful completion of acceptance of the project.

The scope of the contractor shall be, including but not limited to

i) Deputation of O&M, engineering and supporting personnel at site

ii) Cleaning of module surface on regular basis as and when required.

iii) Water for cleaning during O&M period of five years shall be provided by BHU at a single point free of cost to the contractor for all buildings (12000 litres of water per MW per cleaning) anything extra will be chargeable basis. Successful Bidder shall make necessary arrangements for water storage (like sintex water tank / water tank on the ground) with adequate pumping arrangements (pipes, Pumps etc) on the roof for cleaning of the SPV modules. All the buildings having with piping network

on the roof for cleaning of the SPV modules.

iv) Normal and preventive maintenance of the plant such as tightening of all electrical connections, line accessories, transformers and associated switchgear on the HT/LT side.

v) Conducting periodical checking, testing, over hauling and preventive action.

vi) Submission of periodical reports to the Employer/owner on the energy generation & operating conditions of the SPV plant.

vii) The bidder shall be responsible for supply of all spare parts, repairs / replacement of any defective equipment(s) at his own cost as required from time to time during the O&M period. Also, supplier/vendor handling during O&M period shall be under the scope of bidder.

viii) The bidder shall be responsible for rectification of any fault on HT /LT side of Solar PV system by coordinating with Owner.

ix) Materials and accessories, which are necessary or usual for satisfactory and trouble-free operation and maintenance of the rooftop solar plant

x) The Contractor shall keep the measured daily data at regular interval and provide the same to Employer/Owner in electronic form compatible in CSV format. The right to use the data shall remain with Employer/Owner.

xi) Providing a detailed training plan for all operation, maintenance procedures, which shall after approval by Employer/Owner form the basis of the training program. The contractor, shall also provide training to Employer's/Owner's nominated staff.

xii) Employ and coordinate the training of contractors' personnel (at least 2 personals during the O&M period) who will be qualified and experienced to operate and monitor the facility and to coordinate operations of the facility with the grid system.

xiii) Establishing a system to maintain an inventory of spare parts, tools, equipment, consumables and other supplies required for the facility's hassle free operation.

xiv) Maintain at the facility accurate and up-to-date operating logs, records and monthly reports regarding the Operation & Maintenance of facility.

xv) Perform or contract for and oversee the performance of periodic overhauls or maintenance required for the facility in accordance with the recommendations of the original equipment manufacturer (OEM).

xvi) The works to be carried out under O&M contract are detailed in technical specification (TS).

xvii) All the equipment required for Testing, Commissioning and O&M for the healthy operation of the Plant must be calibrated, time to time, from the NABL accredited labs and the certificate of calibration must be provided prior to its deployment.

12.2 Mandatory Spares

i) During the comprehensive O&M period, the contactor shall at his cost maintain the spares for minimising system outage due to time required in getting replacements of defective part of equipment from the manufacturer. The contractor has to use the mandatory spare available at site for replacing defective part of equipment for minimising system outage temporarily and top up the quantity of spares so that the required quantity of spares shall be made available at site at all the times and same shall be handed over to the Owner at the end of O&M period.

ii) Contractor shall supply the Mandatory spares as per the list provided in SOR of the tender document. The mandatory spares are being procured for minimising system outage due to time required in getting replacements of defective part of equipment from the manufacturer. The contractor may use the mandatory spare available at site for replacing defective part of equipment for minimising system outage temporarily and top up the quantity of mandatory spares so that the required quantity of mandatory spares as mentioned in Schedule of Rates (SOR) shall be made available at site at all the times.

iii) Contractor shall handover the list of Mandatory Spares (which are duly tagged and stored) and along with all the mandatory spares to the Owner at the time of completion of O&M contract of the project.

iv) If contractor shall not be able to maintain the required quantity of mandatory spares as mentioned in Schedule of Rates (SOR) at site while handing over the plant to the owner, then owner shall be entitled to discount the cost of respective mandatory spare from the O&M charges.

13. Operation and Performance Monitoring

i) Regular periodic checks of the Modules, PCU's/Inverters and other switchgears shall be carried out as a part of routine corrective & preventive maintenance. In order to meet the maintenance requirements stock of consumables are to be maintained as well as various spare as recommended by the manufacturer at least for 5 years to be kept for usage.

ii) Maintenance of other major equipment involved in Rooftop Solar Photovoltaic Power Plant are step up transformers, overhead line equipment, indoor/ outdoor VCB kiosk, associated switchgears, other fixtures & components and metering panel. Particular care shall be taken for outdoor equipment to prevent corrosion. Cleaning of the insulators and applying Vaseline on insulators shall also be carried out at regular intervals. Earth resistivity of Plant as well as individual earth pit is to be measured and recorded every month. If the earth resistance is high suitable action is to be taken to bring down the same.

iii) A maintenance record is to be maintained by the operator/engineer-in-charge to record the regular maintenance work carried out as well as any breakdown maintenance along with the date of maintenance reasons for the breakdowns steps have taken to attend the breakdown duration of the breakdown etc. Propose the corrective measure to minimise the break down.

iv) The Schedules will be drawn such that some of the jobs other than breakdown, which may require comparatively long stoppage of the Power Plant, shall be carried out preferably during the non-sunny days. An information shall be provided to Engineer-in-charge for such operation prior to start.

v) The Contractor shall deploy enough manpower at Rooftop Solar Photovoltaic Power Plant site to carryout work instructions and preventive maintenance schedules as specified. The contractor shall keep at least two skilled and experienced supervisor at site on permanent basis to supervise the jobs that are being carried out at site.

vi) The Contractor will attend to any breakdown jobs immediately for repair/replacement /adjustments and complete at the earliest working round the clock. During breakdowns (not attributable to normal wear and tear) at O&M period, the Contractor shall immediately report the accidents, if any, to the Engineer In-charge showing the circumstances under which it happened and the extent of damage and or injury caused.

vii) The Contractor shall comply with the provision of all relevant acts of Central or State Governments including payment of Wages Act 1936, Minimum Wages Act 1948, Employer's Liability Act 1938, Workmen's Compensation Act 1923, Industrial Dispute Act 1947, Maturity Benefit Act 1961, Mines Act 1952, Employees State Insurance Act 1948, Contract Labour (Regulations & Abolishment) Act 1970, Electricity Act 2003, Grid Code, Metering Code, MNRE

guidelines or any modification thereof or any other law relating whereto and rules made there under or amended from time to time.

viii) The contractor shall at his own expense provide all amenities to his workmen as per applicable laws and rules.

ix) The Contractor shall ensure that all safety measures are taken at the site to avoid accidents to his or his sub-contractor or Owner's Workmen.

x) If negligence/maloperation of the contractor's operator results in failure of equipment such equipment should be repaired/replaced by contractor at free of cost.

xi) If any jobs covered in O&M Scope as per O&M Plan are not carried out by the contractor during the O&M period, the Engineer-In-Charge can issue a notice to the Contractor. Repetition of such instances for more than 2 times a year may lead to the Termination of the O&M Contract by the Employer/Owner.

13.2 Drawings & Documents

Contractor shall submit following documents, drawings, data design, and engineering information to Engineer-in-charge for review and approval in hard copy and soft copy from time to time as per project schedule.

i) Contour plan (if land is used for the plant)/ Site Plan

ii) GA drawings of the entire project including control room, fire protection system plant lay out etc.

iii) Design basis criteria/ calculation sheet along with relevant standards (list of standards and respective use description only)

iv) Solar insolation data and basis for generation data

v) SLD, Plant lay out, shadow analysis report, structural calculations

vi) Equipment’s Design calculations and sheets.

vii) Detailed technical specifications (GTP) of all equipment.

viii) General arrangement and assembly drawings of all major equipment.

ix) Schematic diagram for entire electrical system & lay out plan.

x) GTP & G.A. drawings for all types of structures/ components, switchgears & other interfacing panels.

xi) Relay setting charts

xii) Quality Assurance Plans (QAP) for manufacturing and field activities plan

xiii) Detailed site, fire safety & evacuation plan and disaster management plan.

xiv) Test reports (for type, acceptance, and routine tests).

xv) O&M Instruction's manuals and its drawings.

xvi) As-built drawings / documents and deviation list from good for construction (GFC)

xvii) O&M plans, schedules and operational manuals for all equipment etc. Daily/ Weekly site work progress report with catch-up plan(s), as necessary to monitor actual timelines of the project during construction period along with the real time snap shots during the time of construction.

xviii) Weekly/ Monthly O&M reports after commissioning of the project.

xix) All drawings shall be fully corrected to agree with the actual "as built" site conditions and submitted to EIC after commissioning of the project for record purpose. All as-built drawings must include the Good for Construction deviation list.

xx) The contractor shall forward the following to EIC within four weeks from issue of FOA

a. Schedule for various activities in the form of PERT Chart.

b. Detailed engineering calculations, Design basis report and complete layout of the plant

c. Equipment data sheets, Guaranteed technical particular of equipment and GA drawings of major equipment like, inverter, mounting structure and transformer.

E. TYPICAL POWER EVACUATION/ GRID CONNECTIVITY SCHEME

The contractor shall design the detail Power Evacuation Scheme for the 8 MWp Rooftop grid connected Solar Power Plant which will be approved by EIC before commencement of the project. However, following evacuation scheme may be referred:

i. The roof top plant should be designed for interconnection with the Allocated Interconnection Substation of distribution/transmission network of Owner. The responsibility of getting connectivity with the transmission/ distribution system will lie with the Successful Bidder. In this regarding the proposed evacuation arrangement that is to be constructed by the bidder only.

ii. The generation projects (building wises) shall be located in the close proximity of allocated Interconnection Substation Grid S/s [(33/11 KV)

iii. The connectivity with distribution network for Solar Power Plants to connect at 11 KV bus of BHU "s Interconnection substations (PSS)

iv. The Transformer shall be loaded as per the UPERC regulation

v. While identifying the site/ buildings for the Project, the Bidder shall be required to obtain an "in-principle" approval from the Owner/Employer.

vi. The requisite arrangement for the evacuation of the power from the generation plant to the allocated Interconnection Substation will be developed by Bidder

vii. The Bidder shall provide step-up transformers, panels, kiosks, protection & metering equipment or any other equipment as required at the generation facility and fully equipped line bay(s) in its switchyard for termination of interconnecting transmission line(s) at the Generation switchyard. In general, the Bidder should procure and set up all such facilities required for facilitating the inter-connection till the point of inter-connection. The Bidder shall also provide proper & reliable communication between the generation facility & Grid substation / Power S/S of BHU where the power is to be delivered by the generation facility. The cost of the communication equipment's and associated works will be borne by the Bidder.

viii. The Bidder shall run the plant as a part of integrated system to generate power in synchronism with the grid and shall inject three phase 50 Hz Request for Proposal for Setting of Grid Connected Solar PV Projects in BHU (nominal) AC Supply into BHU/DISCOM system as per provision of UPERC (State Grid Code) Regulations as amended from time to time.

ix. Delivery of power to the point of interconnection at substation of BHU/DISCOM where the metering will be done shall be the responsibility of the Bidder at its own cost.

x. For this the Bidder shall pay the applicable charges like transmission charges, wheeling charges, surcharge, operating charge, SLDC charges etc. at the rates to be determined by UPERC for transmission of power from its power plant to the sub-station (if applicable) .

xi. It would be deemed that prior to the submission of the Proposal, the Bidder has made a complete and careful examination of the grid connectivity aspects of the Project before bid by site visit.

- BHU shall not be liable for any mistake or error or neglect by the Bidder in respect of the above.
- Successful bidder shall ensure that in case of Grid outage the Solar Power Plant will not energise Distribution Licensee's distribution system. Successful bidder is solely

responsible for any accident to human beings / animals whatsoever (fatal / non-fatal / departmental / non-departmental) that may occur if the Solar Power Plant energises the Grid during Grid outage.

- The Owner/Employer reserves the right to disconnect Solar Power Generator's installation at any time in the event of the Solar Power Plant damaging its Grid, meter or other equipment to prevent any accident or damage
- Solar Power Generator shall install a main switch or isolator near the Energy Feed-In Meter/ Solar meter, which is accessible to the BHU and with which the Solar Power Generator's Solar Power Plant can be disconnected from the BHU distribution system.

xii. The bidder shall obtain all the necessary statutory approvals and clearances (environmental and grid connection related) before connecting the photovoltaic system to the distribution system

F. TECHNICAL SPECIFICATION OF SOLAR POWER PLANT

14. Bill of Material (BoM)

The equipment and material for 8 MWp (DC) Grid Interactive Rooftop Solar Photovoltaic Power Plant with associate system (typical) shall include, but not limited to the following:

Item Details	Unit
PV Modules	Nos.
Module Mounting Structures including fasteners and clamps	Set
Main Junction Boxes with monitoring capabilities (if any)	Lot
Solar module array to Junction box Interconnection cable (Cu)	RM
Junction box to Inverter Interconnection Cable (Cu/ Al)	RM
Connection accessories – lugs, ferrules, glands, terminations etc.	Lot
AC Cable (LT/ HT) of appropriate sizes	RM
Power Conditioning Units/ Inverters	Nos.
Meteorological station with sensors and data logger	Lot
String level monitoring system (DAS) and ancillaries	Set
Transformers (Power and Auxiliary)	Set
Circuit breakers, CT and PT set	Set
Desired kV Indoor/ outdoor interfacing panels with CT, VCB, PT, Relays etc.	Set
Desired kV XLPE Outgoing feeder cable and supports	Set
AC & DC distribution panels/ boards, PDB, LDB etc.	Lot
Control and Relay Panel	Lot

Lightning Arresters of suitable ratings	Nos.
Earth mat for switch yard, DC field array and equipment	Lot
Control and power cables	Lot
Surge Protection devices and Fuses	Set
Earth cables, flats and earthing pits	Lot
Equipment and Control cum office Building with associated equipment	Lot
Rubber Mats for specific kV ratings and safety gadgets, PPE	Lot
Fire extinguisher - Foam type, CO2 type, ABC type etc., as applicable	Lot
Sand Buckets	Lot
Discharge Rods	Lot
Cable for power evacuation with suitable H – poles, towers etc.	Lot
Power efficient peripheral lighting arrangement for the plant safety	Nos.
Fire – Alarm system and signboards in buildings	Lot
Metering Equipment (Meters, and associated CT and PT's)	Set
Protection Equipment	Set
Solar Observatory with remote monitoring assistance	Set
Module cleaning system	Lot
Danger sign plates, anti-climbing, bird protection etc.	Lot

All the information shown here is indicative only and may vary as per design and planning by the bidder. The bidder must provide the BOM of the plant as per the design during the time of bidding. The technical features of major equipment are described hereunder.

15. DC Systems-Photovoltaic Modules

15.1 Photovoltaic Modules

Total capacity of PV Modules to be supplied for the 8 MWp (DC) project is minimum of 8 MWp which is the cumulative rated capacity of all solar PV module under supply as per relevant IEC standards under Standard Temperature Condition (STC). The Project shall consist SPV modules as per the specifications given below:

Sl. No.	Description	Details
1	Type of SPV Module	Poly Crystalline Silicon

2	Peak Power rating of Module	Shall not be less than 300 Wp at Standard Test Conditions (STC) with positive tolerance only (+5 W)
3	Module Efficiency	15.0 % and above at Standard Test Conditions (STC)
4	Number of cells	72
5	Fill Factor	0.72 (Minimum)
6	Glass for the crystalline silicon modules	Toughened low iron glass with minimum thickness of 4.0 mm for 72 cell module
7	Transmittance of the Glass	Above 90% and with bending of less than 0.3%
8	Back sheet	**The back sheet used in the crystalline silicon based modules shall be 3 layered structure. Outer layer of fluoropolymer, middle layer of Polyester (PET) based and Inner layer of fluoropolymer or UV resistant polymer. Back sheet with additional layer of Aluminium also will be considered. The thickness of back sheet should be of minimum 300 microns with water vapor transmission rate less than 3g/m2/day. The Back**
9	**EVA**	**The EVA used for the modules should be of UV resistant in nature. No yellowing of the back sheet with prolonged exposure**

10	**Sealant**	**The sealant used for edge sealing of PV modules shall have excellent moisture ingress protection with good electrical insulation (Break down voltage >15 kV/mm) and with good**
11	**Junction Box**	**The junction box used in the modules shall have protective bypass diodes to prevent hot spots in case of cell mismatch or shading. The material used for junction box shall be made with UV resistant material to avoid degradation during module life and the Junction sealing shall comply IP 67**
12	**PID free modules**	**The crystalline silicon based modules supplied should be of Potential Induced Degradation (PID) free modules and the test certificate from third party lab complying with the same shall be provided.**
13	**Wind Speed**	**Modules should have rugged design to withstand tough environmental conditions and high wind speeds (minimum up to 180 km/h).**
14	**Humidity and Temperature**	**Modules shall perform satisfactorily in relative humidity up to 85% and temperature between -10 degree centigrade and 85 degree**

15	**Warranty**	**1. PV modules must be warranted for their output peak watt capacity, which should not be less than 90% of the initial value at the end of 10 years and 80% of the initial value at the end of 25 years.** **2. The modules shall be warranted for minimum of 10 years against all material/ manufacturing defects and**
16	**Code and Standards**	**1. IEC 61215 2nd Ed. (Design qualification and type approval for Crystalline Si modules)** **2. IEC 61730 (PV module safety qualification testing @ 1000 V DC or higher)** **3. IEC 61701: Salt Spray test for highly corrosive environment, if applicable**
17	**Temperature co-efficient**	**The temperature co-efficient of power for the modules shall not**
18	**Module Mismatch**	**The module mismatch of the modules connected to an inverter should be less than 2%.**

i) The developer shall arrange for the details of the materials along with specifications sheets from the manufacturers of the various components used in solar modules along with those used in the modules sent for certification. The Bill of materials (BOM) used for modules shall not differ in any case from the ones submitted for certification of modules.

ii) 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.

iii) The module frame shall be made of anodized Aluminium or corrosion resistant material,

which shall be electrically compatible with the structural material used for mounting the modules. The anodizing thickness shall be 15 micron or better. In case of metal frames for modules, it is required to have provision for earthing to connect it to the earthing grid.

iv) The I-V characteristics of all modules as per specifications to be used in the systems are required to be submitted at the time of supply.

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

vi) Modules only with the same rating and manufacturer shall be connected to any single inverter.

vii) Bidder shall provide data sheet for Solar PV Module (Under STC) along with their offer as per Guaranteed Technical Particular Data Sheet- 1. Also, the bidder must provide the commercial data sheet indicating the exact power of the module, if the data sheet consists of a range of modules with varying output power.

viii) The Employer/Owner or its authorized representative reserves the right to inspect the modules at the manufacturer's works prior to dispatch.

ix) The Bidder is advised to check and ensure the availability of complete capacity of modules prior to submitting the NIT document.

x) Entire drawings, detailed test & flash reports and compliance certificates of the offered modules should be submitted for approval of EIC within 15 days from the date of placement of order (FOA) and supply should start thereafter.

xi) Review of Document, Inspection and tests:

xii) Incoming Checks on bought out items (listed in third party test reports of relevant standard), as per internal standards of the manufacturer

xiii) In-process checks, as per internal standards of the manufacturer

xiv) Modules deployed must use a **Radio Frequency Identification RFID) tag** for traceability. It should be well protected within the module laminate and containing the following information:

1. **Name of the manufacturer of the PV module**
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**
6. **Wattage, Imp, Vmp 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**

xv) One number RFID reader has to be supplied by contractor compatible to read the data from the RFID tag & download the data to computer. All associated software and cable are to be provided along with the RFID reader. Along with RFID reader, one megger (2.5 KV) and one clamp meter (AC current upto 500 Amp and DC current upto 1000 Amp) shall also be provided by contractor.

xvi) Sample tests as per following:

1. **Scratches on the frame and/or glass**
2. **SPV modules to be checked visually for following defects (as per IS 2500 Part 1):**
3. **Excessive or uneven glue marks on glass or frame**
4. **Inconsistent cell colours**
5. **Completeness of module in all respects**
6. **Performance of SPV module at STC (as per IS 2500 Part 1)**
7. **IR-HV-IR test (as per IS 2500 Part 1)**
8. **Robustness of terminations on 1 sample per offered lot**
9. **Mechanical load test on 1 sample per offered lot**

15.2 PV Array Configurations

The Solar array shall be configured in multiple numbers of sub-arrays, providing optimum DC power to auditable number of sub arrays. The bidder shall submit their own design indicating configuration of PCU and respective sub arrays and associated bill of material.

15.3 Module Mounting Structure

The structure design shall be appropriate and innovative. It must follow the existing roof profile.

The structure shall be designed to allow easy replacement of any module and shall be in line with the site requirements.

Design drawings with material selected and their standards shall be submitted for

prior approval of EIC within 15 days of FoA.

The support structure design shall be designed with reference to the existing roof conditions in order to withstand wind speed applicable for the zone (Site Location) or 180kmph, whichever is higher, using relevant Indian wind load codes.

The structure must be designed with considering appropriate factor of safety. The bidder must provide the detail design and calculation for the structure design.

The structure shall be designed for simple mechanical and electrical installation. It shall support SPV modules at a given orientation & tilt, absorb and transfer the mechanical loads on the trusses of the roof properly. Welding of structure at site shall not be allowed.

The array structure shall be made of Aluminium / Hot deep galvanised MS structure sizes with weather protection coating. The coating of aluminium/ galvanised MS structure shall be as per relevant standards. The structural design need to be approved by Certified Structural Engineer / Agency. Following or better type of mounting structure with clamps and waterproofing arrangement as shown in below photos are proposed to be used for mounting solar PV modules on inclined Metallic roof. Contractor shall submit a structure design for the approval of EIC/Employer. The below shown photos are indicative and for reference purpose only**.**

The array structure on the roofs shall be so designed that it will occupy minimum space without sacrificing the output from SPV panels. The structure shall be designed to allow easy replacement of any module by authorized personnel and shall be in line with the site requirements. Contractor shall also ensure that the sufficient space shall be left between solar array on both the roofs for physical movement by O&M personnel.

15.3.1 Codes and Standards

The system and equipment shall be designed, built, tested and installed in accordance with the latest revisions of the following applicable standards. In the event of other standards being applicable they will be compared for specific requirement and specifically approved during detailed engineering for the purpose:

Codes	Description

IS875	Code of Practice for Design Loads (Other Than Earthquake) For Buildings And Structure. Part 1 Dead Loads - Unit Weights of Building Material And Stored Materials, Part 2 Imposed Loads, Part 3 : Wind Loads, Part 5 Special Loads And Combinations-
IS800	Code of Practice for general construction of steel
IS1893	Criteria for earthquake resistant design of structures -General provisions and buildings
IS513	Cold-rolled low carbon steel sheets and strips
IS814	Covered electrodes for manual metal arc welding of carbon and carbon manganese steel
IS733	Specification for Wrought aluminium and aluminium alloy Bars, Rods and Sections (for General Engineering Purposes)
IS 1868	Anodic Coatings on Aluminium and its Alloys
IS5523	Methods of Testing Anodic Coatings on Aluminium and its alloy.
IS-4759	Hot-dip zinc coatings on structural steel and other allied products
IS 2062	Hot rolled medium and high tensile structural steel — specification
IS 808	Dimensions for hot rolled steel beam, column, channel and angle Sections
IS 811	Specification for cold formed light gauge structural steel sections

15.3.2 Technical Requirements

1. All solar panels must be accessible from the top for cleaning and from the bottom for access to the module junction box.
2. The module mounting structure members would be made of hot dip galvanized MS profiles/ hot rolled/ cold formed steel sections. Galvanization thickness shall be of min 100 micron. Galvanization of the mounting structure shall be in compliance of latest IS 4759.
3. The yield strengths shall be as per relevant standards.
4. Proper design and calculations report should be provided to Employer/EIC/Owner.
5. All nuts & bolts shall be made of very good quality stainless steel of grade SS 304

or higher. Nut & bolts, supporting structures including module mounting structures shall have to be adequately protected against all climatic condition and

all galvanic corrosion at contact point of dissimilar metals.

6. Chipping & anchor fastening at rooftop for better support of module mounting structure is allowed but bidder shall have to do re-waterproofing. Bidder to ensure that roof strength does not reduce after mounting solar PV modules.
7. The minimum clearance of the lowest part of the module structure and the flat concrete shall be 300 mm (in case of flat roof which is available on loading bay of the warehouses).
8. All The structure design shall be appropriate with a factor of safety not less than Foundation dimensions to be decided based on geographical condition, regional wind speed, load bearing capacity of roof, slope stability etc.
9. All mechanical items must be supplied as per approved drawing, BOM and as per direction of EIC.

15.3.3 Load bearing strength of Roof top

Load bearing strength of roof top of buildings and its suitability for installing solar PV plant, design of SPV structure and distribution of load on roof top beam shall be vetted by chartered structural engineer. Any changes in structural design suggested by Employer/EIC//Owner shall be binding on the contractor.

15.4 DC Cables

i. The DC Cables in a solar PV plant are used in the following areas

   1. **Interconnecting SPV modules**
   2. **From SPV Modules up to String Monitoring Unit (SMU)**
   3. **From SMU up to the Inverter.**

ii. DC CABLES (Interconnecting SPV MODULES and from SPV Modules to SMU)

Cables used for inter-connecting SPV modules as well as Modules to SMU's shall conform to the requirements of TUV specification 2 Pfg 1169/08.2007 or EN 50618 for DC cable for photovoltaic system. Minimum 6 sq.mm or may be use 10 sq.mm size of cable to be used to minimise the voltage drop.

These cables shall meet the fire resistance requirement as per TUV specification

2 Pfg 1169/08.2007 and shall be electron beam cured.

The Cables used for positive and negative shall have distinct colour identification on outer sheath of the cable preferably with identifiable line along the cable. Insulation of the cable shall have natural colour without any colour additive.

iii. In addition to manufacturer's identification on cables as per TUV, following marking shall also be provided over outer sheath.

1. **Cable size and voltage grade**
2. **Sequential marking of length of the cable in metres at every one metre**
3. **Colour coding for positive and negative wires.**

iv. The Printing shall be progressive, automatic, in line and marking shall be legible and indelible.

v. Type test, routine, acceptance tests requirements for these cables shall be as per TUV specification 2 Pfg 1169/08.2007.Charges of routine and acceptance tests shall be deemed to be included in the cable price. Sampling for acceptance tests will be as per IS 7098.

15.5 DC Cables (SMU's to Inverter)

Cables used between SMU's and Inverters shall be of min. 1.5 kV (DC) grade. These Power cables shall have copper conductor, XLPE insulated, PVC inner-sheathed (as applicable), Armoured/Unarmoured, FRLS PVC outer sheathed conforming to IS: 7098 (Part-I). These cables shall conform to the requirements of the standards & codes specified under LT Cables head and any other relevant standard.

i. **DC Cables Sizing Criteria**

The Maximum voltage drop of DC Cables (SPV Modules to Inverters) shall be limited to 1.5%.

ii. **Review of Document, Inspection and tests:**

1. **High voltage test**
2. **Conductor resistance at 20deg. C**
3. **Constructional and dimensional test**
4. **Insulation resistance test**
5. **Flammability test**
6. **Cable end sealing**

15.6 String Monitoring Units (SMU) (if required in case of central inverter)

i. General

SMU shall have protection devices to protect the PV modules from current/voltage surges. SMU should be capable to monitor the string/sub- array currents, Array voltage and total current of all the strings connected to SMU. The Nos of Sub-array shall be restricted to two arrays. SMU shall have provision to monitor all the above parameters and shall communicate and transfer the required data to the DAS for remote monitoring purposes.

ii. Codes and Standards

Codes	Relevance
UL 94 V	**Fire Resistant/ flammability**
UL 746C	**UV Resistant**
IEC 62262	**Mechanical Impact Resistance**
IS 2147/IEC 60529	**Enclosure Protection**
IEC 61643-12	**Surge Protection**
IEC 62208	**Enclosure for low voltage Switchgear and control gear assemblies**

iii. General Requirement

SMU shall be equipped (but not limited to) with the following:

DC Disconnector to disconnect the PV strings from the Inverter for maintenance purpose.

String fuses (one for each string).

Surge Protection Devices for protection against surge currents and voltages.

Current and Voltage measurement shall be shunt based sensors.

Suitable communication link/ media /Interface to communicate the data to DAS.

The following parameters shall be available at DAS for monitoring the health of the each PV string:

String(s) Current

Voltage of SMU

Total current of SMU

Total Power of SMU

Status of Disconnector Switches

iv. DC Surge Protection Devices (SPD) for PV Solar application:

SPD shall have thermal disconnector to interrupt the surge current arising from internal and external faults. In order to avoid the fire hazard due to possible DC arcing in the SPD due to operation of thermal disconnector, the SPD shall be able to extinguish the arc.

v. **String Fuses**

In order to provide protection to all cables and modules, suitable size of string fuses shall be provided to avoid fire hazard in positive legs of the string cabling. However, in case of negative grounded inverters, string fuse shall be provided in positive leg only as per recommendation of inverter manufacturer. String fuses shall be of PV category and dedicated to solar applications and conform to IEC 60269-6 or UL-2579 standards. String fuses should be so designed that it should protect the modules from reverse current overload.

vi. SMU/ Junction Box Enclosure

1. **The enclosure shall be fire retardant with self-extinguishing property and free from Halogen.**
2. **Degree of protection for enclosure shall be IP 65 or better.**
3. **The enclosure shall be UV protected.**
4. **The mechanical impact resistance of enclosure shall be IK 07 or better.**
5. **The size of the enclosure shall be designed in such a way that the temperature rise of the enclosure should not more than 30 deg. C above the ambient temp of 50 deg. C. The components mounted inside the SMU shall have higher temperature withstand capability and shall continuously operate under such conditions without degrading the performance parameters and life expectancy. Contractor shall furnish the design calculation for temperature rise for owner's approval.**
6. **In each SMU 5% spare terminals (along with cable glands) rounded off to next higher integer shall be provided to connect the PV strings.**

7. **All terminals blocks shall be rated for min 1000V and rated continuously to carry maximum expected current.**
8. **In case, SMU is proposed to be mounted on the MMS structure, the additional load of the SMU shall be considered for the design of structure.**
9. **All internal wiring shall be carried out with 1100V grade stranded copper wires. All internal wiring shall be securely supported, neatly arranged readily accessible and connected to component terminals and terminal blocks. Wire terminations shall be made with solder less crimping type of tinned copper lugs which firmly grip the conductor and insulation. Insulated sleeves shall be provided at all the wire terminations. Engraved core identification plastic ferrules marked to correspond with the wiring diagram shall be fitted at both ends of each wire. Ferrules shall fit tightly on wires shall not fall off when the wire is disconnected from terminal blocks.**

vii. **DC Plug-In Connectors for Field Cabling**

Cable connector to be used for connecting SPV modules and String monitoring boxes shall be In accordance with DIN EN 50521. Connector shall be of plug and socket design to be plugged together by hand but can be separated again using a tool only.

viii. **Technical Requirements**

Rated Current, IEC (90 °C)	**30 A (4 MM2, 6 MM2)-40 A (10 MM2)**
Rated Voltage	**1000 Volts as per TUV**
Connector Design	**Snap-In locking Type**
Protection Degree	**IP67**
Ambient Temperature	**(-) 40^0 C to (+) 90^0 C**
Protection/Safety Class	**Class II**
Contact material	**Cu**
Contact surface material	**Ag**
Contact resistance for plug connecter	**<0.5 mΩ**
Stripping length	**10mm**
In-flammability class	**acc. to UL 94 UL94-V0**
Insulating Material	**PPE/Noryl (PPE+PS material)**
Certification	VDE 670/TUV, UL 3

Pollution degree **Class II**

ix. **Review of Document, Inspection and tests:**

Suitable numbering system shall be evolved for easy identification and traceability of SMU during erection, commissioning and maintenance. Same numbering system should be reflected in DAS system. Test on SMU shall include the following:

A) Checks on bought out items as per internal standards of the manufacturer

B) In-process checks, as per internal standards of the manufacturer

C) Sample tests as per following:

- **IR-HV-IR test (as per IS 2500 Part 1)**
- **String Monitoring Card/ Power Supply card/ DC-DC Converter function check (as per IS 2500 Part 1),**
- **Communication Function Test (as per IS 2500 Part 1).**

15.7 Power Conditioning Unit (PCU)

1. Power Conditioning Unit (PCU) shall consist of Inverter along with associated control & protection, filtering, measuring instruments and data logging devices. The PCU shall be designed to supply the three phase AC power to grid. The PCU shall be capable to adjust the output voltage & frequency to suit the grid condition. The rated power/name plate capacity of the inverters shall be the AC output of the inverter at 50 deg C. Any inverters with AC output at 50 Deg C, below the name plate/rated power of the inverter shall not be allowed. Alternatively the required inverters may be either string inverters three phase as per design of Bidder
2. PCU must have provision to be isolated from grid through circuit breakers which shall be inbuilt with the inverter or located in separate standalone panel
3. Dimension, weight, cooling arrangement etc. of the PCU shall be indicated by the Bidder in the offer. Type (in- door & out-door) of installation also to be indicated.
4. PCU shall conform to IEC 61000 or equivalent international standard for compliance to requirements for electromagnetic compatibility and to IEC 60068-2 or equivalent international standard for requirement of environment testing.
5. The minimum European efficiency of the inverter shall be 98% as per IEC 61683 standard for measuring efficiency. The Bidder shall specify the conversion efficiency of

different loads i.e. 25%, 50%, 75% and 100% in its offer. The Bidder should specify the overload capacity in the bid.

6. The PCU shall remain connected to the grid as per central electricity authority (CEA) technical (standards for connectivity to the grid) regulation 2007 with all latest amendments and its component shall be designed accordingly.
7. The PCU shall have protection against any sustained fault, lighting discharge in feeder line and earth leakage faults.
8. The incoming DC feeder of PCU shall have suitably rated isolators to allow safe start up and shut down of the system and it terminal should be shrouded. The DC feeder shall terminate in the fuse box through suitable fuse rating. The PCU fuse box shall have one spare terminal with fuse and holder for future use. The connection between the fuse box and inverter shall be through copper bus bars or copper cable.
9. Internal surge protection device (SPD) shall be provided in the PCU on DC and AC side. The discharge capability of the SPD shall be at least 10KA at 8/20 micro second wave as per IEC 61643-12. During earth fault and failure of MOV, the SPD shall safely disconnect the healthy system. SPD shall have thermal disconnector to interrupt the surge current arising from internal and external faults. In order to avoid the fire hazard due to operation of thermal disconnector, the SPD shall extinguish the arc.
10. The PCU should be designed for parallel operation through galvanic isolation. Solid state electronic devices shall be protected to ensure smooth functioning as well as ensure desired life expectancy of the inverter.
11. The PCU shall have anti-islanding protection as IEC 62116 or equivalent international standard. The PCU must synchronise automatically its AC output to the exact AC voltage and frequency of the captive bus. Inverter shall continuously monitor the condition of the captive bus and in the event of captive bus failure, the inverter automatically switches to off-grid supply within 20-50 milliseconds. The Solar system is synchronised with the captive bus immediately after the restoration of captive bus.
12. In case of grid failure, the PCU shall be re-synchronized with grid after revival of power supply. Vendor to furnish the time taken by PCU to be re- synchronized after restoration of grid supply same to be indicated in data sheet to be submitted during detail engineering stage.
13. PCU shall conform to IEC 62109 or IEC 62103 or equivalent international standard for compliance to requirement for the design and manufacture of PCU for protection against electric shock, fire, mechanical and other hazards.

14. Control and read out should be provided on the indicating panel which is the integral part to the inverter. Display should be simple and show all the relevant parameter relating to PCU operational data and fault condition in form of front panel parameter/LED or two line LCD display. It shall include all important parameter i.e. DC input voltage, AC output voltage , AC output current, AC output power, frequency etc. and the same has to be made available to DAS also.
15. The PCU shall be equipped with appropriate self –protective and self-diagnostic feature to protect itself and 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 when the PCU, including commutation failure, shall be cleared by the protective device.
16. The PCU design shall be such that it will not excite any resonant condition in the system that may lead to islanded operation of PV plant and loss of generation.
17. In case PCU need auxiliary power supply, the same shall be met as per clause 21 given hereunder.
18. PCU shall have in built control feature for changing output set point individually and simultaneously from CMC through plant DAS to have real time control over the total power exported to the grid. In addition, operator shall be able to limit the total power (active and reactive) injected in the grid through manual intervention as and required for grid security.
19. 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 PCUs should be incorporated in the PCUs, keeping in mind the extreme climatic condition of the site as per the recommendations of OEM to achieve desired performance and life expectancy.
20. The inverters shall have minimum protection to IP 65(Outdoor)/IP 21(indoor) and Protection Class II.
21. Nuts & bolts and the PCU enclosure shall have to be adequately protected taking into consideration the atmosphere and weather prevailing in the area.
22. 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 (PWM) technology.

23. **Operational Requirements for Inverter/ PCU**

a) **PCU/inverter shall provide 3 phase, 415V (with captive bus tracking of +15%/-**
20%), 50 Hz (with captive bus tracking of ±5% i.e. 47.5 to 52.5 Hz) supply on AC side with voltage THD of less than 3% and current THD of less than 5%. Captive bus voltage shall also be continuously monitored and in the event of voltage going below a preset value and above a preset value, the solar system shall be disconnected from the captive bus within the set time.

b) **The PCU must have the feature to work in tandem with other similar PCU's and be able to be successively switched "ON" and "OFF" automatically based on solar radiation variations during the day. Inverters must operate in synergy and intelligently to optimize the generation at all times with minimum losses.**

c) **The PCU shall be capable of controlling power factor dynamically.**

d) **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 of MPPT shall be mentioned by the Bidder in its offer. The MPPT unit shall conform to IEC 62093 for design qualification. The operating voltage range of PCU and the MPPT shall be large enough such that it satisfactorily operates for PV modules exposed to the maximum ambient temperatures of 50 degree centigrade.**

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

f) **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.**

g) **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.

h) 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.

PCU shall have provisions/features to allow interfacing with monitoring software and hardware devices.

24. Earthing Of Inverters:

DC side components shall be earthed to distinct earth pit through adequate size conductor as per IS 3043 -1987. The size of conductor / procedure for earthing shall be as per the maximum fault current of DC system.

25. Ventilation of Inverter (if required)

Inverter room of PV station shall be adequately ventilated to prevent the rise of temperature within inverter room even in the worst outside ambient temperature. The ventilation plant capacity and air quality of inverter room shall be as per inverter and other auxiliaries' manufacturer's recommendations. Filter banks at the air inlet of the inverter room shall be provided to prevent dust ingress.

26. Standards & Compliances

PCU shall conform to the following standards and appropriately certified by the labs:

Relevance	Standards
Efficiency measurement	IEC 61683
Environmental Testing	IEC 60068-2 or IEC 62093
EMC, harmonics, etc.	IEEE 519
Electrical safety	IEC 62109 (1&2), EN 50178 or equivalent
Recommended practice for PV – Utility interconnections	IEEE standard 929 – 2000 or equivalent
Protection against islanding of grid	IEEE1547/ UL1741/ IEC 62116 or equivalent
Grid Connectivity	Relevant CEA/ CERC regulation and grid code

	(amended up to date)
Reliability test standard	**IEC 62093 or equivalent**

27. The Bidder should select the inverter (Central/ string) as per its own system design so as to optimize the power output.
28. Desired Technical Specifications of PCU.
29. Sinusoidal current modulation with excellent dynamic response.
    a) **Compact and weather proof housing (indoor/ outdoor)**
    b) **Comprehensive network management functions (including the LVRT and capability to inject reactive power to the grid)**
    c) **Total Harmonic Distortion (THD) <3%**
    d) **No load loss < 1% of rated power and maximum loss in sleep mode shall be less than 0.05%**
    e) **Optional VAR control**
    f) **Power factor Control range: 0.9 (lead – lag)**
    g) **Humidity: 95% Non – Condensing**
    h) **Unit wise & integrated Data logging**
    i) **Dedicated Prefabs / Ethernet for networking**
    j) **DC injection is less than 0.5% of nominal load current**
    k) **Flicker as per IEC 61000**
    l) **Maximum noise level 75 dBA**
30. **Inverter/ Power Condition unit must provide protection against:**

a) Over current
b) Sync loss
c) Over temperature
d) AC/ DC bus over voltage
e) Cooling Fan failure (If provided)
f) Short circuit
g) Lightning
h) Earth fault
i) Surge voltage induced at output due to external source

j) Power regulation in the event of thermal overloading

k) Set point pre-selection for VAR control

l) Bus communication via -interface for integration

m) Remote control via telephone modem or mini web server

n) Integrated protection in the DC and three phase system

o) Insulation monitoring of the PV array with sequential fault location

31. Ground fault detector which is essential for large PV generators in view of appreciable discharge current with respect to ground.
32. Over voltage protection against atmospheric lightning discharge to the PV array is required.
33. The power conditioner must be entirely self-managing and stable in operation.
34. A self-diagnostic system check should occur on start up. Functions should include a test of key parameters on start up.
35. PCU/inverter front panel shall be provided with display (LCD or equivalent) to monitor, but not limited to, the following:
    a) **DC power input**
    b) **DC input voltage**
    c) **DC Current**
    d) **AC power output**
    e) **AC voltage (all the 3 phases and line)**
    f) **AC current (all the 3 phases and line)**
    g) **Power Factor**
    h) **Frequency**
36. Document Requirements & Inspection
    a) **The bill of materials associated with PCUs should be clearly indicated while delivering the equipment.**
    b) **The Contractor shall provide data sheet containing detailed technical specifications of all the inverters and PCUs to EIC,**
    c) **Type test reports including temperature rise and surge withstand test. In case of type test report(s) are not found to be meeting the specification requirements, the contractor shall conduct all such tests under this contract at no additional cost to the owner/Employer**

either at third party laboratory in the presence of owner's/Employer's representative and submit the reports for approval.

d) **Operation & Maintenance manual before dispatch of PCUs.**

e) **The Employer//Owner or its authorized representative reserves the right to inspect the PCUs/ Inverters at the manufacturer's site prior to dispatch.**

f) **Routine tests as per following on the assembled PCU:**

g) **Test to demonstrate automatic / manual synchronization and connection to utility service**

h) **Test to demonstrate operation protective (including utility service interface protection) and instrumentation circuits demonstrated by direct test if feasible or by simulation operation conditions for all parameters that cannot be directly tested.**

i) **Test to demonstrate operation of start-up, stable operation of the PCU, disconnection and shutdown controls and response to other control signals**

j) **Following sample tests on the assembled PCU: (1 Panel per offered lot)**

k) **Sample testing to include measurement of phase currents, efficiencies, harmonic content and power factor at four points preferably 25, 50, 75 and 100% of the rated nominal power.**

l) **Maximum power point tracking (MPPT) functional check**

a) AC SYSTEM

LT Switchgear

LT Switchgear shall mean the combination of electrical disconnect switches, fuses or circuit breakers and all associated accessories used to control, protect and isolate electrical equipment on the low voltage side of electrical interconnection.

Codes and Standards

All standards, specifications and codes of practice referred to herein shall be the latest editions including all applicable official amendments and revisions as published one month prior to the date of opening of bids. In case of conflict between this specification and those (IS codes, Standards etc.) referred to herein,

the former shall prevail. All work shall be carried out as per the following codes and standards.

IS CODE	Relevance
IS 694	PVC insulated cables for working voltages up to and including 1100V
IS/IEC 60947–1	Degree of protection provided by enclosures for low voltage Switchgear and Control gear
IS 1248	Electrical Indicating instruments
IS 3202	Code of practice for climate proofing of electrical Equipment.
IS/IEC 60947–2	AC Circuit Breakers including MCCB
IS 2705	Current Transformer
IS/IEC 60947–4-1	Contactors and motors starter for voltages not exceeding 1000 V AC or 1200 VDC
IS 3072	Code of practice for installation and maintenance of Switchgear
IS 3156	Voltage Transformer
IS 3231& IEC 60255	Electrical relays for power system protection.
IS/IEC 60947–1	General Requirements for Switchgear and Control gear for voltages not exceeding 1000 V.
IS 5082	Wrought Aluminum and Aluminum alloys for electrical purposes.
IS/IEC 60947–5-1	LV switchgear and Control gear Control current devices and switching element.
IS 8623 (3	Specification for factory built assemblies of Switchgear &

parts) / IEC 61439-1&2	Control gear for voltages up to and including 1000 V AC & 1200 V DC.
IS/IEC 60947	Air-Break Switches, air break disconnector, air break disconnector and fuses combination unit for voltage no exceeding 1000V AC or 1200V DC
IEC 60255	Electrical Relays
IS 3043	Code of practice for earthing.
IS 11171	Specification for dry type transformers.
IEC 61850	Communication networks and systems in substations
IS 13703/ IEC60269	HRG Cartridge fuses
IS:3043	Code of practice for earthing.

All outdoor equipment shall be designed for operation in tropical humid climate at the required capacity. The reference environmental parameters are as under:-

Particulars	Condition
Maximum ambient temperature	50^{o}C
Maximum daily average ambient temp	40^{o}C
Maximum yearly weighted average ambient temp	35^{o}C
Minimum ambient air temperature (Cooling)	-5^{o}C
Max. Relative Humidity	95%
Yearly Avg. number of thunder storms	30-50
Average Number of rainy days	60 days
Fog	In winter
Number of months during which topical monsoon prevail	5 months
Dust storms	May not occur
Average Annual rain fall	100 cms.
Maximum wind speed	250 kmph

Technical Parameters

Power Supply (AC SYSTEM)

The Bidder shall provide the complete turnkey design, supply, erection, testing and commissioning of equipment to collect the output of PCU(s) at a common location and step-up to 11kV from where it shall be transmitted to the 11 kV substation at BHU Administrative Block through underground cable. However, the detailed scheme of design lies with the bidder and must submit the same to Employer/Owner for approval prior to construction.

1	Voltage	415V+/-10%,3 Phase, 4 wire, Neutral Solidly Earthed
2	Frequency	50 Hz +/- 5%
3	Combined variation (in volts & frequency)	10% absolute sum

i. Cubicle Data (Bus-bar Rating of Inverter Breaker)

1	Continuous Current rating	As per system requirement and SLD
2	Short time rating where	
	a) Circuit Breaker (CB) is used as incomer	50kA (RMS) for one sec
	b) Fuse protection is used in Incomer	Prospective current of 50KA (RMS) for the fuse clearing time
3	Dynamic Rating where	
	a) Circuit Breaker (CB) is used as incomer	105kA (PEAK)
	b) Fuse protection is used in Incomer	Prospective current of 105kA (PEAK) as limited by fuse
4	Bus bar insulation	
	a) For switchgear	PVC Sleeve insulated

Note: For other switchgear, the bus requirement shall be as per system requirement.

b. Circuit Breaker

1	Type	Air break spring charged stored

		energy type
2	Operating duty	O-3min-OC-3min-OC
3	Symmetrical interrupting	50kA (RMS)
4	Short circuit rating	105kA (PEAK)
5	Short Circuit Breaking current	
	a) AC Component	50kA (RMS)
	b) DC Component	As per IS:13947
6	Short time withstand	50kA(RMS) for one sec
7	Number of auxiliary contact	4 NO & 4 NC

DIGITAL Multifunctional Meter

1	Accuracy class	0.5
2	Voltage ratio	415/110 V

Type Test

- Degree of protection as per relevant IS
- Temperature Rise test (Applicable for Panel having capacity more than 400 A)

Routine test

- Verification of make and rating of each component as per the approved drawing
- Finishing and aesthetic look of the panel.
- Physical verification for the completeness of panel such as Dimensions, Bus-bar arrangement (vertical and horizontal), Cable termination arrangement including Gland Plate arrangement, Earth Bus and earthing of panel including hinges.
- IR-HV-IR test.

ii. HT Switchgear

HT Switchgear shall mean the combination of electrical disconnect switches, fuses or circuit breakers and all associated accessories used to control, protect and isolate electrical equipment on the high voltage side of electrical interconnection.

Codes and Standards

CODE	Relevance
IS: 722	AC electricity meters.
IS: 996	Single phase small AC and universal electrical motors.
IS: 1248	Direct Acting indicating analogue electrical measuring instruments and Accessories
IS: 13947	Degree of protection provided by enclosures for low voltage switchgear and control gear.
IS: 2544	Porcelain post insulators for systems with nominal voltages greater than 1000 Volts.
IS: 2705	Current transformers
IS: 3156	Voltage Transformers
IS: 6005	Code of practice for phosphating of iron and steel.
IEC:61850	Communication Standard for Numerical relays
IS: 9046	AC contactors for voltages above 1000 volts and up to and including 11000 Volts.
IS: 13703	Low voltage fuses
IS: 9385	HV Fuse
IS/IEC: 62271-200	High voltage metal enclosed switchgear and control gear.
IS/IEC: 62271-100	High voltage alternating current circuit breakers.
IS: 9921	A.C. disconnectors (isolators) and Earthing switches for

	voltages above 1000 V
IS: 13118	Specification for high voltage AC circuit breakers.
IEC: 60099-4	Metal oxide surge arrestor without gap for AC system

Technical Parameters

System Parameters		
1	Nominal System Voltage	11 kV
2	Highest System Voltage	12 kV
3	Rated Frequency	50 Hz
4	Number of Phases/Poles	3
5	System Neutral Rating	Solidly grounded
6	Minimum system Fault level	As per system design
7	Short time rating for bus bars, ckt breakers, current transformers and switchgear assembly	12.5 kA (rms)*
8	Dynamic withstanding rating	2.5 times of system fault current
9	Control Supply Voltage	220 V DC/110V DC unearthed
10	Max. Ambient air Temp	50 deg C

*12.5 kA or system requirement whichever is higher

Bus Bar

SYSTEM PARAMETERS		
1	Continuous current rating at 50 deg C	As per requirement
2	Temperature Rise allowed above ambient	40 deg C for plane joints 55 deg C for silver plated joints

Current Transformer

CURRENT TRANSFORMER		
1	Secondary Current	1A
2	Class of insulation	Class E or better
3	Rated output of each	Adequate for the relays and devices connected, but not less than five (5) VA.
4	Accuracy class	
	a) Protection	5P20
	b) Measurement	0.2S
5	Minimum primary earth fault current to be detected by CBCT	3
6	Instrument Security factors for Measurement CTs	5
7	Number of terminals in marshalling box	All terminals of control circuits wired up to marshalling box plus 20% spare terminals

Circuit Breakers

CIRCUIT BREAKERS		
1	The circuit breakers current rating shall be selected from the load current given in SLD which is at an ambient of 50 deg. C.	
2	Short circuit breaker current	11 KV
	A.C. component	12.5 kA or system requirement whichever is higher
	D.C. component	As per IS: 13118 or IEC-62271
3	Short Circuit making current	2.5 times of system fault current

		(peak)
4	Operating Duty	O-3 Sec.-CO-3 Min-CO
5	Total break time	Not more than 4 cycles
6	Total make time	Not more than 5 cycles
7	Operating Mechanism	Motor wound spring charged stored energy type as per IEC-62271

Voltage Transformers

VOLTAGE TRANSFORMERS		
1	Rated voltage factor	2 continuous for all VTs
2	Class of insulation	Class E or better
3	Other parameters	BUS PT-0.5 Class, VA req. adequate for application. Line PT-0.5 Class for sync. / 3P for door interlocks & protection, VA req. adequate for application.
4	One Minute Power frequency withstand voltage for secondary winding	2 kV RMS
5	Number of terminals in control Cabinet	All terminals of control circuits wired up to marshalling box plus 10 terminals spare
6	Partial discharge level	ico Coulombs max.

Switchgear Panel

The switchgear boards shall have a single front, single tier, fully compartmentalized, metal enclosed construction complying with IEC 62271-200, comprising of a row of free standing floor mounted panels.

The circuit breakers and bus VTs shall be mounted on withdrawable trucks which shall roll out horizontally from service position to isolated position. For complete withdrawal from the panel, the truck shall rollout on the floor or shall roll out on telescopic rails. In case, circuit breaker is to be rolled out on telescopic rails, Contractor shall provide suitable trolley for withdrawal and insertion of the truck from and into the panel at each location i.e. switchgear room. Testing of breaker shall be possible in isolated position by keeping the control plug connected.

The trucks shall have distinct SERVICE and ISOLATED positions. It shall be possible to close the breaker compartment door in isolated position to retain the specified degree of protection of switchgear panel. Circuit Breaker rack-in and rack-out from service to test, test to isolated position or vice-versa shall be possible only in the compartment door closed condition.

The switchgear assembly shall be dust, moisture, rodent and vermin proof.

The control/ relay compartments shall have degree of protection not less than IP 5X in accordance with IS/IEC 60947. However, remaining compartments can have a degree of protection of IP 4X. If louvers are provided, shall have very fine brass or GI mesh screen. Tight fitting gourmet/ gaskets are to be provided at all openings in relay compartment. Numerical relays shall be fully flush mounted on the switchgear panels at a suitable height.

The switchgear shall be specially design to withstand internal explosion etc. so that it should not endanger the operating personal while operating the breaker. In addition, pressure relief device shall be provided in each high voltage compartment of a panel for vent out the gases that may be generated in case of fault without spreading to other compartment. The pressure relief device shall not however reduce the degree of protection of panels under normal working condition.

Enclosure shall be constructed with rolled steel sections. The doors and covers shall be constructed from cold rolled steel sheets of 2.00mm or higher thickness. Gland plates shall be 2.5mm thick hot or cold rolled steel section and for non-magnetic material it shall be 3.0mm.

Total height of the switchgear panels shall not exceed 2600 mm. The height of switches, pushbuttons and other hand operated devices shall not exceed 1800mm

and shall not be less than 700mm. Switchgear shall be cooled by natural air flow.

Suitable base frame made out of steel channels shall be supplied along with necessary anchor bolts and other hardware, for mounting of switchgear panels. These should be despatched in advance so that they may be installed and levelled when the flooring is being done.

Circuit Breakers

a. The circuit breakers shall be of Vacuum type.

b. They shall comprise of three separate, identical single pole interrupting units, operated through a common shaft by a sturdy operating mechanism. An arrangement of two breakers in parallel to meet specified current rating shall not be acceptable.

c. Circuit breaker shall be restrike free, stored energy operated, anti-pumping and trip free type. Motor wound closing spring charging shall be provided for each breaker, even if it has built-in mechanical anti-pumping features. During closing, main poles shall not rebound and mechanism shall not require adjustment. Suitable dampers shall be provided to withstand the impact at the end of opening stroke.

d. The operating mechanism shall be such that failure of any auxiliary spring shall not prevent tripping and shall not lead to closing or tripping of circuit breaker. Failure of any auxiliary spring shall also not cause damage to the circuit breaker or endanger the operator.

e. Mechanical indicators shall be provided on the breaker trucks to indicate OPEN/ CLOSED conditions of the circuit breaker and charged/ discharge conditions of the closing spring. An operation counter of breaker shall be visible without opening the breaker compartment door.

f. The closing coil and spring charging motor shall operate satisfactorily at all values of control supply voltage 187-242 V AC/ 93.5-121V DC.

g. The time taken for charging of closing spring shall not exceed 30 seconds. The spring charging shall take place automatically preferably after closing operation. Breaker operation shall be independent of the spring charging motor which shall only charge the closing spring. Opening spring shall get charged automatically during closing operation. As long as power supply is available to the charging motor a continuous sequence of closing and operations shall be possible. One open-close-

open operation of the circuit breaker shall be possible after failure of supply to the motor.

h. The Bidder may note that total break time of the breaker shall not be exceeded under any duty conditions specified such as with the combined variation of the trip coil voltage, pneumatic pressure etc. While furnishing the proof of the total break time of complete circuit breaker, the Bidder may specifically bring out the effect of non-simultaneity between same pole and poles and show how it is covered in the guaranteed total break time.

i. Bidder shall indicate the noise level of breaker at distance of 50 to 150 m from base of the breaker.

j. The circuit breaker will normally be controlled from remote control panels through closing and shunt trip coils. The local control console of relay flush mounted on the switchgear would normally use only for testing of circuit breaker in isolated position and for tripping it in an emergency. The closing and opening of the breaker shall also be possible from laptop through front serial port of the relay to facilitate commissioning activities.

k. 6NO and 6NC auxiliary contacts per pole shall be provided as spare contacts.

l. Each panel shall have two separate limit switches, one for the service position and other for isolated position. Each of these limit switches shall have at least four (4) contacts which shall close in the respective positions.

Numerical Relays and Networking

All circuit breaker feeders shall be provided with communicable numerical relays (IED, i.e. Intelligent Electronic Device) complying with IEC-61850, having protection, control, measurement and monitoring features. These relays shall be networked and suitably interfaced with the Solar SCADA system for dynamic SLD display, status monitoring, measurements, event / alarm displays, reports, etc. The relays shall be flush mounted on panel front with connections from the inside. These numerical relays shall be of types as proven for the application and shall be subject to Employer's/Owner's approval. Numerical relays shall have appropriate setting ranges, accuracy, resetting ratio and other characteristics to provide required sensitivity. All equipment's shall have necessary protections.

The numerical relay shall be capable of measuring and storing values of a wide range of quantities, events, faults and disturbance recording. The alarm/ status of each protection function and trip operation shall be communicated to solar SCADA. The numerical relays shall have built in features / hardware interface to provide such inputs to solar SCADA for analog / digital value.

All relays shall be rated for control supply voltage (AC OR DC) and shall be capable of satisfactory continuous operation between 80-120% of the rated voltage.

Failure of a control supply and de-energization of a relay shall not initiate any circuit breaker operation.

All numerical relays shall have freely programmable optically isolated binary inputs (BI) and potential free binary output (BO) contacts as per the requirement of control schematics. The quantities of such input / outputs shall be finalized during detailed engineering.

All the numerical relays shall have communications on two ports, local front port communication to laptop/desktop and rear port on IEC 61850 to communicate with the interface equipment for connectivity with the Solar SCADA. Latest version of hardware and Software for interfacing the numerical relays with laptop/desktop has also to be provided.

All numerical relays shall have adequate processor memory for implementing the programmable scheme logic required for the realization of the protection/control schemes in addition to the built in protection algorithms.

All numerical relays shall have features for electrical measurements including voltage, current, power (active and reactive), frequency, and power factor and energy parameters. Measurement accuracy shall be 1% of rated RMS current and voltage.

Relays shall have event recording feature, recording of abnormalities and operating

parameters with time stamping. Sequence of events shall 1ms resolution at device level.

Master trip (86) and non 86 trips shall be software configurable to output contacts and no separate master trip relay shall be used.

All numerical relays shall have provision of both current and voltage inputs. Relays shall be suitable for both residually connected CT input as well as CBCT input. Number of CT inputs shall be adequate for protections detailed elsewhere but not less than 4 sets, 3 nos. for phase fault & 1 no. for earth fault. The Numerical relays in the Incomers shall have at least 5 CT inputs. Relays shall be suitable for CT secondary current of 1A. All transformer feeder relays shall have provision for 3 VT inputs. Relays used in incomers, ties and bus couplers shall have provision of two sets of voltage signal inputs for the purpose of synchronization.

All CT terminals on the relays shall be of fixed type suitable for connection of ring-type lugs to avoid any hazard due to loose connection leading to CT open-circuit. In no circumstances Plug In type connectors shall be used for CT / VT connections.

All numerical relay shall have key pad/ keys to allow relay settings from relay front. All hand reset relays shall have reset button on the relay front.

Relays shall have self-diagnostic feature with self-check for power failure, programmable routines, memory and main CPU failures and a separate output contact for indication of any failure.

Relays shall have at least two sets or groups of two different sets of adoptable settings. Relays shall have multiple IEC/ ANSI programmable characteristics.

Design of the relay must be immune to any kind of electromagnetic interference. Vendor shall submit all related type test reports for the offered model along with the offer.

All cards / hardware of numerical relays shall be suitable for operation in Harsh Environmental conditions with respect to high temperature, humidity & dust.

All I/O s shall have galvanic isolation. Analog inputs shall be protected against switching surges, harmonics etc.

Numerical relays shall have feature for Time synchronization through the SCADA System / networking. The resolution of time synchronization shall be +/- 1.0 millisecond or better throughout the entire system.

Relays & Ethernet switches shall be suitable to accept both AC & DC supplies with range 120V or 240V with tolerance of 70 % to 120 % of rated voltage & shall be finalized during detailed engineering.

Disturbance Record waveforms, event records & alarms shall be stored in Non-volatile memory and failure of control supply shall not result in deletion of any of these data.

Bus-bars and Insulators

All bus bar and jumper connections shall be of high conductivity aluminium alloy. They shall be adequately supported on insulators to withstand electrical and mechanical stresses due to specified short circuit currents.

Bus bar cross-section shall be uniform throughout the length of switchgear. Bus bars and other high voltage connection shall be sufficiently corona free at maximum working voltage.

Contact surfaces at all joints shall be silver plated or properly cleaned and non-oxide grease applied to ensure an efficient and trouble free connection. All bolted

joints shall have necessary plain and spring washers. All connection hardware shall have high corrosion resistance. Bimetallic connectors or any other technically proven method shall be used for aluminium to copper connections.

Bus bar insulators shall be of arc and track resistant, high strength, non-hygroscopic, non-combustible type and shall be suitable to withstand stresses due to over-voltages, and short circuit current. Bus bar shall be supported on the insulators such that the conductor expansion and contraction are allowed without straining the insulators.

Successful Bidder shall furnish calculation establishing adequacy of bus bar sizes for the specified continuous and short time current ratings.

Earthing and Earthing Devices

A copper / galvanized steel earthing bus of suitable cross section to carry the short circuit and short time fault currents to earth shall be provided at the bottom and shall extend throughout the length of each switch board. It shall be bolted/ welded to the framework of each panel and each breaker earthing contact bar.

All non-current carrying metal work of the switchboard shall be effectively bonded to the earth bus.

All metallic cases of relays, instruments and other panel mounted equipment shall be connected to earth by independent stranded copper wires of size not less than 2.5 sq. mm. Insulation colour code of earthing wires shall be green. Earthing wires shall be connected to terminals with suitable clamp connectors and soldering shall not be acceptable. Looping of earth connections which would result in loss of earth connection to other devices, when a device is removed is not acceptable. However, looping of earth connections between equipment to provide alternative paths of earth bus is acceptable.

VT and CT secondary neutral earthing shall be at one place only on the terminal

block. Such earthing shall be made through links so that earthing of one secondary circuit may be removed without disturbing the earthing of other circuits.

Interlocks shall be provided to ensure that all safety features are taken care off. Details of the safety feature in-built shall be provided in the technical bid and technical data sheet.

All hinged doors shall be earthed through flexible earthing braid of suitable size.

Instrument Transformers

All current and voltage transformers shall be completely encapsulated cast resin insulated type, suitable for continuous operation at the ambient temperature prevailing inside the switchgear enclosure, when the switchboard is operating at its rated load and the outside ambient temperature is 50 deg. C. The class of insulation shall be E or better.

All instrument transformers shall withstand the power frequency and impulse test voltage specified for the switchgear assembly.

Current transformers may be multi or single core and shall be located in the cable termination compartment. All voltage transformers shall be single phase type and shall be supplied with a common marshalling box for a set of three single phase units.

Polarity marks shall indelibly be marked on each instrument transformer and at lead terminals at the associated terminal block.

Surge Arrestor

The surge arrestors shall be of metal oxide, gapless type generally in accordance

with IEC 60099-4 and suitable for indoor duty. These shall be mounted within the switchgear cubicle between line and earth, preferably in the cable compartment. Surge arrestor selected shall be suitable for un-earthed system and rating shall be in such a way that the value of steep fronted switching over voltage generated at the switchgear terminals shall be limited to the requirements of switchgear.

Control Supply

Each switchboard shall be provided at least two (02) Nos of 110/220V DC feeders for the control supply.

Each sub circuit shall have separate fuses. Fuse size shall be determined so as to achieve selective clearance between main circuit and sub circuit in case of fault. Potential circuits for protection and metering shall also be protected by separate fuse.

All fuses shall be of HRC link type conforming to IS: 13703 / 9385 mounted on suitable fuse bases. Fuses shall have operation indicators for indicating blown fuse condition. Fuse carrier base shall have imprints of the fuse rating and voltage. All accessible live connection to fuse bases shall be adequately shrouded.

Space Heater

Each switchgear panel shall be equipped with thermostatically control space heater(s), suitably located in breaker and cable compartments to prevent condensation within the enclosure. The space heater shall be connected to 240v single phase AC auxiliary supply available in the switchgear through switches and fuses provided separately for each panel.

In addition, a single phase 50 Hz AC plug point shall be provided in the interior of each cubicle with ON-OFF switch for connection of hand lamp.

Switchgear Wiring

All internal wiring shall be carried out with 650V grade, single core, 1.5 sq.mm stranded copper wires having minimum of seven strands per conductor and colour coded, PVC insulation, and CT circuits shall be wired with 2.5 sq.mm wires. Extra flexible wires shall be used for wiring between fixed and moving parts such as hinged doors.

All wiring shall be properly supported neatly arranged, readily accessible and securely connected to equipment terminals and terminal blocks. Wiring troughs or gutters be used for this purpose. Internal wire terminals shall be made with solderless crimping type tinned copper lugs which shall firmly grip the conductor. Insulation sleeves shall be provided over the exposed parts of lugs.

Printed single tube ferrules marked to correspond with panel wiring diagram shall be fitted at both ends of each wire. The wire identification making shall be in accordance with IS: 375. Red Ferrules should be provided on trip circuit wiring.

Power Cable Termination

Cable termination compartment shall receive stranded aluminium conductor, XLPE insulated, shielded, armoured/ unarmoured, PVC sheathed, single/three core, unearthed/earthed grade power cable.

Minimum clearance of about 600mm shall be kept between the cable lug bottom ends and gland plates for stress cone formation for XLPE cables. Interphase clearance in the cable termination compartment shall be adequate to meet electrical and mechanical requirements besides ease of connection and disconnection of cables.

Cable termination compartment shall have provision for termination of power cables of sizes as finalize during detail engineering with removable undrilled gland plates. For all single core cable gland plates shall be nonmagnetic material. Cable entry shall be from bottom.

Name Plates and Labels

Each switch board shall have a name plate for its identification. All enclosure mounted equipment hall be provided with individual engraved name plates for clear equipment identification. All panels shall be identified on front as well as backside by large engraved name plates giving the distinct feeder description along with panel numbers. Back side name plates shall be fixed in panel frame and not on the rear removable cover.

Tests

Type Tests

All equipment to be supplied shall be of type tested design. During detailed engineering, the contractor shall submit for Owner's approval the reports of all the following type tests carried out not earlier than ten years prior to the date of bid opening. These reports should be for the test conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

A. Reports of the following type tests carried out on circuit breaker/ circuit breaker panels, of each voltage class and current rating shall be submitted:
   1) Short circuit duty test on circuit breaker, mounted inside the panel offered along with CTs, bushing and separators
   2) Short time withstand test on circuit breaker, mounted inside panel offered together with CTs, bushings and separators.
   3) Power frequency withstand test on breaker mounted in side panel.
   4) Lightning impulse withstand test on breaker mounted in side panel.
   5) Temperature rise test on breaker and Panel together
   6) Internal Arc Test as per IEC 62271-200
   7) Measurement of resistance of main circuit.
   8) Mechanical operation test.

B. Short circuit withstand test of earthing device (truck / switch).

ROUTINE TESTS: All acceptance and routine tests as per the specification and relevant standards IEC 62271-200 & IEC 62271-100 shall be carried out. Charges for these shall be deemed to be included in the equipment price.

COMMISSIONING CHECKS/TEST: After installation of panels, power and Control wiring and connections, Contractor shall perform commissioning checks as listed below to verify proper operation of switchgear / panels and correctness of all equipment in all respects. In addition, the Contractor shall carry out all other checks and tests recommended by the manufacturers.

GENERAL

a. Check name plate details according to specification.
b. Check for physical damage
c. Check tightness of all bolts, clamps and connecting terminals
d. Check earth connections.
e. Check cleanliness of insulators and bushings
f. Check heaters are provided
g. H.V. test on complete switchboard with CT & breaker in position.
h. Check all moving parts are properly lubricated.
i. Check for alignment of bus bars with the insulators to ensure alignment and fitness of insulators.
j. Check for interchange ability of breakers.
k. Check continuity and IR value of space heater.
l. Check earth continuity for the complete switchgear board.

Circuit Breakers

a. Check electrical and mechanical interlocks provided.

b. Checks on spring charging motor, correct operation of limit switches and time of charging
c. All functional checks.

Current Transformers

a. IR Value between windings and winding terminals to body.
b. Polarity tests.
c. Ratio identification checking of all ratios on all cores by primary Injection of current.
d. Magnetisation characteristics & secondary winding resistance.
e. Spare CT cores, if any to be shorted and earthed.

Voltage Transformers

a. Insulation resistance test.
b. Ratio test on all cores.
c. Polarity test.
d. Line connections as per connection diagram.

Cubicle Wiring

a. Check all switch developments.
b. It should be made sure that the wiring is as per relevant drawings.
c. All interconnections between panels shall similarly be checked.
d. All the wires shall be checked for IR value to earth.
e. Functional checking of all control circuit e.g. closing, tripping interlock, supervision and alarm circuit including proper functioning of component / equipment.
f. Check terminations and connections.
g. Wire ducting.

b. Inverter Transformer and Auxiliary Transformer

i. Technical Requirements

Sr. No.	Parameters	INVERTER TRANSFORMER	AUXILIARY TRANSFORMER
1.	VA Rating & Quantity	As per system requirement and SLD	
2.	Voltage Ratio (KV)	As per system requirement and SLD	
3.	Duty, Service & Application	Continuous Solar Inverter application and converter Duty (outdoor)	Continuous application (Outdoor)
4	Winding	As per SLD	2
5	Frequency	50 Hz	50Hz
6	Nos. of Phase	3	3
7	Vector Group & Neutral earthing	As per system/inverter manufacturer requirement and SLD	
8	Cooling	ONAN	ONAN
9	Tap Changer	OCTC , No. of steps shall be as per the SLD and system requirement	
10	Impedance at75 ^{o}C	As per Inverter Manufacturer requirement and SLD	As per system requirement and SLD
	Principal Tap		
	Other Taps		
11	Permissible Temperature rise over an ambient of 50 ^{o}C (irrespective of tap)		
	Top Oil	50deg. C	50deg. C
	Winding	55deg. C	55deg. C
12	SC withstand time (thermal)	2 Sec.	2 sec.
13	Fault Level & Bushing CT	As per system requirement and SLD	
14	Termination	As per system requirement and SLD	

15	Bushing rating, Insulation class (Winding & bushing)	As per relevant IS/IEC(However Inverter Transformer LV side winding & bushing insulation class shall be of at least 3.6 kV)
16	Noise level	AS PER NEMA TR-1
17	Loading Capability	Continuous operation at rated power on any TAP with voltage variation of +/-10%, also transformer shall be capable of being loaded in accordance with IS: 6600/IEC60076-7
18	Flux density	Not to exceed 1.9 Wb/sq.m. at any tap position with +/-10% voltage variation from voltage corresponding to the tap. Transformer shall also withstand following over fluxing conditions due to combined voltage and frequency fluctuations: a) 110% for continuous rating. b) 125% for at least one minute. c) 140% for at least five seconds. Bidder shall furnish over fluxing char. up to 150%
19	Air Clearance	As per CBIP

* Single Line Diagram (SLD) will be finalized during detailed engineering.

Note: -

- Auxiliary transformers shall be suitable for 3 phase, 4 wire system with additional LVN bushing for equipment earthing.
- Inverter Transformer shall have Shield winding between LV & HV windings. Each LV winding must be capable of handling non- sinusoidal voltage with voltage gradient as per relevant applicable standards. Also shield winding shall be taken out from tank with separate connection with 2 nos. shield bushings and same shall be brought down along

with support insulator from tank & copper flat up to the bottom of the tank for independent grounding.

- Vector group of inverter transformer shall be as per the inverter manufacturer requirement.
- Auxiliary Transformer up to and including 100 KVA can be either Oil filled or Dry Type (refer relevant clauses for their detail specification).
- Transformer shall be designed for at least 5% total harmonic distortion to withstand distortion generated by the inverter as well as possible outside harmonics from the network.

ii. **Codes and Standards**

Standard	Relevance
IS:2026, IS:6600, IEC:60076	Specification of Power Transformers
IS:2099, IEC:60137	Bushings for alternate voltage above 1000V
IEC 60296	Insulating oil
IS:2705,IEC60185	Bushing CTs
IS: 3639	Fittings and accessories for power Transformer
Indian Electricity Act 2003, BEE Guideline 3 star or better & CEA notifications	

iii. Constructional Details

Windings

a. The bidder shall ensure that windings of all transformers are made in dust proof & conditioned atmosphere.
b. The conductors shall be of electrolytic grade copper free from scales & burrs.
c. All windings of the transformers shall have uniform insulation.
d. Tapping shall be so arranged as to preserve the magnetic balance of the transformer at all voltage ratio.

Core

a. The core shall be constructed from non-ageing, cold rolled, super grain oriented silicon steel laminations equivalent to M4 grade steels or better.
b. Core isolation level shall be 2 kV (rms.) for 1 minute in air.
c. Adequate lifting lugs will be provided to enable the core & windings to be lifted.

Insulating oil

No inhibitors shall be used in the transformer oil. The oil supplied with transformers shall be new and previously unused and must conform to following while tested at supplier's premises and shall have following parameters.

S.No.	Properties	Permissible values
1	Kinematic Viscosity, mm^2/s	=<12 at 40 deg.C =<1800 at (-)30 deg.C
2	Flash Point,deg. C	>=140 deg.C
3	Pour point, deg. C	=<(-)40 deg. C
4	Appearance	Clear, free from sediment and suspended matter
5	Density kg/dm3 at 20 deg. C	=<0.895
6	Interfacial Tension N/m at 25 deg. C	>=0.04
7	Neutralisation value, mgKOH/g	=< 0.01
8	Corrosive sulphur	Non Corrosive
9	Oxidation Stability -Neutralization value, mgKOH/g -Sludge, % by mass	 =<1.2 =<0.8
10	Breakdown voltage As delivered, kV After treatment, kV	 >=30 >=70
11	Water content mg/kg	=< 30 in bulk supply =<40 in drum supply

12	Anti-oxidants additives	Not detectable
13	Dissipation factor, at 90deg. C And 40 Hz to 60 Hz	=<0.005
14	PCA content	=<1%
15	Impulse withstand Level, kVp	>=145
16	Gassing tendency at 50 Hz after 120 min, mm^3/min	≤ 5

Bushings

a. Bushing below 52KV shall be oil communicating type with porcelain insulator.
b. No arcing horns to be provided on the bushings.
c. Inverter transformer LV bushing palms shall be silver/tin plated.

Bushing CTs

a. They shall be of adequate rating for protection as required, WTI etc. All CTS (except WTI) shall be mounted in the turret of bushings.
b. All CT terminals shall be provided as fixed type terminals on the Marshalling box to avoid loose connection leading to CT opening. Plug in type connectors shall be used for CT.

Valves

a. All valves up to and including 50 mm shall be gun metal or of cast steel. Sampling & drain valves should have zero leakage rate.

Gaskets

a. Gasket shall be fitted with weather proof, hot oil resistant, rubberized cork gasket.
b. If gasket is compressible, metallic stops shall be provided to prevent over compression.
c. The gaskets shall not deteriorate during the life of transformer if not opened for maintenance at site. All joints flanged or welded associated with oil shall be such that no oil leakage or sweating occurs during the life of transformer. The quality of these joints is considered established, only if the joints do not exhibit any oil leakage or sweating for a continuous period of at least 3 months during the guarantee period. In case any sweating / leakage is

observed, contractor shall rectify the same & establish for a further period of 3 months of the same. If it is not established during the guaranteed period, the guaranteed period shall be extended until the performance is established.

Testing and Inspection

In case the bidder/contractor has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit the type test reports to the Owner/Employer for waiver of conductance of such type test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

In case the Bidder is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests under this contract at no additional cost to the Owner/Employer and submit the reports for approval.

Routine Tests

a. All routine test shall be carried out in accordance with IEC 60076 & IEC 60076-1.
b. Magnetic Balance and Magnetising Current Test
c. Measurement of no load current with 415 V, 50 Hz AC supply
d. Load Loss & Short Circuit Impedance Measurement on principal & Extreme taps
e. Measurement of capacitance & tan delta to determine capacitance between winding & earth.
f. Induced overvoltage test.
g. IR measurement on wiring of Marshalling Box.

Type Test

Type test shall be carried out on one transformer of each rating.

a. Lightning impulse (Full & Chopped Wave) test on windings (as per IEC 60076-3)
b. Temperature Rise test at a tap corresponding to maximum losses as per IEC 60076. Gas Chromatography shall be conducted on oil sample taken before & immediately after Temperature Rise test. Gas analysis shall be as per IS:

9434 (based on IEC: 60567), results will be interpreted as per IS: 10593 (based on IEC:60599).

c. Measurement of harmonics of no load current (special test)
d. Measurement of acoustic noise level as per NEMA TR-1 (special test).
e. Tank Vacuum & Pressure Test (as per CBI norms)

NOTE: -

i) All the type and special tests shall be conducted after performing Short Circuit Test. If Tank Vacuum & Pressure Test is to be carried out then it shall be conducted before SC test.

ii) Inverter Transformer LV winding Di-electric tests shall be carried out corresponding to levels (as per IEC 60076) for 3.6 kV class.

iii) Type and Special tests are not applicable in case of auxiliary transformers of rating including 100 KVA and below.

Transformer efficiency shall be as per Central Electricity Authority (Technical Standards for Construction of Electrical Plants and Electrical Lines) regulation, 2010.

Name plate and Markings

a. Rating plate

- Name of manufacturer
- Serial number
- Year of manufacture
- Number of phases
- KVA or MVA rating
- Frequency
- Voltage ratings.
- Tap voltages.
- Connection diagram.
- Cooling class
- Rated temperature in °C
- Phasor or vector diagram
- % impedance between primary and secondary and between primary
- Approximate mass or weight of the transformer

- Type of insulating liquid.
- Conductor material of each winding.
- Oil volume (of each transformer Container/Compartment)

Valve schedule Plate

The name plate shall contain the information of all the valves, their locations, quantities and schematics for the valve.

OCTC plate

- Type
- Serial number
- Year of manufacture
- Phase
- Frequency
- Steps (Number)
- Steps voltages.
- Control voltage.
- Weight with and without oil

Marshalling Box

- Name of manufacturer
- Serial number
- Year of manufacture
- Purchase order No.
- Engraved drawing of control circuit, CT/ PT circuit and TB.

Oil filling instruction plate of conservator

- Step wise process for filling the oil in conservator

c. Earthing Of PV Arrays

i. Each Module Mounting Structure (MMS), SPV Module frames, mounting arrangement for String Monitoring Boxes, Metallic Junction Boxes, Metal frames/Panel, Metallic Pipes of the solar array shall be effectively earthed by two separate and distinct connections to earthing system. Earthing system for solar

array shall consist of earth mat/Earth grid to be laid at the suitable depth below the ground. Earth mat shall be a mesh of interconnected Galvanizing Steel (GS) flat laid in the solar farm for the purpose of earthing/grounding. Equipment and structure in the solar farm shall be earthed in compliance to the IS: 3043 (Code of Practice for Earthing) and Indian Electricity Rules/Acts.

ii. The earthing system shall be designed with consideration of the earth resistivity of the project area. The earth resistivity values shall be measured prior to designing the earthing system. Unless otherwise specified, earthing system shall be in accordance with IS: 3043 and IEEE 80, Indian Electricity Rules, Codes of practice and regulations existing in the location where the system is being installed.

iii. The Contractor shall furnish the detailed design and calculations for Owner's approval as per IEEE80-2000 to determine the number of earth pit and size of earth mat conductor.

iv. Each PV Module frame shall be earthed in accordance with module manufacturer guidelines.

v. Earth pit shall be constructed as per IS: 3043. Electrodes shall be embedded below permanent moisture level. Minimum spacing between electrodes shall be 600mm. Earth pits shall be treated with salt and charcoal if average resistance of soil is more than 20 ohm meter.

vi. Method and practice of laying of earthing conductor, earth pits and riser not mentioned herewith but bidders will submit detail drawing/sketch with write up for uniform implementation at site.

vii. Based on the design of detail engineering, contractor shall have to arrange additional earth pit as mentioned below:

Earth pit for earthing of Inverter Transformer Shield. Number of shield earth pit shall be minimum two for each transformer. Shield earth pit shall be connected to inverter transformer shield bushing conductor with copper flat. Size of Cu flat shall be decided during detailed engineering but shall not be less than 25X6 Cu flat. Contractor has to comply with the guidelines of

Inverter Transformer/Inverter manufactures (if any) for shield earthing.

Electronic/Isolated earth pit for SCADA/Electronic devices. No. and location of electronic earth pit shall be decided during detailed engineering however minimum no. of electronic earth pit shall be equal to the total Nos. of inverter rooms, pooling switchgear/s and/or Main control room.

d. Lightning Protection System

i. Codes and Standard

IS: 2309	Code of Practice for the protection of building and allied structures against lightning.
NFC 17-102 (Latest revision)	Protection from direct lightning stroke with Early Streamer Emission air terminal (ESEAT).

Lightning system shall comprise of air terminations, down conductors, test links, earth electrode etc. as per approved drawings.

Protection Level (i.e. level – I, II, III) should be site specific.

Necessary foundation / anchoring for holding the lightning conductor in position to be made after giving due consideration to shadow on PV array, maximum wind speed and maintenance requirement at site in future.

The Bidder shall submit the drawings, calculations and detailed specifications of the PV array lightning protection equipment to Employer/Owner for approval before installation of system.

ESE air terminal shall be type tested in any national/ international approved lab for advance triggering time (ΔT) and lighting Impulse current test and type test report shall be submitted for approval.

Each ESE air terminal shall be provided with separate earthling termination and test link for equipotential bonding of lighting protection system as per OEM guidelines/ NFC 1ESE air terminal shall be equipped with lightning stroke counter to be fixed at suitable height in serial on the down conductor.

The lightning conductor shall be earthed through flats and connected to the grounding mats as per applicable Indian Standards with earth pits. Three

earth pits shall be provided for each lightning arrestor.

Contractor needs to provide the lightning protection for each inverter, Switchyard building (if applicable) and MCR building in accordance to IS: 2309.

e. Metering System

i. ABT energy meter shall be provided as approved by state Utility under the metering scheme, to measure the delivered quantum of energy to the grid for sale. The responsibility of arranging for the meter, its inspection/calibration/testing charges etc. rests with the Bidder. All charges incurred on Meter testing, shall be borne by the Bidder. ABT energy metering system is to be approved by state utility.

ii. Meter must be provided with the necessary data cables.

iii. ABT compliant meters are to be provided at the interface points as per SERC regulation to measure import and export of energy.

iv. Interface metering shall conform to the Central Electricity Authority (Installation and Operation Meters) Regulation 2006 and amendment thereof Commercial settlement of solar Photovoltaic Grid Interactive based power project as well as any state regulations.

v. Meter shall be suitable for interfacing for synchronizing the built-in clock of the meter by GPS time synchronization equipment either through a synchronization pulse received from the time synchronization equipment or through a remote PC synchronized to GPS clock.

vi. All charges for testing and passing of the meter with relevant government agency shall be borne by Contractor, the Employer/Owner will assist Bidder for necessary document as and when required. Bidder has to intimate the required documents at least 7 days prior of such requirements.

vii. ABT compliant Energy Meters shall have technical specification as given below (not limited to specified requirement, Bidder can provide Meter with latest facilities):

Meters shall be microprocessor-based conforming to IEC 60687 / IEC 6205211/ IEC 62053-22 / IS 14697

Meters shall carry out measurement of active energy (both import and export) and reactive energy (import) by 3-phase, 4 wire principle suitable for balanced/ unbalanced 3 phase load.

Meters shall have an accuracy of energy measurement of at least Class 0.2 for active energy and at least Class 0.5 for reactive energy according to IEC 60687, and shall be connected to Class 0.2 CT cores and Class 0.2 VT windings or as per state grid regulations.

The active and reactive energy shall be directly computed in CT & VT primary ratings.

Meters shall compute the net MWh and MVArh during each successive 15-minute block metering interval along with a plus/minus sign, instantaneous net MWh, instantaneous net MVARh, average frequency of each 15 minutes, net active energy at midnight, net reactive energy for voltage low and high conditions at each midnight.

Each energy meter shall have a display unit with a seven digit display unit. It shall display the net MWh and MVARh with a plus/minus sign and average frequency during the previous metering interval; peak MW demand since the last demand reset; accumulated total (instantaneous) MWh and MVARh with a plus/minus sign, date and time; and instantaneous current and voltage on each phases.

All the registers shall be stored in a non-volatile memory. Meter registers for each metering interval, as well as accumulated totals, shall be downloadable. All the net active/reactive energy values displayed or stored shall be with a plus /minus sign for export/import.

At least the following data shall be stored before being over-written for the following parameters.

S. No.	Parameters	Details	Min No of days
1	Net MWh	15 min. block	90 days in meter
2	Average Frequency	15 min. block	90 days in meter
3	Net MVARh for > 103%	15 min. block	90 days in meter
4	Cumulative net MWh	At every mid night	30 days in meter/ 90 days in PC
5	Cumulative net MVARh for >103%	At every mid night	30 days in meter/ 90 days in PC
6	Date & time blocks for VT failure on any phase		

Shall have a built in clock and calendar with an accuracy of less than 15 seconds per month drift without assistance of external time synchronizing pulse.

Date/time shall be displayed on demand. The clock shall be synchronized by GPS time synchronization equipment existing at the station provided by Bidder.

The meter shall be suitable to operate with power drawn from the VT supplies. The burden of the meters shall be less than maximum 2VA.

The power supply to the meter shall be healthy even with a single- phase VT supply. An automatic backup, in the event of non-availability of voltage in all the phases, shall be provided by a built in long life battery and shall not need replacement for at least 10 years with a continuous VT interruption of at least 2 years. Date and time of VT interruption and restoration shall be automatically stored in a non-volatile memory.

Even under the absence of VT input, energy meter display shall be available and it shall be possible to download data from the energy meters.

Meters shall have an optical port on the front of the meter for data collection from either a hand held meter reading instrument (MRI) having a display for energy readings or from a notebook computer with suitable software.

The meter shall have means to test MWh and MVARh accuracy and calibration at site in-situ and test terminal blocks shall be provided for the same.

viii. The Employer/ Owner shall have the right to carry out surprise inspections of the

Metering Systems from time to time to check their accuracy.

f. **SCADA**

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

ii. Bidder shall include in his proposal all the 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.

iii. SCADA System shall have the provision to perform the following functions:

Real-time acquisition and display of data, status, alarms and trends.

Display of status of major equipment in Single Line Diagram (SLD) format

Control of switchgears and Inverters

Display and storage of measured values

Display and storage of derived/calculated/integrated values

Display and Storage of Alarm, Event and Trends

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

Generate, store and retrieve user configurable periodic reports

Remote monitoring of essential parameters on the web using standard modem (Internet connection for transmitting data over world wide web shall be taken by Contractor in the name of Owner for O & M period. All associated charges under this head shall be borne by the Contractor).

Control and monitoring of status of all Breakers and Inverters

System self-supervision

iv. It shall be possible to remove/replace redundant controller or various modules (like any I/O module, interface module, etc.) from its slot for maintenance purpose without switching off power supply to the corresponding rack without releasing any spurious signal to controller and causing disturbance or loss of controller functions for other controller.

v. The Control system shall be designed to operate in non-air conditioned area. However contractor shall provide a Package/Split AC of suitable capacity decided by heat load requirement in SCADA room at Main Control Room.

Programmable Logic Based Control System at Main Control Room:

Bidder shall provide PLC based SCADA at main control room. For other locations such as Inverter room, Sub Pooling Switchgear Room (if applicable) bidder may offer IO modules/RTU/PLC for completeness of SCADA.

PLC Processor

The processor unit shall be capable of executing the following functions: -

a. Receiving binary and analog signals from the field and providing command output to MCC/SWGR/Drive etc. through Input / Output modules and operator initiated commands from HMIS / control panel.
b. Implementing all logic functions for control, protection and annunciation of the equipment and systems.
c. Providing supervisory information for alarm, various types of displays, status information, trending, historical storage of data etc.
d. Performing self-monitoring and diagnostic functions

PLC unit shall be provided with two 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. 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. The memory capacity shall be sufficient for the complete system operation and have a capability for at least 20% 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 72 hours. The batteries shall be lithium or Ni-Cd type.

Priority of different comments shall be as follows:

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.

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 programme.

The SCADA shall be OPC 2.05a or later version compliant and implement an OPC- DA 2.05a (or later version) server as per the specification of OPC Foundation. All data should be accessible through this OPC server. SCADA shall have OPC connectivity for other systems.

Graphical Interface Unit (GIU) / Operator work station (OWS) shall perform control, monitoring and operation of all devices interacting with PLC based control system.

All frequently called important functions including major displays shall be assigned to dedicated function keys on a soft keyboard for the convenience of the operator for quick access to displays & other operator functions. Navigation from one display to any other should be possible efficiently through paging soft keys as well as through targets defined on the displays. There should be no limitation on number of such targets.

The system shall have built-in safety features that will allow/disallow certain functions and entry fields within a function to be under password control to protect against inadvertent and unauthorized use of these functions. The system security shall contain various user levels with specific rights as finalized by the Employer/Owner during detailed engineering. However, no. of user levels, no. of users in a level and rights for each level shall be changeable by the programmer (Administrator).

GIU shall be ruggedly designed to withstand hard environments like high temperature, shock and vibration.

Bidder has to provide suitable hardware and software based firewall for network security to restrict unauthorized access to HMI/Solar SCADA PCs and system.

vi. Software Requirement

All necessary software required for implementation of control logic, operator station displays / logs, storage & retrieval and other functional requirement shall be provided.

Industry standard operating system like WINDOWS (latest version) etc. to ensure openness and connectivity with other system in industry shall be provided. SCADA system shall support following standard protocols (included but not limited to) to communicate with different sub system/Devices:

i. Modbus (TCP/IP, RTU, ASCII)
ii. Sub Station Protocol like IEC-61850
iii. IEC 60870 -5-101//104
iv. Any other protocol on which the offered equipment (by Contractor) will communicate with SCADA.

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

g. Data Communication System (DCS) at Main Control Room

The DCS shall have the following minimum features:

vii. Redundant communication controllers shall be provided to handle the communication between I/O Modules (including remote I/O) and PLCs and between PLCs and operator work station.

viii. The design shall be such as to minimize interruption of signals. It shall ensure that a single failure anywhere in the media shall cause no more than a single message to be disrupted and that message shall automatically be retransmitted. Any failure or physical removal of any station/module connected to the system bus shall not result in loss of any communication function to and from any other station/module.

ix. Built-in diagnostics shall be provided for easy fault detection. Communication error detection and correction facility (ECC) shall be provided at all levels of communication. Failure of one bus and changeover to the standby system bus shall be automatic and completely bump less and the

same shall be suitably alarmed/logged.

x. Data transmitting speed shall be sufficient to meet the responses of the system in terms of displays, control etc. plus 25% spare capacity shall be available for future expansion.

xi. Contractor shall employ redundant Fibre optic backbone (Ring topology or better) for data communication between Inverter rooms and main control room.

xii. The Contractor shall furnish details regarding the communication system like communication protocol, bus utilization calculations etc.

xiii. Operator Interface Displays/Logs/Reports

xiv. Suitable Operator Interface Displays/Logs/Reports for control operation & monitoring shall be provided. The details shall be furnished and finalized during detailed engineering stage.

xv. Control & Power Supply Scheme

Contractor shall provide the UPS/DC Power supply of suitable rating to cater all the load requirements of SCADA system and its auxiliaries. The power backup for the entire system should be at least for 02 hours.

xvi. Control Cabinets / Panels / Desks at Main Control Room

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.

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**.**

xvii. 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.

xviii. Hardware at MAIN CONTROL ROOM

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.

All the peripherals shall conform to the following minimum requirement but the exact make & model shall be as approved by Employer/Owner during detailed engineering. The LAN to be provided shall support TCP/IP protocol (Ethernet connectivity) with OPC RDI for interface with PLCs/other systems and shall have data communication speed of min. 100 MBPS. All network components of LAN and Workstations shall be compatible to the LAN, without degrading its performance.

Processor	**64 Bit**
Hard disk	500 GB -RAID 1
Memory	4 GB RAM upgradable to 8 GB
Monitor	Min 22" LCD Flat Monitor with non-interfaced refresh rate min. 75 Hz. Communication port-2 Serial bus, one parallel Dual 10/100/1000 Mbps. Ethernet Graphic Memory=16 MB Expansion slot=3
Removable Bulk Storage Media for above (with each server/ work-station)	10 nos.
DVD R/W	16x or higher
Intelligent UPS (on line) with remote monitoring for each workstation/ server	1 no. with 30 mins. Battery backup on machine load
Keyboard	ASCII
Pointing Device	Mouse

Colour Laser Printer	Heavy duty type with resolution of 600 dpi Resolution

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.

h. **Plant Illumination System**

xix. Design Philosophy

A comprehensive illumination system shall be provided in the entire project. Each building shall be provided with adequate light fittings, 6A/16A socket, etc.

All outdoor lighting system shall be automatically controlled by synchronous timer or photocell. Provision to bypass the timer or photocell shall be provided in the panel.

xx. Lighting System Description for CMCS and Inverter Room

Normal AC Lighting System: AC lighting system 415V, 3Phase, 4wire, will be fed from lighting panels Control Board (LPs) which in turn will be fed from the lighting distribution boards (LDBs) of AC Switch board MCC.

Emergency AC Lightning System: The emergency lighting system consisting of 20% of the lights shall be fed from UPS DB or DCDB as per scheme adopted by the Contractor. Load of the same has to be considered **for UPS/ Battery and charger sizing.**

Lighting Fixture, Lamps & Accessories

All lighting fixtures and accessories shall be designed for continuous operation for its life under atmospheric conditions existing at site.

AC lighting fixtures and accessories shall be suitable for operation on 240 V, AC, 50 Hz supply with supply voltage variation of +/-10%, frequency variation of +/-5% and combined voltage and frequency variation (absolute sum) of 10% DC lighting fixtures and accessories shall be suitable for operation on 220 V, with variation between 190 V & 240

Codes and Standards

16101:2012	General Lighting. LEDs and LED modules Terms and definitions
16102(Part 1):2012	2012 Self Ballasted LED Lamps for General Lighting Services. Part-1 Safety Requirements.
16102(Part 2):2012	Self-Ballasted LED Lamps for General lighting Services. Part-2 Performance Requirements.
16103(Part I):2012	LED modules for General lighting Safety Requirements.

Junction Boxes, Conduits, Fitting & Accessories

a. Junction box for indoor lighting shall be made of fire retardant material. Material of JB shall be Thermoplastic or thermosetting or FRP type.

b. Junction boxes for street lighting poles and lighting mast if applicable, shall be deep drawn or fabricated type made of min. 1.6 mm thick CRCA Sheet. The box shall be hot dip galvanized. The degree of protection shall be IP55.

c. All switches and receptacles up to 16A shall be modular type. These shall be provided with pre-galvanized/galvanized modular switchbox.

d. Heavy duty PVC conduits conforming to IS: 9537 Part-III along with various accessories shall be used for indoor wiring in the buildings. These conduits shall be concealed in the wall/floor/roof. However, in PEB's, conduits can be fixed on surface.

e. Pull out boxes shall be provided at suitable interval in a conduit run. Boxes shall be suitable for mounting on Walls, Columns, etc. Pull-out boxes shall have cover with screw. Pull out boxes used outdoor shall be weather proof type suitable for IP: 55 degree of protection and those used indoor shall be suitable for IP: 52 degree of protection.

Lighting Wires

Lighting wires shall be 1100 V grade, light duty PVC insulated unsheathed, stranded copper/aluminium wire for fixed wiring installation. Colour of the PVC insulation of wires shall be Red, Yellow, Blue and Black for R, Y, B phases & neutral, respectively and white & grey for DC positive & DC negative circuits, respectively. Minimum size of wire shall not be less than 1.5. Sq.mm. for copper and 4 sq.mm. for aluminium.

Lighting Poles

The Street Light system and peripheral lighting shall be designed generally in line with design guidelines. Height of the poles should be chosen so as not to affect working of Solar panels. The poles shall be hot-dip galvanized as per relevant IS2629/ IS2633/ IS4759. The average coating thickness of galvanizing shall be min. 70 micron. The System shall be capable of withstanding the appropriate wind load etc. as per IS 875 considering prevailing soil/ site condition considering all accessories mounting on pole.

The street light poles shall have loop in loop out arrangement for cable entry and light fixture / wiring protected with suitably rated MCB.

Hot dipped Galvanized with 80 mm thickness hexagonal/Octagonal lighting pole with inbuilt JB shall also be acceptable

Earthing

Lighting panels, etc. shall be earthed by two separate and distinct connections with earthing system. Switch boxes, junction boxes, lighting fixtures, fans, single phase receptacles etc. shall be earthed by means of separate earth continuity conductor. The earth continuity conductor 14 SWG GI wire shall be run along with each conduit run. Cable armours shall be connected to earthing system at both the ends.

Alternately Vendor may offer technically superior and proven product subject to approval of employer/Owner.

Average Illumination Level

Location	**Average Illumination Level (Lux)**	**Type of Fixture**
Control Room	300	LED Luminaries
Store Room	200	LED Luminaries
Switchgear Room, HT Breaker Room	150	LED Luminaries

Inverter Room	150	LED Luminaries
Street lighting-Roads	10	LED Luminaries
Switchyard and Substation	20(general) 50(on strategic equipment)	LED Luminaries
Security Room Lighting	50	LED Luminaries

i. Auxiliary Power Supply System

xxi. Each inverter room shall have its own auxiliary power supply system comprising of AC distribution board (ACDB) which shall be fed from inverter output through suitably rated transformers. All ACDB‟s shall receive at least two incomers from different sources. All Auxiliary loads like illumination, SMU etc. shall be fed from this ACDB. However auxiliary power supply for Power Conditioning Unit and other emergency loads (SCADA, control and protection requirement of switchgears and emergency lighting etc.) shall be taken through suitably rated UPS fed from this ACDB. Size and rating of UPS shall be chosen based on criteria specified elsewhere in the specification. In case the PCU does not require any external Auxiliary power supply, Contractor may choose to supply suitable DC system in place of the above UPS for feeding of control and protection loads of switchgear, SCADA, Emergency lighting and other emergency loads.

G Performance Measurement procedure

16. Performance Ratio Test Procedure

16.1 PR - Provisional Acceptance Test Verification Procedure

i. After Commissioning of the Plant and after receiving all the satisfactory results regarding the correct operation of the plant, there will be continuous monitoring of the performance for 10 days. This monitoring will be performed on the site under the presence of the Employer //Owner. For the purpose of this clause, The Performance Guarantee Tests (PG tests) shall be assessed through the Plant Performance Ratio (PR) measurement.

ii. The Performance Ratio (PR) test aims at the comparison of the actual PV plant energy

production with the guaranteed value for a limited operation time of the PV plant of 10 consecutive days. The test shall be conducted at site by the bidder in presence of the Employer/Owner.

iii. The Contractor's commissioning / start-up Engineer shall make the plant ready to conduct such tests. The Performance Guarantee Tests (PG tests) shall be commenced, within a period of one (1) month after successful Commissioning. Any extension of time beyond the above one (1) month shall be mutually agreed upon. These tests shall be binding on both the parties to the contract to determine compliance of the equipment with the guaranteed performance parameters.

iv. The test will consist of guaranteeing the correct operation of plant over 10 days. For system acceptance, the plant should be having a PR of more than 75% in at least 7 days out of these 10 days.

v. The Efficiency or performance ratio (PR) of the PV Plant is calculated as the ratio of plant output versus installed plant capacity at any instance, with respect to the radiation measured.

PR= (Measured output in kW /Installed Plant capacity in kW) * (1000 W/m^2/Measured radiation intensity in W/m^2).

The instantaneous PR will be calculated for the instant having maximum solar radiation in the given day.

vi. If the plant fails to pass the Performance Test, the Successful Bidder will be given another two chances to make good of the generation and Call SECI again for Performance Test. Such Call should be made within one month from the preceding date of Plant Evaluation by SECI's representative. However, it is the responsibility of Successful Bidder to complete any such re-tests within the project completion timeline.

16.2 Monitoring System for PR Verification

i. The following instrumentation will be used to determine the Solar Plant Performance:

a) Power Meter at the individual delivery points (building wise).

b) One nos. calibrated pyranometer to determine irradiance on the plane of array (with a target measurement uncertainty of ± 2).

c) One nos. calibrated pyranometer to determine irradiance on horizontal plane (with a target measurement uncertainty of ± 2)

ii. Data measurement shall be witnessed in the format mutually agreed before the start of PR test by the Employer/Owner and the bidder jointly for the said period.

iii. The bidder shall show the specified PR for Operational Acceptance and committed CUF for Final Acceptance (i.e. *after one year form the date of commissioning*).

iv. Capacity Utilization Factor (CUF) shall be calculated as per the following formula:

CUF = E_N / (8760*P_{nom})

E_N = No. of units recorded at the meter excluding the auxiliary consumption P_{nom} = Installed DC capacity at STC

Pnom shall be reduced at the end of each year considering the module degradation as per the module data sheet.

H Civil and Allied Works

17. Civil and Allied Works

17.1 Detailed Survey of the Site

The LSTK contractor shall be responsible for detailed site survey at required location for the purposes of design and other planning required for the successful completion of the project. The contractor must submit the detailed project site survey report to Employer.

17.2 Buildings survey

The formation levels of the proposed rooftop power plant have to be fixed with reference to wind speed of the proposed site. The structures shall be fixed taking into consideration the rooftop Structure of the buildings. Accordingly, detailed drawings of the same shall be submitted.

17.3 Other investigations

Successful Bidder shall obtain and study earthquake and wind velocity data for design of rooftop solar PV system, equipment and buildings and foundations after considering all parameters related to the weathers conditions like Temperature, humidity, flood, rainfall, ambient air etc.

The Successful Bidder shall carry out Shadow Analysis and structure analysis of the existing roof at the site and accordingly design strings and arrays layout considering optimal use of space, material and man-power and submit all the details / design to Employer/Owner for its review / suggestions / approval.

17.4 Structures

The contractor is responsible for designing of all the structures in the plant. The module mounting structures, equipment, buildings and other important

structures must be approved by Employer prior to construction. The contractor must provide the detailed design and calculations of the structures. The foundation designs and structure analysis must be approved by Charted Structural Engineer or consultant.

17.5 Switch board room civil works

Switch board civil work includes transformer plinth (if required) , HT Switchgear kiosk plinth, structure foundation, earth pits, cable trenches, cable trays, and surrounding masonry work, metal spreading curb wall in and around substation, plinth protection, trenches & precast covers and fencing. The transformer/ HT switchgear kiosk plinth shall be made of RCC/ brickwork/ Random Rubble masonry, as required and approved, conforming to relevant standards. The height of transformer /HT Switchgear kiosk plinth shall be decided based on 33 kV ground clearance. Earth pit construction shall be of brickwork covered with RCC (1:2:4) slabs. Switchboard area must be surrounded by chain link fencing with pre-cast RCC post/ galvanized MS angle of suitable size with double leaf gate will be provided. Area enclosed within this perimeter must be filled with gravel. All the trenches shall be made up of precast sections/ brick work with plaster. The trenches must be covered with precast slabs with handles of suitable sizes.

17.6 Buildings

Bidder will require to construct a central control room cum store building for the operation & maintenance of rooftop Solar Photovoltaic Power Plant. The building shall be constructed with conventional RCC framed structure with brick partition walls. Bidder shall furnish the drawing of the proposed buildings to the Employer for approval, prior to construction. The construction of the same shall be as under-

17.7 RCC Works

All RCC works shall be as per IS 456 and the materials used viz. Cement, reinforcement steel etc. shall be as per relevant standards.

Brick Works

Brick works in cement mortar (CM) 1:6 for 9" thick and 4½" thick wall respectively. All brick works shall be using 1st class bricks of approved quality as per IS 3102.

Doors & Windows

Steel framed doors, Windows and ventilators shall conform to IS – 1081 with necessary float glass panels including of all fixtures and painting etc. complete. Doors and windows shall be made of aluminium 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 aluminium sections and combination of compact sheet and clear float/ wired glass. The control room shall require a number of windows/ louvers to provide ventilation/ fresh air circulations.

Plastering

Plastering in cement mortar 1:5, 1:6 and 1:3 shall be applied to all internal, external walls and ceiling of slab respectively as per IS 1542.

Flooring (as per relevant IS codes for selection and laying)

Store area:	Cement flooring in concrete mix (1:2:4) using 10 mm aggregates as per IS 2571: 1970
Control Room cum supervisor room:	Heavy Duty Vitrified tiles 8 mm thickness
DAS Room:	Heavy Duty Vitrified tiles 8 mm thickness
Equipment room:	Heavy Duty Vitrified tiles 8 mm thickness
Toilets:	Ceramic tiles 8 mm thickness
Lobby:	Vitrified Tiles 8 mm thickness

The floor finishing must include skirting up to a suitable height. The wall tiles, if proposed, shall be glazed tiles of 6 mm thickness and provided up to lintel level.

Roofing

The roof of the building shall be insulated and waterproofing shall be done as per relevant IS standard.

Plinth Protection

Plinth protection 1000mm wide shall be provided around all the buildings as per relevant standards using brick bats.

White washing & colour washing

White washing and colour washing work shall conform to relevant IS codes. The right of selection of colour/ shades shall lies with the Owner. Bidder has to follow respective and relevant IS codes of practice for the finishing process.

Internal walls: **Acrylic distempering**

External walls: **Heat reflective synthetic enamel**

MMS foundations and Earth pit Enclosures: **Cement painting**

Steel/ Al doors, windows and ventilators: **Powder coated paint**

Rolling Shutters

Rolling shutters made of cold rolled strips shall conforming to IS 4030 with approved gauge thickness shall be provided with all fixtures, accessories, painting all etc.

Complete Electrification of Building

Air Conditioner for Control Room

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

Fire Extinguishers

Liquefied CO_2 / foam/ ABC type fire extinguisher shall be upright 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.

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.

Sign Boards

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

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

Safety signs, building evacuation plan and direction signs, assembly points

shall also be placed at strategic locations.

The Contractor shall provide to the Employer/Owner, detailed specifications of the sign boards.

Water supply & Cleaning

i. Water used for cleaning purpose shall be fit for cleaning the PV modules, cleaning procedure and pressure requirement shall be as per the recommendation of PV module manufacturer.

ii. A suitable arrangement of water shall be ensured to cater the day-to-day requirement of drinking water and needs of Solar Photovoltaic plant during entire O&M period.

iii. The Bidder shall estimate the water requirements for cleaning the photovoltaic modules at least once in every week or as per the DUST LEVEL at site, in order to operate the plant at its guaranteed plant performance. Also, bidder is required to plan the water storage accordingly.

iv. All necessary arrangement for wet cleaning of the solar panels shall be in the scope of the bidders.

v. Bidder has to plan and install the effective module cleaning system as per the prevailing conditions at Site.

vi. All the pipes thus laid must be buried in ground at least 0.5 meter below FGL.

Drainage

The storm water drainage shall be planned for the plant to ensure no water stagnation at the buildings. The drains must be constructed with brickwork/ RCC/ RR masonry as suitable for the site conditions. The drains outfall must be connected to the nearest drain in the plant premises. It is advised that the drainage for the plant must be designed keeping the natural flow of water to the nearest exit point.

17.8 Painting & Finish

i. All metal surfaces and support structures shall be thoroughly cleaned of rust, scale, oil, grease, dirt etc. Fabricated structures shall be pickled and then rinsed to remove any trace of acid. The under surface shall be made free from all imperfections before undertaking the finishing coat.

ii. After Phosphate treatment, two (2) coats of yellow zinc chromate primer will be applied followed by two (2) coats of epoxy based synthetic enamelled paint. Shade shall be

Siemens Grey RAL- 7032. Thickness of paint shall be not less than 75 micron.

iii. All unpainted steel parts shall be cadmium plated or suitably treated to prevent rust formation. If these parts are moving elements then they shall be greased.

I. Inspection & Testing

18. Inspection & Testing

i. Employer/Owner shall have free access to Bidder's manufacturer's works to inspect, expedite and witness shop floor tests. Any materials or work found to be defective or which does not meet the requirements of the specification will be rejected and shall be replaced at Bidder's cost. Employer reserves the right to carry out stage wise inspection of fabrication and components. The Bidder shall furnish a detailed quality assurance plan (QAP) for review by the Employer.

ii. The test & inspection shall be carried out at manufacturer's work and at the site with the Bidders obligation. The test and Inspection shall be done in accordance with the relevant standards and the Manufacturer's standard before the delivery to site as well as after the erection and commission at site. The bidders shall give the list of tests that they will carry out at site to show the performance of plant.

iii. A detailed 'QAP' for Manufacturing and Inspection shall be submitted by the Bidder for Employer's/Owner's approval. The data of each test and inspection shall be recorded and submitted as soon as the test/ trials are conducted and will also be a part of final documentation.

iv. The shop test shall be carried out to prove the performance parameters of the offered model. The testing shall be done in the presence of the representatives of the Employer. /Owner

v. Employer will nominate its representatives for inspection of stage manufacturing and testing at works & 7 days training at premises of SPV module and PCU manufacturer. The notice of such inspection shall be given 30 days in advance in case of countries outside India and 15 days in India.

vi. Manufacturer has to submit procedure for Test carried out at their Factory:

a) Start Up Trials

b) Load Test

c) Records & Measurements

d) Safety Device List

e) Setting values for all sensors for Pressure and Temperature

f) Dimensional Check-up, Overall Inspection, Completeness of Scope of Supply

g) Shop Test/Load Test for Solar Power Plant

h) Load Trials & Reliability test at Site

vii. Performance Guarantee Test at Site for Rooftop Grid Connect Solar Power Plant, HT/LT Panel etc. These tests will be conducted at site as per site conditions at available load and after performing all pre-commissioning check and trials and after readiness of the entire Solar Power Plant system which are required to carry out the load trials

viii. All the tests which are mentioned in the load test of Solar Power Plant will be carried out in presence of Employers'/Owner's Representative at Site under site conditions and the parameters checked in accordance with the data sheet and guaranteed parameters given by the Contractor.

ix. All the equipment supplied by the vendor will be tested as per relevant standard/ Quality assurance plan at site conditions and the performance monitored.

x. Quality Considerations

xi. Contractor will submit and get finalized detailed comprehensive Standard Field Quality Plan (SFQP) within 30 days from date of issue of the order for bought out items and items manufactured by them. The Standard Field Quality Plan shall relate to the specific and objective erection practices right from storage of equipment till final inspection and testing to be followed for bought out items and items manufactured by Contractor. Accordingly, the Manufacturing Quality Plan shall be submitted broadly under following sub-heads:-

i) Raw material/Bought Out items and Components.

j) In process inspection and test/checks to establish successful completion/ accomplishment of the process.

k) Final tests/checks in accordance with relevant national/ international standards/ specification.

l) The quantum of check for each and every inspection/test items shall be based on an established sampling method and the quantum of check indicated in the SFQP should be designed adequate quality protection.

m) In case reference documents/acceptance norms are indicated as per plant standards then the same shall be duly substantiated/properly explained by well-established and proven engineering practices. All submissions will be in English language only.

xii. Bidder will allow Employer/EIC//Owner to carry out Quality/Audit/Quality surveillance on bidders and our sub-vendor's work with reference to contractual obligations to ensure that the quality management practices/norms as detailed out in the Quality Manual are adhered to. To facilitate this activity, the contractor shall keep Employer/EIC//Owner informed all progress of work in this contract on monthly basis.

xiii. Contractor will associate/fully witness in each inspection being carried out at their/their sub-vendor's works by our authorized inspection engineer(s).

xiv. Employer/EIC//Owner shall also carry out quality audit and quality surveillance of the systems, procedures and quality control activities. However, this shall not relive the contractor of any of his contractual responsibilities under the contract.

19. Performance and Functional Warranty / Guarantees

i. PV modules used in grid connected solar power plants must be warranted for peak output wattage, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years.

ii. The modules shall be warranted for at least 10 years for failures due to material defects and workmanship.

iii. The mechanical structures, electrical works and overall workmanship of the grid connected solar power plant must be warranted for a minimum of 5 years.

iv. The Contractor must ensure that the goods supplied under the Contract are new, unused and of most recent or current models and incorporate all recent improvements in design and materials unless provided otherwise in the Contract.

v. The warranty / guarantee period shall be as follows:

   a) Solar PV Modules: Modules shall be warranted for a minimum period of 25 years in the Bidder's detailed Warranty / Guarantee certificate.

   b) Power Conditioning Units (PCU): PCUs shall be warranted for a period of minimum 5 years or guarantee period provided by the OEM, whichever is higher.

   c) Transformers, associated switch gear and others shall be warranted for a period of minimum 1 years or guarantee period provided by the OEM, whichever is higher.

   d) All other associated equipment, not mentioned, but otherwise included in the scope of the contract must be warrantied for minimum 5 years against its

performance and workmanship.

vi. During the period of Warranty / Guarantee the Contractor shall remain liable to replace any defective parts, that becomes defective in the plant, of its own manufacture or that of its sub-Contractors, under the conditions provided for by the Contract under and arising solely from faulty design, materials or workmanship, provided such defective parts are not repairable at Site. After replacement, the defective parts shall be returned to the Contractors works at the expense of the Contractor unless otherwise arranged.

vii. At the end of guarantee period, the Contractor's liability shall cease. In respect of goods not covered by the first paragraph of this clause, the Employer/Owner shall be entitled to the benefit of such guarantee given to the Contractor by the original Contractor or manufacturer of such goods.

viii. The performance of the plant will be determined by the performance ratio (PR). The same shall be measured and recorded for a period of one month for operational acceptance of the plant as mentioned under TS Clause 29.

ix. During the first year of assured performance demonstration and Operation & Maintenance thereafter, the Contractor shall be responsible for any defects in the work due to faulty workmanship or due to use of sub-standard materials in the work. Any defects in the work during the guarantee period shall therefore, be rectified by the Contractor without any extra cost to the Employer/Owner within a reasonable time as may be considered from the date of receipt of such intimation from the Employer/EIC/Owner failing which the Employer/EIC/Owner shall take up rectification work at the risk and cost of the Contractor.

x. During the O&M period, the bidder, in concurrence with the Owner, is encouraged to carry out the PR test in similar fashion for a period of 7 days, at regular intervals, in order to check the continued performance of the plant and to determine the necessary steps to meet the CUF commitment. However, for the O&M period committed CUF shall be considered only. CUF shall be determined for every year for the performance obligations of the Contract.

Plant Monitoring Desk

Computer aided data acquisition unit shall have features for simultaneous monitoring and recording of various parameters of different sub-systems, power supply of the Power Plant at the DC side and AC side.

Computer Aided Data Acquisition Unit shall be a separate & Individual system comprising of different transducers to read the different variable parameters, A/D converter, Multiplexer, De-multiplexors, Interfacing Hardware & Software, Industrial Type PC, which will be robust & rugged suitable to operate in the Control Room environment.

Reliable sensors for solar Radiation, Temperature & other electrical Parameters are to be supplied with the data logger unit.

The PC Shall of Industrial type, rugged & robust in nature to operate in an hostile environment. The PC have minimum Intel 2 Duo processor having 2 ×150 GB HDD with 2 GB RAM. The PC shall also have 21" TFT colour monitor, DVD Drive with writer, multimedia kit and UPS with 4 hours Power back up. The printer shall be of industrial type, rugged & robust in nature. The printer shall be equipped for printing, scanning, copying and fax.

The data acquisition system shall perform but not limited to the following operations:

- Measurement and continuous recording of (I) ambient Air Temperature near Array Field (II) Control Room Temperature (III) Module Back Surface Temperature (IV) Wind Speed at the level of Array Plane (V) Solar Irradiation Incidental to Array Plane (VI) Inverter Output (VII) System Frequency (VIII) DC Bus Output (IX) Energy delivered to the GRID in kWh.
- All data shall be recorded chronologically date wise. The data file should be MS Excel compatible. The data logger shall have internal reliable battery backup to record all sorts of data simultaneously round the clock. All data shall be stored in a common work sheet chronologically. Representation of monitored data shall be in graphics mode and/or in tabulation form. All instantaneous data can be shown in the Computer Screen.
- The Bill of Materials associated with the equipment must clearly indicate especially the detail about the PC, Modems, etc.
- The data acquisition system should be housed in a desk made of sheet steel.

20. SPECIAL CONDITIONS FOR OPERATION & MAINTENANCE OF THE SOLAR POWER PLANT

Term

The Operator shall be responsible for operation and maintenance of the Solar Power Plant for a period of twenty five (5) years from the date of handing over of the Solar Photovoltaic Power Plant as a whole for O & M.

Extension of Term

This term may be extended for such additional period on terms and conditions that are mutually agreeable to the BHU and Contractor.

Battery Limit

- The battery limit for bidder during the period of O&M contract shall cover complete Solar Power Plant and power evacuation system up to inter connection point.

- The bidder shall be responsible for performance to net minimum guaranteed generation as offered by the bidder for five years of O&M period. For any shortfall in the minimum guaranteed generation the LD/compensation shall be recovered from the O&M contractor as per clause no……...

- The bidder shall be responsible for supply of all spare parts as required from time to time, schedule and preventive maintenance, major overhauling of the plant, replacement of defective, modules, inverters, PCU's etc and maintaining log sheets for operation detail, deployment of staff for continuous operations and qualified engineer for supervision of O&M work.

Scope of Work

Operator shall provide all day-to-day operation and maintenance for the Power Plant as set forth herein. Operator shall perform the Work and supply all required spare parts in a prudent and efficient manner and in accordance with-

(i) Manufacturers and systems designers' specifications, the Annual Operating Plan for the Plant and all operation and maintenance manuals,

(ii) All Indian applicable laws including environmental protection, pollution, sanitary, employment and safety laws, ("Government Rules").

(iii) Prudent Utility Practice.

Operator uses all reasonable and practical efforts-

i. To maximize plant capacity utilization,

ii. To reduce plant downtime,

iii. To optimize the useful life of the equipment of the power plant

The Operator shall perform the following obligations prior to takeover of the O&M activity:

i. Prepare Mobilization plan in consultation with the Employer/Owner

ii. Provide the services and personnel set forth in the Mobilization Plan

iii. Prepare in consultation with the Employer/Owner, the initial Annual Operating Plan.

iv. Develop and implement plans and procedures including those for firefighting, maintenance planning, procuring and inventory control of stores and spares, plan to meet emergencies, plant safety and security; and such other facilities and systems as may be necessary to commence of Operator's ongoing responsibilities.

v. Provide in plant training to Employer/Owner personnel who will gain experience for the operation and maintenance of the plant.

- After taking over the activity of O&M for the power plant, the Operator shall be responsible for the operation and maintenance of the plant

and shall perform all necessary services including applicable services listed below:

i. Provide all operations and maintenance services necessary or advisable to efficiently operate and maintain the plant, including all associated and appurtenant mechanical and electrical keeping in view the objectives set forth herein above.

ii. Maintain the Plant accurate and up-to-date operation logs, records and Monthly reports regarding the operation and maintenance of the Plant which shall include detail of power output, other operating data, repairs performed and status of equipment. Upon expiry of term, the operator shall hand over such records to the owner; however, Employer/Owner shall have access to all such records at any time.

iii. Regularly update and implement equipment repair and preventive maintenance program that meets the specifications of the equipment manufacturers and the recommendations of the manufacturers.

iv. Perform periodic overhauls or preventive maintenance required for the Plant in accordance with the recommendations of equipment manufacturers. Also attend break down and other maintenance in the Plant.

v. Provide technical & engineering support for solving operation and maintenance problems.

vi. Perform the service required to procure all spare parts, overhaul parts, tools and equipment, required to operate and maintain the Plant in accordance with the recommendations of individual original equipment manufacturer.

vii. Operate and maintain fire protection plant and safety equipment.

viii. Maintain with the assistance of the Employer/Owner, accounting records regarding the facility in accordance with the generally acceptable accounting principles under the Laws of India.

Personnel

The Operator shall employ only such personnel who are adequately qualified and experienced for operating and maintaining the power generating sets. The Operator shall ensure that such personnel are on duty at the plant at all times, twenty-four (24) hours a day and seven (7) days a week commencing from the Date of Commercial Operations.

Insurance

Operator shall provide or obtain and maintain in force throughout the period of contract the following insurance coverage:

- Workmen compensation and / or group personal accidents Insurance policy covering all its employees and works including of the sub Operator. Insurance to cover third party liability.

- Insurance in respect of claims for personal injury to or death of any person in the employment of operator and arising out of and in the course of such employment, which insurance shall comply with all applicable Indian law and directives.

- Motor vehicle, general liability and other insurance and deductibles / excess thereon as may be required by applicable Indian law or in order to enable the operator to comply with prudent utility practice.

- Operator shall provide insurance, which shall cover among other things, fire, earthquake, and flood damage and deductibles thereon. Machinery breakdown insurance and deductibles / excess thereon for modules, inverters, PCU's, other auxiliaries and complete Solar Photovoltaic Power Plant..

Measurement of Energy and Metering

Metering Systems:

The operator shall maintain the Metering System (which shall include energy meter, current and potential transformers and tele-metering equipment) as per state metering code and CEA guidelines. The Metering System will be designed so as to measure outgoing energy and power delivered by the Operator for the BHU at the delivery point, i.e. point of inter connection and also for import of energy for any purpose. The accuracy class of the energy meters and current and potential transformers will be selected and agreed upon by the Owner/ DISCOM/Employer so that all levels of energy produced or taken the Solar Power Plant will be measured accurately, and in no case shall this equipment have applicable accuracy class. The specification of items mentioned above and installation thereof shall be subject to prior written approval of the Owner/Employer. Meter reading shall be done jointly on monthly basis or at mutually agreed time interval. Such measurement will got recorded in the measurement book by the Engineer in charge or his authorized representative and signed in token of acceptance by the Operator or his authorized representative.

Testing of Meters.

The BHU/ DISCOM shall have the right to carry out surprise inspections of the Metering Systems from time to time to check their accuracy.

All testing equipment shall conform to the relevant IS/IEC/RVPN/DISCOM standards.

If either the Operator or the Owner finds any inaccuracy in the Metering System, the Operator or the Owner, as the case may be, shall notify the other party in writing within 24 hours for a joint inspection and testing from DISCOM or other agreed agency.

Sealing and Maintenance of Meters

The Metering System shall be sealed in the presence of both parties. Representative of BHU & DISCOM & Employer. When the Metering System and/or any component thereof in found to be outside the acceptable limits of accuracy or otherwise not functioning properly, it shall be repaired, re-calibrated or replaced by the Operator as soon as possible. If the meters are found tempered during entire O&M period, the responsibility of any charges recoverable by DISCOM on this account shall be borne by the O&M Contractor.

The payment of O&M charges shall be made on yearly basis after deduction of leviable taxes and adjustment of dues payable to BHU. The BHU will be billed by the Operator promptly following the end of each year of O&M period. For the purpose of payment, the first year shall be reckoned from the date of hand over of Solar Photovoltaic Power Plant to the contractor for O& M purpose till 31st March of that financial year. In subsequent years the payment shall be made for the period from 1st April to 31st March of the financial year. In the last year the payment shall be made for the period from 1st April to the date of expiry of the O&M period.

Contractor's Office at the Site

During the execution of the contract the Operator shall ensure that a Plant Manager with authority to take decisions to be available at site. Such person deputed by the Operator shall report to the Engineer in Charge for smooth operation of the plant. The operator shall also provide and maintain an office at the site for the accommodation of the agents and the staff and such office shall be open at all reasonable hours to receive instructions, notices or other communications. The Operator shall be responsible for any misconduct/ in-discipline by his employees or sub operator / agent employees. The Operator shall be responsible for any mis-conduct / in-discipline by his employees or sub operator/agent employees. The Operator shall abide by the instructions of the Owner representative, if given in this regard.

Handing over the Plant after expiry of O&M Term

After the expiry of term & extension of term as the case may be, operator shall hand over the plant to the Employer/Owner in excellent condition. The operator shall demonstrate performance test of all the major & critical equipment to ensure Generation from the Solar Photovoltaic Power Plant. While handing over the plant operator shall hand over all technical documents, literature, instruction manuals, lists of spare part & tools & tackles. Operator will also hand over all the relevant record/documents, spares and consumable required for two year's Operation & Maintenance.

On completion of O&M term the Operator will apply to the Engineer in-charge for the issue of Handing Over Certificate and the same will be issued within 1 months of the Handing Over in all respects, after verifying from the documents & tests and satisfying himself that the Operation & Maintenance has been completed in accordance with details set out in the control documents & Prudent Utility Practices.

All the aforesaid safeguards / rights provided for the company shall not prejudice its other rights / remedies elsewhere provided herein and / or under law.

Final Payment

Whenever, in the opinion of the Engineering-in-charge the Operator has completely performed the contract on his part, the Engineer in-charge will so certify in writing to the Operator.

The final payment to the Operator shall be made after accounting for all the previous payments/advances/adjustments of dues, provided always that Operator furnishes a "NO further claim – No dues certificate". The release of final payments does not relieve the Operator from his any other obligations as provided for in the contract.

The company shall be deducting statutory taxes at source as per prevailing rates from bills of the Operators.

Failure of the Operator to comply with the provisions of the Contract

If, the Operator refuses or fails to execute the work or any separable part thereof with such diligence or fails to perform any of his obligations under the contract or in any manner commits a breach of any of the provisions of the contract, it shall be open to the company, to adopt following course of action at its option, by written notice to the Operator.

i) To determine the contract in which event the contract shall stand terminated and shall cease to be in force and effect on and from the date the decision is announced by the company. The Operator shall stop forthwith any of the Operators work, then in progress and hand-over the work to the company. The company shall be entitled for recovery of cost / compensation to complete the unfinished obligations.

ii) Without determining the contract, to take over the work of the Operator or any part thereof and complete the same through a fresh contractor or by other means at the risk and cost of the Operator.

iii) In the event that the company proceeds in the manner given in above clause then Bank Guarantee furnished by the Operator is liable to be forfeited without prejudice to the other rights of the company. The company shall also have the right of taking possession and utilizing such materials, equipment and plant, belonging to the Operator, as may be at the site of the work in order to complete the unfinished work.

iv) The amount that may have become due to the Operator on account of work already executed by him shall not be payable to him until after the expiry of six months reckoned form the date of the determination of contract of from the taking over of the work or part thereof by the company as the case may be. Further during this period of six months the responsibility for faulty workmanship in respect of such completed work shall, under the contract, rest exclusively with the Operator.

v) Termination of the contract shall not prejudice or affect the rights of the company which may have accrued up to the date of such termination.

Data Sheets

SHEET-1

Guaranteed Technical Particular data Sheet for Solar PV Module

(To be furnished by the bidder)

S. No.	Particulars	Unit	Type/ Value
1	PV Module Manufacture (Name & Country)		
2	PV Module type (Crystalline- Multi)		
3	Product Code (commercial)		
4	No. of PV cells per Module	cells	72
5	Mounting arrangement for Solar Module		
6	Solar Module frame material (if framed)		
7	Module dimensions		
8	Output Cables (viz., Polarized Weather Proof DC rated multi-contact connector)		
9	Availability of Reverse Blocking Diode and Bypass Diode		
10	Construction Front glass description and thickness Back sheet details Encapsulating details		72
11	Cell efficiency	%	
12	Module efficiency	%	
13	Nominal Wattage (P_{nom})	W	
14	Power Tolerance (≤+5W)	W	
15	Peak power voltage (V_{mp})	V	
16	Peak power current (I_{mp})	A	
17	Open circuit voltage (V_{oc})	V	
18	Short circuit current (I_{sc})	A	
19	Weight of each module	kg	
20	Fill Factor	%	
21	Standards/Approvals from International Agencies	IEC 61215 IEC 61730 IEC 61646 IEC 61701 IEC 62716 Others	
22	Module is suitable to operate up to 50° ambient	Yes/No	

SHEET-2

Technical Particular Data Sheet for Power Conditioning Unit

(To be furnished by the bidder)

Particulars	**Unit**	**Value**
Make		
Capacity		
Origin		
AC Side		
Nominal AC power @ 25^{o}C	kW	
Nominal AC power @ 50^{o}C	kW	
Output AC voltage	V	
Output AC Current	A	
Frequency (and Variation)	Hz	
Total Harmonic Distortion (< 3%)	%	
AC over/under voltage, over/under frequency protection		
Phase shift (cos phi)		
DC Side		
Maximum Input DC power	kW	
Maximum DC voltage	V	
MPPT voltage range	V	
Maximum DC current	A	
DC over voltage protection		
DC voltage ripple	%	
Others		
Maximum Efficiency	%	
Euro Efficiency	%	
Ambient temperature range	^{o}C	
Humidity (non-condensing)	RH	
Quiescent power	kW	
Degree of protection	IP	
Dimensions approx. (HXWXD)	mm	
Weight	kg	
Compliances (Reference Standards)		

SHEET -3

TECHNICAL PARTICULARS OF STEP-UP TRANSFORMER

(To be furnished by the bidder)

S. No.	Description	Guaranteed particulars to be filled in by the manufacturer
1.	Service	
2.	Type	
3.	Rating (kVA)	
4.	Rated frequency (Hz)	
5.	Number of phase HV side LV side Neutral (separate outside)	
6.	Rated Voltage a) HV winding (kV) b) LV winding (kV)	
7.	Vector group	
8.	Type of cooling (ONAN/ONAF)	
9.	Insulation level a) Power frequency withstand -kV rms. (HV/LV) b) Impulse withstand voltage -kV (HV/LV)	
10.	Method of Earthing	
11.	Duty	
12.	Short circuit level	
13.	Off circuit tap changer: a) Range % b) In steps of c) Tapping provided on HV side	
14.	Tap changer type	
15.	Impedance voltage at 75^{o}C a) At principal tapping %	
16.	Temperature rise above 50^{o}C ambient a) Top of oil by thermometer ^{o}C b) Womdomg by resistance ^{o}C	
17.	Terminal details a) HV side b) LV side	
18.	Losses (at 75^{o}C and principal tapping)	

a) No load loss at rated voltage kW and frequency
b) Load loss at rated current kW (ONAN)
c) Total loss at maximum rated power kW

19. Efficiency at 75°C and 0.9 PF
a) At full load (ONAN) %
b) At 75% load (ONAN) %
c) At 50% load (ONAN) %

20. Hot spot temperature in winding limit to °C

21. Shipping dimensions
a) Height m
b) Breadth m
c) Length m

22. Painting

23. Reference Standards

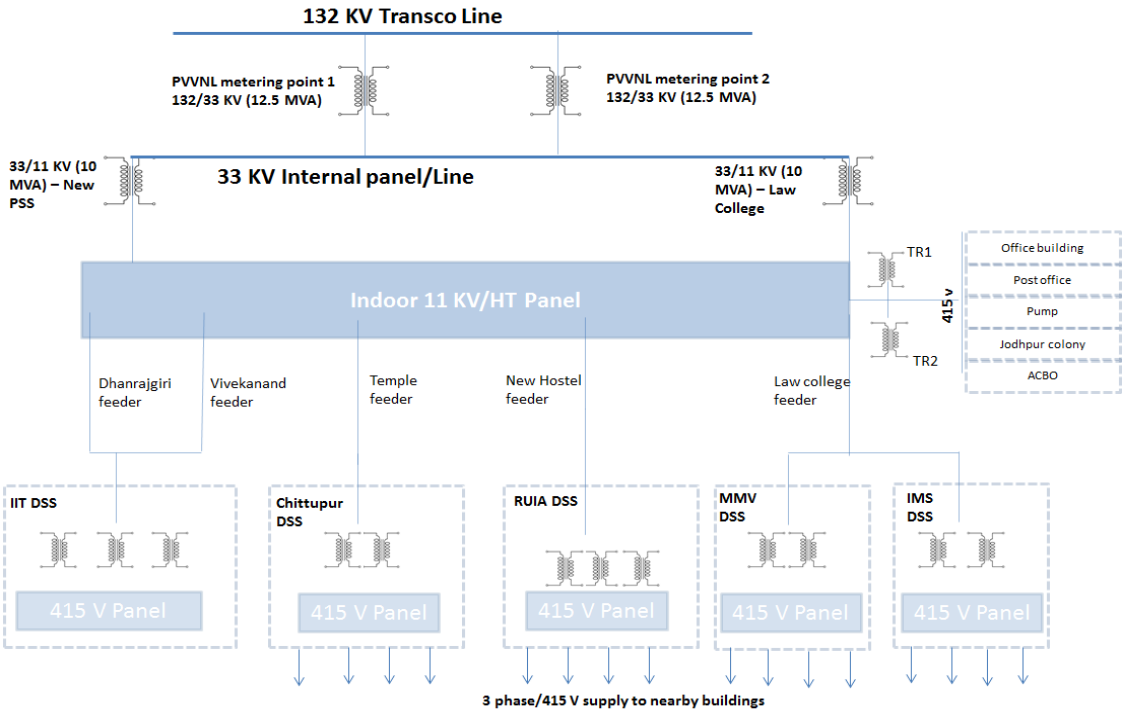
SHEET- 4

Guaranteed Technical Particulars of LED lights

(To Be Submitted By the Bidder)

S. No.	Parameter	Guaranteed Value
1.	LED Operating Current	
2.	Output Luminous Flux	
3.	Beam Angle	
4.	Illuminance	
5.	Photometric Curve	
6.	Material of Luminaire	
7.	Dimension	
8.	Weight	
9.	Impact Resistance	
10.	LED Life	

Indicative block diagram of Power Distribution System



Annexure-1: List of Indicative buildings details:

S.No.	Name of Building	BHU Assessed Area (sqm)	Tentative RTPV Capacity (kW)
1	**Central Library New/ Academic Staff College and Central Library**	4136	228.55
2	**Chemistry Dept.**	4005	319
3	**Botony Dept.**	1636	147.09
4	**Zoology Dept.**	1880	152.91
5	**F/O Ayurveda(wards.)**	1804	132.91
6	**C/o Building for Deptt. Of Physical Education**	1979	149.82
7	Faculty of Arts(Main Bldg.)	6779	462.18
8	F/O Ayurveda(Main Bldg.)	4780	343.27
9	Computer Centre	2029	138.36
10	**F/O Sanskrit Vidya Dharma Vigyan**	3379	239.64
11	Mahila Maha Vidyalaya Main	2690	178.55
12	IMS Main Building 4-Block	4807	323.36
13	New OPD Building	2888	210
14	550 Beded Ward Bldg. V &VIth Floor	2192	155.45
15	Lecture theater Complex of I.Ag.Sc.,BHU.	1621	114.91
16	Seminar hall	2652	173.55
17	MMV Science Block	1664	107.36
18	Dental College (Sthapana Sthal)	2339	165.82
19	Shed for processing plant seed store(2nos)seed testing laboratory/G.O.T. seed sample store	562	37.82
	Total Potential in Departments		**3780.6**
20	Broacha Hostel	4293	195.18
21	Dalmia Hostel	2394	90.91
22	Birla Boys Hostel	1789	68.18
23	New Doctors Hostel	995.8	34
24	Ramakrishna Hostel	1519	37.73

25	Ruiya Hostel (Sanskrit and Medical block	9171.95	163.64
26	Nagarjuna Girls hostel	737.79	14.55
27	Dr. B.R.Ambedkar Hostel	451.98	18.49
28	Swastic kunj Girls Hostel	1225.76	53.49
29	Kriti Kunj Girls Hostel	2185.72	55.09
30	Kundan Devi Girls Hostel	523.62	24.28
31	Jyoti Kunj Girls Hostel	1047.24	49.51
32	KG Girls Hostel	683.54	36.04
33	Student Nurse Hostel	395.81	20.51
34	Sarojini Naidu Girls Hostel	760.62	36.65
35	Gargi Girls Hostel	689.45	31.34
36	Ganga Girls Hostel	500.43	24.11
37	Yamuna Girls Hostel	601.5	29.53
38	Saraswati Girls Hostel	500.43	22.75
39	Naveen Girls Hostel	706.95	34.7
40	International Hostel	494.87	22.04
41	Raja Ram Mohan Rai Hostel	1421.55	55.55
42	A.N.D. Hostel	1271.42	48.55
43	Dhanwantari Hostel	1423.33	60.82
44	PG Doctors Hostel	1088.72	52.46
45	Married Doctors Hostel	527.16	21.57
46	Bhabha Hostel	1421.58	48
47	Dr.J.C.Bose Hostel	1189.76	54.08
48	CPR Ayer Hostel	2228.72	85.1
49	MotherTeresa Hostel	1275.39	56.81
50	Married Staff Nurse Hostel	716.24	31.25
51	Dr. S.R.K. Hostel	2445.62	100.05
52	Bal Ganga Dhar Tilak	1432.12	57.28
53	Bhartendu Harishchandra Hostel	388.06	14.82
54	Management Hostel	682.06	32.86
55	Dr. Bhagwan Das Hostel	2371.27	103.47
56	Dr. I.N. Gurtu Hostel	2371.27	105.63
57	Ram Kinker Hostel	314.65	12.01
58	Sukanya Girls Hostel(Medical)	796.55	30.41
59	Godawari Hostel	482.51	20.18
60	Gandhi Smrity Girls Hostel	903.52	39.43
61	Sardar Ballabh Bhai patel Hostel	762.74	33.98
62	Atrey Hostel (Medical)	1590.2	60.72

63	Kavery Girls Hostel	482.51	21.49
64	Working Women (Medical Enclave)	658.2	31.11
65	C/o Extension Student Nurses Hostel	540.1	20.62
66	J.C. Bose Extension Hostel	991.72	42.37
67	Management Hostel	662.55	25.3
68	Agriculture Girls Hostel	1126.11	51.19
69	Chanakya Hostel	660.9	27.64
70	A.N.D. Back 58 Rroom	866.67	37.82
71	I.T.C. Hostel	3496	133.48
72	Naveen Girls (Pragyan)Hostel	573.12	25.53
73	R.R.M. Back side	308.03	12.6
74	Gomati Girls hostel	2358.65	107.21
75	Boys hostel (Medical) Sthapana Sthal	1562.61	66.77
76	Dhanrajgiri Hostel	3296.35	149.83
77	PG Boys Hostel Chiraigaon)	244.42	11.33
78	PG Girls Hostel	101.42	4.15
	Total Potential in Hostels		***2956***
79	**Central office**	2893	168.18
80	Vishvanath Temple	3855	175.27
81	Bharat Kala Bhawan	3538	210.55
	Total Potential in Offices		***554***

	Total Potential in BHU (kW)-Campus 1	**7290.7**

1	Central Hindu Boys School Kamachha	3137	213.91
	Total Potential in BHU (kW) Campus 2		**50**
2	Central Hindu Girls Boys School Kamachha	2293	160.55
	Total Potential in BHU (kW) Campus 3		**20**

1	CHGS Primary Section Kolhua	2127	145.02
	Total Potential in BHU (kW)- Campus 4		**3**

1	R.P. Hostel (K)	414.87	15.84
2	A.B.Hostel (K)	1772.02	67.66
3	Bhargav Hostel	106.06	4.63
	Total Potential in BHU (kW)- Campus 5		**23**

1	Riva Kothi	378.72	16.18
	Total Potential in BHU (kW)- Campus 6		**15**

1	Girls Hostel Back side of S.N.P.G. Hostel	574.09	27.14
2	Boys hostel (Vindhyachal hostel)	4814	201.31
3	Boys hostel (Shivalik hostel)	4814	183.81
4	Farmer's hostel	499	21.77
5	Girls hostel	4226	188.25
6	Scientist hostel	1504	58.79
	Total Potential in BHU (kW)- Campus 7		**681.1**
1	IIT	14103	910.28
2	Chemical Engineering	8421	612.44
3	Professor Satyendra Nath Bose Hostel, Block (A) IIT.	1656.5	64.75
4	Dr. Srinivasa Ramanujan Hostel Block (B) IIT.	924.02	37.8
5	Arya Bhatta Hostel, Block(C)-I.I.T. Hostel	3323.26	151.06
6	Gurudev Ravindranath Tagore Apartments	2052	78.35
7	Gandhi Smiriti Extension Hostel	722.51	34.81
8	30 P.G.hostel	855	34.98
9	Vivekananda Hostel	2729.37	104.21
10	Vishwakarma Hostel	2729.37	121.58
11	Rajputana Hostel	2867.44	138.16
12	Limbdi Hostel	2867.44	119.91
13	Day Hostel	3368.44	140.86
14	Visweshvaraiah Hostel	2318.3	99.05
15	IT Girls Hostel (Principal Colony)	741.42	34.37
16	Sir C.V. Raman Hostel	1540.53	79.83

17	Morvi Hostel	3049.23	116.43
	Total Potential in BHU (kW)-IIT		**2879**
	Total BHU Potential		***8083***

List of Existing substations (GSS) of BHU Campus:

Sl. No.	Name of Electric Sub-Station or Location of Sub-Station	Voltage Level	Transformer Capacity in MVA/ KVA	Electric Sub-Station Capacity in MVA/KVA	Peak Load in MVA / KVA	Balance capacity in MVA/KVA
1.	132 KV Sub-station, near Vishkarma Hostel,BHU	132/33 KV	2 X 10MVA	20MVA	17 MVA	1MVA
2.	33KV Primary Sub-station (PSS) , in front of Bal Ganga Tilak Hostel,BHU	33/11KV	2 X 10MVA	20 MVA	17 MVA	1 MVA
3.	PSS cum DSS, in front of Bal Ganga Tilak Hostel,BHU	11/0.415 KV	2 X 500KVA	1000KVA	350KVA	650KVA
4.	Temple DSS ,near Vishwanath Mandir,BHU	11/0.415 KV	4X 500KVA	2000KVA	950KVA	1050KVA
5.	Chiitupur DSS, near controller of Examination office, BHU	11/0.415 KV	3 X 500KVA	1500KVA	850KVA	650KVA
6.	Law college DSS, near Law College,BHU	11/0.415 KV	2 X 500KVA	1000KVA	400KVA	600KVA
7.	New Science College DSS, near Chemistry Department,BHU	11/0.415 KV	4 X 500KVA	2000KVA	1100KVA	900KVA
8.	Old Science college DSS, near Mathematics Department,BHU	11/0.415 KV	1X 500KVA	500KVA	400KVA	100KVA

9.	Science Faculty Sub-station, in front of Botany Department, BHU	11/0.415 KV	4X 1000KVA	4000KVA	300KVA	3700KVA
8.	Ruia DSS,near Birla Hostel ,BHU	11/0.415 KV	5X 500KVA	2500KVA	1200KVA	1300KVA
9.	Hostel DSS, near Brocha Hostel,BHU	11/0.415 KV	2X 500KVA	1000KVA	450KVA	550KVA
10.	Post office DSS near Post office, Jodhpur Colony,BHU	11/0.415 KV	3 X 500KVA	1500KVA	750KVA	750KVA
Sl. No.	**Name of Electric Sub-Station or Location of Sub-Station**	**Voltage Level**	**Transformer Capacity in MVA/ KVA**	**Electric Sub-Station Capacity in MVA/KVA**	**Peak Load in MVA / KVA**	**Balance capacity in MVA/KVA**
11.	Treveni DSS, near Treveni Hostel complex,BHU	11/0.415 KV	1 X 500KVA	500KVA	300KVA	200KVA
12.	Naria DSS , Near New Medical Enclave colony,BHU	11/0.415 KV	2 X 500KVA	1000KVA	200KVA	800KVA
13.	SSH Old DSS, in the premises of SSH Hospital,BHU	11/0.415 KV	6X 500KVA	3000KVA	1900KVA	1100KVA
14.	SSH New DSS, in the premises of SSH Hospital,BHU	11/0.415 KV	3X 500KVA	1500KVA	835KVA	165KVA
15.	SSH New (Extension) DSS, in the premises of SSH Hospital,BHU	11/0.415 KV	2X 500KVA	1000KVA	350KVA	650KVA
16.	IMS DSS, in the premises of IMS,BHU	11/0.415 KV	2X 500KVA	1000KVA	600KVA	400KVA
17.	IMS (Extension)DSS, in the premises of IMS,BHU	11/0.415 KV	2X 500KVA	1000KVA	300KVA	700KVA

18.	MMV DSS, in the premises of Mahila Maha Vidhyala, BHU	11/0.415 KV	2X 500KVA	1000KVA	700KVA	300KVA
19.	Trauma Centre DSS, in the premises of foundation stone, BHU	11/0.415 KV	4X 500KVA	4000KVA	2000KVA	2000KVA

11/0.415 KV Electric Sub-stations in IIT(BHU) Area are not included in the above information.