

Panels, SCADA cum Operator room, wash room, store room etc. along with requisite furniture, workstations, air conditioning, internal and external illumination & finishing, other equipment etc. as per the specifications.

- d) Suitable arrangement of water shall be ensured to cater to day-to-day requirement of drinking water and permanent water supply for module cleaning and other needs of SPV power Plant during entire O&M period.
- e) Water storage tank for storage of water for drinking and module cleaning system. Water for cleaning during O&M period of ten years shall be provided by Customer free of cost to the contractor. Bidder shall make necessary arrangements for water storage (like sintex water tank / water tank on the ground) with adequate pumping arrangements (1 working pump + 1 standby pump) as required at each location with piping network on the each roof for cleaning of the SPV modules.
- f) Suitable Communication System for SCADA with remote monitoring capabilities and internet facility.
- g) Supply, packaging, transport and installation of Module cleaning system(s).
- h) Construction and erection of perimeter fence for outdoor Transformer etc.
- i) Laying of underground / over ground Cables (all types) with proper arrangements along with appropriate sized Trenches/Trays, ferrules, lugs, glands and terminal blocks. Laying of cables inside the building trench and other locations as required shall be over GI cabletrays with proper support and accessories. Laying of cable as per the evacuation route plan, from take-off point at plant to the delivery point at nearby substation/location including road crossings considering horizontal drilling/by installing hume pipe.
- j) Suitable earthing for plant along with earth pits as per standards.
- k) Pre-commissioning inspections / checks / tests, MRT tests and coordination with state and central departments such as SEB/CEA etc. for necessary approvals/clearances for commissioning, synchronization with grid and post-commissioning operation of the plant.
- l) All approvals, for equipment, items and works, which are not otherwise specifically mentioned in this document but are required for successful completion of the work in all aspects, including construction, commissioning, O&M of Solar PV Power Plant and guaranteed performance are deemed to be included in the scope of the contractor.
- m) 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.

n) Additional Protection System to Prevent tripping and disturbance in connecting substations and owner's power 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(s).
- 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 REIL / Customer.

4. COMMISSIONING:

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.

The Contractor shall make all required Liaisoning with Customer for interconnection/synchronization of the solar power plant with power system of Customer, 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 power system of Customer after obtaining necessary approvals, if required for synchronization.

5. STATUTORY APPROVALS:

Obtaining statutory approvals /clearances/ compliances on behalf of the Customer from various Government Departments including CEA, not limited to the following: -

- a) Pollution control board clearance, if required

- b) All other approvals, as necessary for setting up and connectivity of solar power plants including CEIG/ CEA/State electricity board power evacuation, OISD, PTCC etc. as per the suggested guidelines.
- c) All other statutory approvals and permissions not mentioned specifically but are required to carry out hassle free Construction, commissioning and O&M of the plant contractor shall also be responsible for payment of all types of statutory fees including clause no.5.1 above.
- d) Assistance in fulfilling RPO obligations In light of '**STATEMENT OF REASONS ORDER**'

The Central Electricity Regulatory Commission (Terms and Conditions for recognition and issuance of Renewable Energy Certificate for Renewable Energy Generation) (Fourth Amendment) Regulations, 2015.

Amendment to Regulation 8 of the Principal Regulations:

Clause (3) of Regulation 8 of the Principal Regulations shall be substituted as under:

“An eligible renewable energy generator including an eligible captive generating plant shall be permitted to retain the certificates for offsetting its renewable purchase obligation as a consumer subject to certification and verification by the concerned State Agency.”

- e) UPERC (Captive and Renewable Energy Generating Plants) Regulation 2019 dated 25/7/2019:-
 - (i) As per para 11 (ii) of the said regulation DPR, schedule date of COD, Half yearly progress report of construction for information.
 - (ii) As per para 11(iii) Provision of ABT regime in terms of function, duties and obligations are applicable.
 - (iii) As per para 11 (vi) Provision of DSM shall be applicable as per UPERC (Forecasting, scheduling ,Deviation settlement related matters solar and wind generation sources) Regulation 2018.
 - (iv) Metering arrangement shall be as per para 29 of the regulation.

6. OPERATION AND MAINTENANCE:

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 two (2) year from date of operational acceptance of the project. The scope of work includes Operation and Maintenance (O&M) of the plant, wherein the plant shall generate at least equivalent to the guaranteed Performance of Plant. The Bidder shall submit in the Bid a comprehensive project execution schedule as well as Operation and

Maintenance (O&M) schedule with resource planning in the form of Gantt chart and shall be liable for abiding by the schedule.

a) Date of commencement of Operations and Maintenance:

Zero date for O&M shall be the actual date on which the 2.64MWp(DC) Solar Plants commissioned in synchronization with grid, completion of all the works in the scope of the vendor and achieved Operational Acceptance and handing over & taking over.

- b) Total Operation & Maintenance of the Plant and Equipment shall be with the Contractor, from the date of operational acceptance of the plant till final handover (after completion O&M period) which shall include deployment of supervisors, technicians and manpower for module cleaning.
- c) Bidder shall provide a detailed training plan for Customer's nominated staff, which shall have prior approval from the Customer.
- d) Bidder shall employ and coordinate the training of its own/sub-contractor's personnel who will be qualified and experienced to operate and monitor the facility and to coordinate operations of the facility with the grid system.
- e) Bidder shall maintain accurate and up-to-date operating logs, records and monthly Operation & Maintenance reports at the facility. Bidder shall submit daily progress report, daily maintenance report, daily generation report to REIL / Customer in electronic form through email.
- f) Procurement of spare parts, overhaul parts, tools & tackles, equipment, consumables, etc. required for smooth operation and maintenance of the Plant and Equipment as per prudent/standard utility practices, OEM recommendations and warranty clauses for the entire O&M period.
- g) To upkeep Main control room, tool room, stores room, equipment clean and in workable conditions.
- h) To carry out periodic overhauls or maintenance required as per the recommendations of the original equipment manufacturer (OEM) and to furnish all such periodic maintenance schedules at the time of plant commissioning/ start of O&M contract.
- i) Maintain inventory of spare parts, tools, equipments, consumables and supplies for the facility's operation along-with required recommended spares with all associated information regarding replacement records, supplier details, tentative cost, storage details, specifications on the basis of replacement frequency and mean time between failures (MTBF) and mean time to restore (MTTR) and at the culmination of penultimate year under O&M period.

- j) Bidder shall provide essential spare parts required for the plant operation for a minimum period of 10 years.
- k) The bidder shall be responsible for rectification of any fault on HT (33KV) side of Solar PV system by coordinating with Customer.
- l) 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.
- m) Contractor shall deploy following minimum personnel for comprehensive O&M for 2 years.
 - (i) Two working level staff with diploma level qualification in engineering with competence for operating electrical / electronic / mechanical equipment, taking measurements, data logging/maintaining registers, supervising and conducting normal and preventive maintenance of the plant such as tightening of all electrical connections, line accessories, transformers and associated switchgear on the HT side.
 - (ii) The site-incharge(s) deputed by contractor for O&M period of 2 years shall be the employee of contractor. The site-incharge shall coordinate the daily maintenance activities including administrative control of O&M team. The site-incharge shall be holding the single-point responsibility as contractor's representative for the complete O&M tenure of 2 years.
 - (iii) Preparations of reports in computer.
 - (iv) To conduct periodical checking, testing, over hauling and preventive action.
 - (v) Submission of daily, weekly and monthly reports to the REIL / Customer on the energy generation & operating conditions of the SPV plant.
 - (vi) Four unskilled persons for regular Housekeeping and water cleaning of modules etc.
 - (vii) However, Contractor shall engage additional manpower as and when need arise.
 - (viii) In case any of the above mentioned O&M Personnel is on leave, reliever(s) shall be arranged by the Contractor for smooth continuance of O&M activities. Contractor shall ensure that certain minimum operating staffs are present at the power plant even on festivals, public holidays and any other unique occasions so that the plant is run under competent supervision on all days.
 - (ix) O&M Personnel shall be provided with rain coats, tool sets, earthing rods, safety gloves, safety goggles, gum boots, helmets and all other personal protective equipment (PPE) that will be relevant to ensure human safety.
 - (x) Names, Qualification, work responsibility of personnel shall be listed on a display board within control room.
 - (xi) Attendance register shall be maintained for the O&M teams.
 - (xii) Vendor shall ensure that operating staff are present in the power plant during plant operation every day.
 - (xiii) Contractor shall ensure statutory requirements such as ESI, PF and Labour

- license for their O&M Personnel posted at site.
- (xiv) REIL / Customer shall have right to disallow any O&M employee, if found unfit to perform. REIL / Customer instructions issued in writing shall be binding on contractor who shall replace the person.
 - (xv) O&M personnel at site shall conform to general regulations in force at site and to any special instructions from local administration/Customer.
 - (xvi) O&M personnel shall, strictly, not use any part of the power plant for their personal / residential purposes. Their presence at the plant shall, strictly, be meant only for the purpose of operation and maintenance of plant.
- n) The contractor shall be responsible for all the required activities for the successful running, committed energy generation & maintenance of the Solar Photovoltaic Power Plant covering:
- (i) Deputation of qualified and experienced engineers and technicians at the site.
 - (ii) Successful running of Solar Power Plant for committed energy generation.
 - (iii) Co-ordination with SLDC/other statutory organizations as per the requirement on behalf of REIL / Customer for Joint Metering Report (JMR), furnishing generations schedules as per requirement, revising schedules as necessary and complying with grid requirements, if required.
 - (iv) Monitoring, controlling, and troubleshooting of solar PV plant equipments.
 - (v) Maintaining of periodical logs & records, registers.
 - (vi) Furnishing generation data daily to REIL / Customer daily.
 - (vii) Periodic cleaning of solar modules as approved by the REIL / Customer.
 - (viii) Replacement of Modules, Inverters/ PCU's and other equipment as and when required during the O&M period without additional cost to REIL / Customer.
 - (ix) Employ and coordinate the training of contractors' personnel who will be qualified and experienced to operate and monitor the facility and to coordinate operations of the facility with the grid system.
 - (x) Establishing a system to maintain an inventory of spare parts, tools, equipment, consumables and other supplies required for the facility's hassle free operation.
 - (xi) Contractor has to submit O&M Schedule for upcoming month in the last week of running month.
 - (xii) Maintain at the facility accurate and up-to-date operating logs, records and monthly reports regarding the Operation & Maintenance of facility.
 - (xiii) Perform and oversee the performance of periodic overhauls or maintenance required for the facility in accordance with the recommendations of the original equipment manufacturer (OEM).
 - (xiv) 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.

Continuous monitoring of performance of the Plant and Equipment and regular maintenance of the whole system including Modules, PCU's, transformers, Cables, outdoor/indoor panels/ kiosks etc. are necessary maintaining the maximum energy output from the Solar Power Plant.

Preventive and corrective O&M of the Plant and Equipment including supply of spares, consumables, wear and tear, overhauling, replacement of damaged modules, invertors, PCU's and insurance covering all risks (Fire & allied perils, earth quake, terrorists, burglary and others) as required without any additional cost to the REIL / Customer.

Minimum requisite spares shall be maintained by the Contractor, in case of PCU/inverter comprising of a set of control logic cards, IGBT driver cards etc. Junction Boxes, fuses, MOVs / arrestors, MCCBs etc. along with spare set of PV modules shall be maintained at site for the entire period of Comprehensive O&M.

The Contractor shall ensure that all safety measures are taken at the site to avoid accidents to his or his sub-contractor or REIL / Customer's Workmen. This will include procurement of all safety gadgets during Construction and O&M period including but not limited to, rubber mats of appropriate grade, PPE, rubber gloves and shoes, arc flash suits of appropriate ratings etc.

The Contractor shall be responsible for the proper behavior of all of his staff and shall exercise a proper degree of control over them. The Contractor shall be liable for all acts or omissions on the part of his staff and others in his employment, including misfeasance or negligence of whatever kind in the course of their work or during their employment, which are connected directly or indirectly with the Contract.

7. MANDATORY SPARES:

The contractor shall supply mandatory spares along with delivery of material at site. During the comprehensive O&M period, the contractor shall at his cost maintain the spares for minimizing system outage due to time required in getting replacements of defective part(s) of equipment from the manufacturer. The contractor has to use the mandatory spare(s) available at site for replacing defective part(s) of equipment for minimizing system outage temporarily and top up the quantity of spares so that the required quantity of spares mentioned in Schedule of Rates shall be made available at site at all the times and same shall be handed over to the REIL / Customer at the end of O&M period.

Additionally, contractor shall handover the list of Mandatory Spares (which are duly tagged and stored) and along with all the mandatory spares to the REIL / Customer at the time of completion of O&M contract of the project.

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

8. OPERATION AND PERFORMANCE MONITORING:

Operation part consists of deputing necessary manpower necessary to operate the Solar Photovoltaic Power Plants at the full capacity. Operation procedures such as preparation to starting, running, routine operations with safety precautions, monitoring etc., shall be carried out as per the manufacturer's instructions for trouble free operation of the complete system.

Regular periodic checks of the Modules, PCU's 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 must be maintained as well as various spare as recommended by the manufacturer for at least 2 years to be kept for usage.

Maintenance and monitoring of other major equipments of Rooftop Solar Photovoltaic Power Plant like step up transformers, indoor 33 KV switchboard, 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.

Daily work of the operation and maintenance in the Solar Photovoltaic Power Plant involves periodic cleaning of Modules, logging the voltage, current, power factor, power and energy output of the Plant at different levels. The operator shall also note down time/failures, interruption in supply and tripping of different relays, reason for such tripping, duration of such interruption etc. The other task of the operators is to check battery voltage-specific gravity and temperature (if applicable). The operator shall record monthly energy output, down time, etc. in a log for SPV plant.

Monsoon protection of Junction boxes, outdoor equipments including transformer, CSS, and other installation to prevent disturbance, fault due ingress of moisture/water.

A maintenance record is to be maintained by the operator/supervisor to record the regular maintenance work carried out as well as any breakdown maintenance along with the date and reasons for the breakdowns, steps should be taken to attend the breakdown etc.

The Schedules shall 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. Information shall be provided to Engineer-in-charge for such operation prior to start.

The Contractor shall attend any breakdown jobs immediately for repair/ replacement/ adjustments and complete at the earliest by working round the clock. The contractor

shall immediately report the breakdowns, failures, accidents, incidents if any during O&M period to the Engineer In-charge showing the circumstances under which it happened and the extent of damage and or injury caused. The contractor shall at his own expense provide all amenities to his workmen as per applicable laws and rules.

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.

The contractor shall at his own expense provide all amenities to his workmens during construction and O&M period as per applicable laws and rules.

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

If negligence / mal operation of the contractor's operator results in failure of equipmentsuch equipment should be repaired/replaced by contractor at free of cost.

Cleaning of water storage tanks, Pest control for control room (rats, snakes etc) – sprays,chemicals, medicines etc. to be applied wherever required on quarterly basis.

O&M activities – yearly basis

- (i) BDV measurements for oil samples from all the transformers and submission of report to REIL / Customer.
- (ii) Filtration of oil to be arranged, if required, based on BDV measurement report.
- (iii) Lubrication of moving contacts (VCBs, Earth switches etc.) with appropriate greaseetc.
- (iv) Painting of earthing chambers, other steel structures within control room and PV Array area if required based on conditions of rusting etc.
- (v) Checking tightness of hardware in solar array structures and tightening wherever required.
- (vi) Checking tightness of power cable terminations in SPV modules (MC4), SMBs, electrical panels of control room.
- (vii) Measurement of earth resistance and maintenance of earthing system including earth pits.

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 theO&M Contract by the Employer.

9. TYPICAL POWER EVACUATION SCHEME

The contractor shall design the detail Power Evacuation Scheme for the 2.64MWp (DC) Rooftop grid connected Solar Power Plants which will be approved by REIL / Customer before commencement of the project. However, contractor may refer the power evacuation scheme provided in the section “Technical Specifications”.

All the information shown here is indicative only and may vary as per design and planning as per project requirement by the customer.

The Contractor must provide the BOQ of the plant as per the design during the time of bidding. Bidder shall take necessary permits for work in plant area for project and for O&M prior to commence any works.

SPECIAL NOTES:

1. Stair cases and ladders shall be installed by Contractor at 18 locations out of 22 locations (as per building heights – approx. 10 to 12 meters). Technical details have been provided in the tender documents.
2. Appropriate Walkways and Lifelines shall be provided by Contractor on each shed. Technical details have been provided in the tender documents.
3. Contractor shall place well qualified and dynamic manpower at site to handle all the activities at site.
4. Safety, Health and Environment Protocols to be followed by the contractor as per Oil & Gas Industry rules and regulations.
5. Timely delivery of material is required.
6. Parallel teams are required for installation of Solar Power Plant on RCC Roofs and Shed Roofs.
7. Main Control Room (MCR) will be constructed by contractor for suitable O&M of Plant during O&M period. The details have been provided in the tender documents.
8. Project shall be installed Set Wise. 4 set is scheduled in the project i.e. 1361 kWp, 768 kWp, 330 kWp, 182 kWp.
9. SCADA system to be installed by contractor to monitor complete SPV Power Plant of cumulative capacity 2641 kWp. The monitoring shall be done either GSM (SIM based) / Wi-Fi / LAN / RS-485 cable. The charges pertaining to recharge the SIM / Wifi charges / any other, shall be borne by Contractor till completion of the maintenance period.
10. Ballast Type Structures shall be used on the RCC roofs and Mono Rail (long and short run type) shall be used on the Shed type roofs (profile sheet).
11. Module cleaning arrangements to be done by the contractor at each location. Appropriate size of Tank and suitable Motor (to lift the water) shall be provided by the contractor. The water shall be provided the customer.
12. Cable Tranches shall be done as per requirement and upto satisfaction level of the REIL / customer.
13. Energy meters (as per DISCOM specifications) shall be installed at each location by the contractor and shall be sealed by the DISCOM to fulfill RPO obligations. Contractor shall liaison with concerned DISCOM & Electrical Inspector for required clearances.

TECHNICAL SPECIFICATIONS

CONTENTS

- I. **SYSTEM DESIGN AND PHILOSOPHY**
- II. **DETAILED SPECIFICATIONS: ELECTRICAL SYSTEM (DC & AC SYSTEMS)**
 1. PV ARRAY CONFIGURATIONS
 2. SOLAR AND DC CABLES
 4. INVERTER TRANSFORMER
 5. 33 KV HT SWITCHGEAR
 6. COMPACT SUB-STATION (CSS)
 7. AC CABLES
 8. CABLE TRAYS
 9. CABLE TRENCH
 10. AUXILIARY SUPPLY SYSTEM
 11. METERING SYSTEM
 12. EARTHING
 13. LIGHTNING PROTECTION SYSTEM
 14. COMMUNICATION CABLES
 15. SCADA
 16. DATA ACQUISITION SYSTEM / PLANT MONITORING
 17. AUTOMATIC REPORT GENERATION
 18. ILLUMINATION
 19. WEATHER MONITORING SYSTEM
 20. FIRE ALARM & FIRE FIGHTING SYSTEM
 21. TESTING INSTRUMENTS
 22. TOOL KITS
 23. OFFICE FURNITURE
 24. PERSONAL PROTECTIVE EQUIPMENT'S
 25. POWER EVACUATION SYSTEM
 26. LT SWITCHGEAR
 27. IMPORTANT NOTES
 28. PERFORMANCE MEASUREMENT PROCEDURE

III. DETAILED SPECIFICATIONS: CIVIL & MECHANICAL

1. GENERAL REQUIREMENT
2. STRUCTURAL INVESTIGATION
3. OTHER INVESTIGATIONS
4. SWITCH BOARD ROOM CIVIL WORKS
5. MAIN CONTROL ROOM BUILDING
6. FIRE EXTINGUISHERS
7. SAND BUCKET
8. SIGN BOARDS
9. DRAINAGE
10. PAINTING & FINISH
11. MODULE MOUNTING STRUCTURE(MMS)
12. CONCRETE WORKS
13. MISCELLANEOUS STEEL WORKS
14. MASONRY WORK
15. PLASTERING, POINTING & COPING WORKS
16. BUILDING WATER SUPPLY & PLUMBING WORKS
17. PIPE & CABLE TRENCHES
18. WATER SUPPLY & CLEANING OF MODULES
19. STRUCTURAL STEEL WORK
20. STEEL STAIRWAYS
21. ANCHOR BOLTS AND FOUNDATIONS

IV. QUALITY ASSURANCE AND INSPECTION OF CIVIL WORKS

1. INTRODUCTION
2. QA AND QC MAN POWER
3. PURCHASE AND SERVICE
4. FIELD QUALITY PLAN
5. GENERAL QA REQUIREMENTS
6. INSPECTION & TESTING
7. QUALITY CONSIDERATIONS

V. ANNEXURE & ENCLOSURES TO TECHNICAL SPECIFICATIONS

1. ANNEXURE-1 PRE-COMMISSIONING INSPECTIONS, CHECKS & TESTS
2. ANNEXURE-2 PERFORMANCE GUARANTEE MEASUREMENT TEST PROCEDURE
3. ANNEXURE-3 LIST OF RECOMMENDED MANUFACTURERS
4. ANNEXURE-4 BILL OF MATERIAL (BOM) (INDICATIVE ONLY)
5. ANNEXURE-5 SINGLE LINE DIAGRAM OF PLANTS

I. SYSTEM DESIGN AND PHILOSOPHY

Design philosophy of Roof Top Solar PV plant **2.64 MWp (DC)** capacity is described below.

1. Both phases shall be executed simultaneously and for captive use only. Vendor has to deploy enough manpower to carry out the work simultaneously at both the sites.

- a) The main objective of the design philosophy is to construct the plants with in-built Quality and appropriate redundancy to achieve high availability and reliability with minimum maintenance efforts. In order to achieve this, the following principles shall be adopted while designing the system.
- b) The rooftop SPV power plant should be designed to operate satisfactorily in synchronization with the internal grid of Customer within permissible limits of 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 Customer and sudden overloading during falling of portion of the loads on the power plant unit in island mode, under fault / feeder tripping conditions.
- c) Any faults not taken care will result in damage of rooftop SPV power plant or existing power systems of Customer. Thus suitable protective measure shall be in-built in the system design so that any disturbance of the internal grid of the Customer will not cause any damage to the equipment's of the Solar Power Plant and vice versa.
- d) Very fast responsive microprocessor based Directional (20 millisecond to 50 millisecond) 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 required for meeting the objective shall be provided.
- e) Adequate capacity of SPV modules, PCUs, Junction boxes etc. to ensure generation of power as per design estimates. This will be done by applying liberal de-rating factors for the array and recognizing the efficiency parameters of PCUs, transformers, conductor losses, system losses, site conditions etc.
- f) DC Supply shall be used for control and protection system of switchgear in Control Room/CSS. In case UPS AC supply are considered for auxiliary control and protection supply for switchgear, then suitably rated AC/DC converter/power pack shall be used to meet the DC control supply requirement of switchgear panels.
- g) 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.
- h) **Shadow Analysis:**
Partial or complete shadow can have a significant impact on performance of the system, and accelerate degradation of modules. Partial and point shadows are one of the major cause of formation of hot spots and discoloration of cells. Hence, it is imperative that shadow analysis shall be performed by trained technical personnel using proper on-site tools such as Solar Path Finder or online tools such PVSyst or Sketch-up.

If the project site is located above Tropic of Cancer, shadow analysis shall be performed for day of Winter Solstice (or December 22). It is recommended that time window of 4 hours, before and after solar noon is considered for the analysis. Output of the shadow analysis shall dictate maximum solar capacity that may be installed on a given roof.

- i) Use of equipment and systems with proven design and performance that have high availability track records under similar service conditions.
- j) Selection of the equipment and adoption of a plant layout to ensure ease of maintenance.
- k) Strict compliance with approved and proven quality assurance (QA) systems and procedures during different stages of the project, starting from sizing, selection of recommended make, shipment, storage (at site), during erection, testing and commissioning.
- l) Proper monitoring of synchronization and recording, to ensure availability of power to the grid and for captive consumption.
- m) The plant monitoring and control system should be designed to ensure high availability and reliability of the plant to assist the operators in the safe and efficient operation of the plant with minimum effort.
- n) **Roof Condition:** The available roofs are slanted with 8-18 deg tilt and in different facings. 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 (to meet required CUF&PR values as required by client) from the rooftop Solar PV power plant will be achieved.

2. The basic and detailed engineering of the plant shall aim at achieving high standards of operational performance especially considering following:

- a) Best practices for the installation of a solar PV power plant system involves the optimization of the system for solar energy production as well as structural considerations. Elements to be optimized in a solar energy system include:
 - Roof orientation with respect to panel orientation – sun path chart and shade ellipse
 - Roof slope – the type of solar mount installation and associated safety issues
 - Shading – solar panel placement with respect to shading from Roof Elevations, Air Extractors, chimneys, vents, trees, etc.
 - Setback requirements – determined by local building codes; can be an issue with regard to installer/maintenance issues
 - Type of roof – includes shape (flat or sloped) and material (asphaltic shingle, shake, clay tile, metal, etc.); will dictate placement and connections
 - Structural roof framing details – rafter, truss, beams with steel bar, Pipes, Angles, Channels, joists, and structural steel are multiple structural options that will impact best installation practices.
 - Panel array layout – panel layout (portrait or landscape) and number of panels will impact the best installation practices
- b) SPV arrays are commonly fixed at an optimum tilted angle facing the equator. In case of fixed tilt, the tilt angle shall be defined in such a way that optimum generation is achieved at all times.
- c) Shadow free plant layout to ensure minimum losses in generation during the daytime.
- d) Higher system voltage and lower current options to be followed to minimize ohmic losses.
- e) Selection of PCUs with High Efficiency, proven reliability and minimum downtime. Ready availability of requisite spares.
- f) Careful logging of operational data / historical information from the Data Monitoring Systems, and periodical analysis of the same to identify any abnormal or slowly deteriorating conditions.

- g) The designed array capacity at STC shall be suitably determined to meet the proposed guaranteed generation output at the point(s) of interconnection by the contractor in his bid. The contractor shall take care of first year degradation also by installing additional DC capacity, as the CUF calculations will not factor the first year degradation of the modules.
- h) 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 mean time between failures and mean time to restore, such that the availability of complete system is assured. Bidder's recommendation of the spares shall be on the basis of established reliability.
- i) Bidder shall design the plant and equipment in order to have sustained life of 25 years with minimum maintenance efforts.
- j) The work execution planning for supply, erection, commissioning and all other allied works for SPV Power Plant shall be such that it is completed within stipulated time from the date of order/ LOI/FOA.

3. All documents and drawings shall be submitted to the REIL / Customer both in soft as well as hard copies (3 nos.) for review and approval. Every drawing shall also be submitted in '*.dwg' format. In case of design calculations done in spreadsheet, editable (working) soft copy of the spreadsheet shall also be submitted along with 'pdf' copies during every submission. The REIL / Customer shall return, as suitable, either soft or hard copies to the Contractor with category of approval marked thereon. The drawings/documents shall be approved in any one of the following categories based on nature of the comments/ type of drawing or document.

Category-I	: Approved
Category-II	: Approved subject to incorporation of comments. Re-submit for approval after incorporation of comments
Category-III	: Not approved. Re-submit for approval after incorporation of comments
Category-IV	: Kept for record/reference
Category-IVR	: Re-submit for record/ reference after incorporation of comments

(Note: Approval of document neither relieves the Vendor/ Contractor of his contractual obligations and responsibilities for correctness of design, drawings, dimensions, quality & specifications of materials, weights, quantities, assembly fits, systems/ performance requirement and conformity of supplies with Technical Specifications, Indian statutory laws as may be applicable, nor does it limit the REIL / Customer's rights under the contract).

- 4. After LOI, the Contractor shall submit complete Master Document & Drawing list (MDL) to the REIL / Customer within 14 days. The MDL shall list all the Drawings & Documents envisaged for submission/ approval from the REIL / Customer and shall also have all the required information like drawing no., title, scheduled date of submission, actual date of submission and approval. The category of approval shall be decided mutually between Contractor and the Employer at the time of finalization of the MDL which shall be the basis for drawing & document approval process during project execution.
- 5. The construction shall be done only as per drawings approved under Category – I, II & IV.
- 6. The specifications provided with this bid document are functional ones; any design provided in this document is only meant as an example. The Contractor must submit a detailed design philosophy document for the project to meet the functional requirements based upon their own design in-line with the above. The bidders are advised to visit the site and satisfy themselves before bidding.

II. Detailed Specifications: Electrical system (DC & AC systems)

NOTE: The SPV Modules & String Inverters of cumulative 2641 kWp capacity shall be supplied by REIL at site. However, Contractor shall coordinate unloading and storage of SPV Modules & String Inverters at site.

1. PV ARRAY CONFIGURATIONS

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

- UV resistant Cable-ties (preferably SS Ties) (suitable for outdoor application shall be used to hold and guide the cables/wires from the modules to junction boxes or inverters. All the cables shall be aesthetically tied to module mounting structure.
- Every major Component of the Plant should be suitably named/ numbered & marked for ease of traceability, identification and maintenance.

String Monitoring Unit

Adequate number of array junction boxes shall be provided for termination of array string with inverter. The Array Junction Boxes shall be suitable for interfacing with SCADA system and all necessary transducers shall be included in the scope of supply.

a) **Standards and Codes**

Standard/Code	Description
IEC 60296	Fuse
IEC 61643-12	Surge Protection Device
IEC 62852 or EN 50521	Solar cable connector
UL 94 V	Safety of Flammability of Plastic Materials for Parts in Devices and Appliances testing
UL 746C	Polymeric Materials - Use in Electrical Equipment Evaluations
IEC 62093	Balance-of-system components for photovoltaic systems - Design qualification natural environments
IEC 62262	Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)
IEC 60529	Degrees of protection provided by enclosures (IP Code)
IEC 62208	Empty enclosures for low-voltage switchgear and controlgear assemblies - General requirements
IEEE 80	Communication networks and systems for power utility automation - ALL PARTS
IS 3043	Code for Earthing Practice
IS 2147	Degree of protection provided by enclosures for low voltage switchgear and control gear

b) **Construction**

- (i) Enclosure shall be made of UV resistant, fire retardant, thermoplastic material. Enclosure degree of protection shall be IP 67, mechanical impact resistance shall be at least IK07 and free from halogen. 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.

- (ii) Contractor shall install the SMBs on walls/Roofs or independent structure with foundation in the solar array area as per final array layout. 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.
- (iii) Not more than two strings can be connected in parallel to a single input of SMU. One spare input terminal along with connector shall be provided for each SMU
- (iv) All terminals blocks shall be rated for min 1000V and rated continuously to carry maximum expected current.
- (v) 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.
- (vi) 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.
- (vii) String Fuses: Every SMU input shall be provided with fuses on both positive and negative side. 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. Also, the rating of the fuses shall be selected such that it protects the modules from reverse current overload. The fuses shall be 'gPV' type conforming to IEC 60269-6.
- (viii) DC disconnect switch of suitable rating shall be provided at SMU output to disconnect both positive and negative side simultaneously.
- (ix) DC Surge Protection Devices (SPD): Type-II surge protective device (SPD) conforming to IEC 61643-12 shall be connected between positive/negative bus and earth.
- (x) Resistance Temperature Detector (RTD) type or semiconductor type temperature sensor shall be provided to monitor the cabinet temperature.
- (xi) The maintenance free earthing shall be done as per the relevant standards.
- (xii) MC4 connector conforming to IEC 62852 or EN 50521 shall be provided at each SMU input. Cable gland of suitable size for DC cables shall be provided at the SMU output.
- (xiii) UV resistant printed cable ferrules for solar cables & communication cables and punched/ embossed aluminium tags for DC cables shall be provided at cable termination points for identification.
- (xiv) Suitable and Unique numbering system shall be installed for easy identification and traceability of SMU during erection, commissioning and maintenance. Same numbering system should be reflected in SCADA system.
- (xv) Suitable (including wireless) communication interface shall be provided to communicate the data to SCADA. The following parameters shall be measured/ monitored and made available at SCADA.

- (i) String current
- (ii) Bus voltage
- (iii) Output current
- (iv) Cabinet temperature
- (v) DC disconnect switch ON/OFF status
- (vi) SPD operating status
- (vii) Output Power

c) Technical Requirements

Rated Current, IEC (90 °C)	30Amp (4 mm ² , 6 mm ²)-40Amp (10mm ²)
Rated Voltage	1000 Volts as per TUV

Connector Design	Snap-In locking Type
Protection Degree	IP67
Ambient Temperature	(-) 40° C to (+) 90° C
Protection/Safety Class	Class II
Contact material	Cu
Contact surface material	Ag
Contact resistance for plug connector	<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

d) Warranty

The SMU unit shall be warranted for minimum of 5 (five) years against all material/ manufacturing defects and workmanship.

e) Approval

Documents/Drawings

- (i) Guaranteed Technical Particular (GTP) Datasheet.
- (ii) Bill of Materials for the proposed SMU along with the datasheet of each component
- (iii) General Arrangement (GA) drawing

f) Test Certificates/Reports

- (i) Test certificates of fuse, SPD and solar cable connector
- (ii) Enclosure ingress protection and impact protection test certificates

g) Tests

Routine tests and acceptance tests for the assembled unit shall be as per the Quality Assurance Plan (QAP) approved by the REIL / Customer.

Test on SMU shall include the following:

- (i) Checks on bought out items as per internal standards of the manufacturer
- (ii) In-process checks, as per internal standards of the manufacturer
- (iii) Sample tests as per following:
 - IR-HV-IR test (as per IS 2500 Part1)
 - String Monitoring Card/ Power Supply card/ DC-DC Converter function check (as per IS 2500 Part1),
 - Communication Function Test (as per IS 2500 Part1).

2. SOLAR AND DC CABLES

a) Standards and Codes

Cable	From	To	Conductor / Insulation	Voltage Rating	Applicable Standard
Solar Cable *	Module	SMU / other Module	Copper/ XLPO	1.1 kV DC/ 1.5 kV DC	IEC 62930/ EN50618
DC Cable	SMU	Power Conditioning Unit	Copper or Aluminium / XLPE	1.1 kV DC/ 1.5 kV DC	IS 7098

* Cable used for module interconnection shall also be referred as solar cable.

- b) All the DC and AC cables are designed for outdoor application with a continuous ambient temperature of 50°C.
- c) All cables shall be supplied in the single largest length to restrict the straight-through joints to the minimum number.
- d) Cable terminations shall be made with suitable cable lugs etc., crimped properly and passed through brass compression type cable glands at the entry & exit point of the cubicles.
- e) Solar cable (6 Sqmm CU unarmoured cable may be preferred), outer sheath shall be flame retardant, UV resistant and black in colour. Solar cable with positive polarity should have marking of red line on black outer sheath.
- f) DC cables (from AJB to PCU) shall be single core, armoured, Flame Retardant Low smoke (FRLS), PVC outer sheath conforming to IS 7098-I. DC cable with positive polarity should have marking of red line on black outer sheath.
- g) In addition to manufacturer's identification on cables as per relevant standard, following marking shall also be provided over outer sheath.
 - (i) Cable size, Core, Conductor and voltage grade
 - (ii) Word 'FRNC/ FRLS' (as applicable) at every metre Sequential marking of length of the cable in meters at every meter.

Cables shall be sized based on the following considerations:

- (i) Rated current of module
- (ii) The average voltage drop in the cables (Modules to Inverter) shall be limited to 1.5% of the rated voltage.
Contractor shall provide voltage drop calculations in excel sheet.
- (iii) Short circuit withstand capability
- (iv) De-rating factors according to laying pattern

Warranty

The cables (Solar and DC) shall be warranted for minimum of 5 (five) year against all material/ manufacturing defects and workmanship.

Approval

Documents/Drawings

- (i) Guaranteed Technical Particular (GTP) Data-sheet.
- (ii) Solar and DC Cable sizing calculation.
- (iii) Quality Assurance Plan (QAP).

Tests

- a) Power cables should be tested at the site as per standard in front of REIL / Customer engineer present at the site. The Cables shall also conform to IEC 60189 for test and measuring methods and they should be UV Protected.
- b) Data sheets of individual cable sizes shall be submitted for approval by REIL / Customer. Drum numbers and drum length details shall be submitted with each consignment.
- c) Type test, Routine test and acceptance tests requirements shall be IEC 62930/EN 50618 for solar

cables and IS 7098 for DC cables.

- d) Testing of the cable shall be done according to relevant IS standards and standards mentioned above. Testing of the cable shall include but not limited to the following.
 - i. High voltage test
 - ii. Conductor resistance at 20 deg.C
 - iii. Constructional and dimensional test
 - iv. Insulation resistance test
 - v. Flammability test
 - vi. Cable end sealing
 - vii. Any other type and routine test as required

Installation

- a) Cable installation shall be as per IS-1255.
- b) DC cables for Interconnecting SPV MODULES, from SPV Modules to SMBs and from SMBs to inverters shall be laid only in Galvanized Cable Trays mounted on mild steel supports duly painted.
- c) Only terminal cable joints shall be accepted. No cable joint to join two cable ends shall be accepted.
- d) Solar cables shall be provided with UV resistant printed ferrules and DC cables shall be provided with punched/ embossed aluminium tags. The marking shall be done with good quality letter and numbers of proper size so that the cables can be identified easily.
- e) Cable terminations shall be made with properly crimped lugs and passed through cable glands at the entry & exit point of the cubicles. Bimetallic lugs shall be used for connecting Cu bus bar and Al cables or vice-versa.
- f) Solar cables, wherever exposed to direct sunlight to be buried underground and wherever long runs are there from panel to SMB along the structure shall be laid through Double Wall Corrugated (DWC) HDPE conduits.
- g) Solar cables shall be aesthetically tied to Module Mounting Structure using UV resistant cable-ties suitable for outdoor application.
- h) A.C and D.C cables shall be kept in separate Trays or maintain safe distance as per IS.
- i) The horizontal and vertical clearances between power and communication cable shall not be less than 300mm.
- j) Cable should be tagged at every 20 meter for identification; all cable trays should be covered by GI sheet.

4. **INVERTER TRANSFORMER**

SCOPE

This section covers the activities related to design, manufacturing, testing at works, supply, insurance, transportation and delivery at Project site, storage, erection, testing, commissioning of step up transformers and associated equipment as detailed here under.

3- Φ , oil filled (ONAN) inverter transformers with suitable capacity shall be provided to step up voltage from 3- Φ , Grid tied Solar Inverters output to 33 kV voltage level for feeding the generated power to the 33 KV Power system.

LV winding of the transformer shall be connected to the combined outputs of inverters and the HV side shall be connected to the 33KV bus through VCB, Isolator etc.

The transformer(s) shall be suitable for outdoor installation.

The contractor shall keep necessary spares required for normal operation & maintenance of transformers including special tools required for erection & maintenance. Corresponding parts of all the equipments & spares shall be of the same material & dimensions, workmanship & finish and shall be interchangeable. All the material & workmanship shall be of suitable commercial quality as have proven successful in their respective uses in similar services & under similar condition.

The transformers and associated equipment shall be suitable for interfacing with SCADA system and all necessary transducers shall be included in the scope of supply.

Standards and Codes

Inverter transformer shall comply with the latest edition of the following standards and codes including amendments.

Standard	Description
IS:2026, IEC:60076	Specification of Power Transformers
IS:2099, IEC:60137	Bushings for alternate voltage above 1000 V
IS: 3639	Fittings and Accessories for Power Transformers
IS: 12063	Degree of protection provided by enclosures
IS:6600	Guide for loading of oil immersed transformers
IEC 60296	Fluids for Electro-technical Applications
IS: 2544	Porcelain post insulators for systems with nominal voltage greater than 1000 V
IS:6088	Dimensions for porcelain transformer bushings
IS:3347	Loading guide for oil-immersed transformers
IS:335	Transformer oil
IS:3637	Gas and oil operated relay
CBIP publication no. 295	Manual on Transformers Publication
Indian Electricity rules and other statutory regulations	

Technical Requirements

Sl. No.	Standards	Description
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)
4	Winding	As per system requirement
5	Nos. of Phase	3
6	Vector Group & Neutral earthing	As per system/inverter manufacturer requirement and SLD
7	% Impedance at 75°C, rated current & frequency	As per relevant Indian Standard
8	Type of cooling	ONAN
9	Winding material	Copper
10	Earthing	As per system requirement
11	Rated Frequency	50 Hz
12	Type of Bushing	
	HV Winding	Porcelain/ XLPE bushing
	LV Winding	Porcelain bushing
13	Tap Changer	OCTC , No. of steps shall be as per the SLD and system requirement
14	Range	+5% to -5% @ 2.5%
15	Permissible Temperature rise	over an ambient of 50 deg C (irrespective of tap)
	Top Oil	50 deg. C
	Winding	55 deg. C
	Hot spot temperature over a maximum yearly weighted average ambient temperature of 32 °C	105°C
16	Short circuit current for 1 sec. on HV side	25 kA
17	Short circuit withstand time (thermal)	2 sec
18	Fault Level & Bushing CT	As per system requirement and SLD
19	Termination	As per system requirement and SLD
20	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)
	Loading Capability	Continuous operation at rated MVA on any TAP with voltage variation of +/-5%, also transformer shall be capable of being loaded in accordance with IS: 6600/IEC60076-7