SECT ION – V – TECHNICAL SP EC IFICATION

1. SCOPE :

Supply, installation, testing and commissioning of LT Grid connected Solar Power Plant of capacity of **35KWp** rating at the Roof-top of the High Rise buildings of TANTRANSCO Sub-Station, Tirunelveli Operation Circle

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2. GENERAL REQUIREMENTS :

The Solar PV Power plant shall have capacity as listed in SECTION V Sub clause 1. The power plant shall provide the following general requirements.

- The project should full fill all the conditions necessary for availing the MNRE subsidy for such plant. The MNRE sanction has already been communicated through TEDA for this project. The bidder should ensure the full requirements of MNRE for obtaining the grant under CFA as the entire CFA would be considered only upon satisfactory installation, testing and commissioning of the Solar Power Plant and submission of SOE, completion report and verification of these systems at site.

- The should have the Capacity Utilisation Factor (CUF) of not less than 19% as per the CERC (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations 2012.

- Supply of adequate capacity of SPV modules, inverters, etc to ensure maximum generation.

- Use of equipment and systems with proven design and performance that have a high availability track record under similar service conditions.

- The plant instrumentation and control system should be designed to ensure high availability and reliability of the plant for safe and efficient operation of the plant.
- The power plant has to operate in parallel with the grid system which is a n infinite electrical system. Any faults not taken care will result

in damage of SPV power plant, thus the Solar Power Plant has to protect its equipment against any possible fault or other disturbances from the Grid.

- All the materials shall be as per standard SPV plant requirements and may adhere to the necessary safety standards and environmental requirements.

- The plant and machinery including accessories and other materials should be new and complying with international standards, and approved either by the MNRE (or) by approved test centers in India/ International test houses

3.SOLAR PHOTOVOLTAIC MODULES

The total solar PV array capacity should not be less than capacity as listed in SECTION V Sub clause 1 and should comprise of solar mono/poly crystalline modules of minimum 270 Wp and above wattage. The module shall be tested as per IEC 61215 latest edition and manufactured in India and also type tested by any one of the accredited test laboratories under Ministry of New & Renewable Energy, Government of India. Also modules must qualify to IEC 61730 Part I and II for safety qualification testing. The type test certificate for solar module shall be submitted as part of the bid offer. Further a self undertaking from manufacturer of the modules has to be obtained and furnished to TANGEDCO stating that the modules are supplied as per above along with the supply of materials.

The PV module shall perform satisfactorily in humidity conditions up to 100% with temperature between 10^{o}C to 85^{o}C. Since the modules would be used in a high voltage circuit, the high voltage insulation test shall be carried out on each module and a test certificate to that effect should be provided along with the supply of materials.

Solar PV module array shall consist of high efficiency Solar Modules utilizing Crystalline Silicon Solar PV cells. Power output Guarantee Certificate offered for the SPV Module shall not be less than 25 years. Individual Solar Module rating shall not be less than 270 Wp at Standard test conditions.

The PV modules shall be supplied using a RF identification tag (RFID), which must contain the following information. The RFID can be inside or outside the module laminate, but must be able to withstand harsh environmental conditions.

(i) Name of the manufacturer of PV Modules

(ii) Name of the Manufacturer of Solar cells

(iii) Month and year of the manufacture (separately for solar cells and module)

(iv) Country of origin (separately for solar cells and module)

(v) I-V curve for the module

(vi) Peak Wattage, Im, Vm and Fill Factor (FF) for the module

(vii) Unique Serial No and Model No of the module

(viii) Date and year of obtaining IEC PV module qualification certificate

(ix) Name of the test lab issuing IEC certificate

(x) Other relevant information on traceability of solar cells and module.

Other general requirements for the PV modules and subsystems shall be as follows.

a. Raw materials(Solar cells) and technology employed in the module production processes shall have to be certified and a certificate giving details of major materials i.e. cells, Glass, back sheet, their makes and data sheets to be submitted for the modules at the time of supply of materials by the bidder.

b. The rated output power of any supplied module in single string shall have tolerance of +/- 3% to avoid array mismatch losses.

c. The peak-power point voltage of any supplied module and/or any module string (series connected modules) shall not vary more than 3 (three) per cent from the respective arithmetic means for all modules and/or for all module strings, as the case may be.

d. The front module surface shall consist of impact resistant, low-iron tempered glass for strength with anodized Aluminium frame.

e. Crystalline high power cells shall be used in the Solar Photovoltaic module. Solar module shall be laminated by lamination technology using stabilized polymer Ethyl Vinyl Acetate (EVA) and Tedlar/Polyester laminate.

f. The solar modules shall have suitable encapsulation and sealing arrangements to protect the silicon cells from the environment. The arrangement and the material of encapsulation shall be compatible with the thermal expansion properties of the Silicon cells and the module framing arrangement/material. The encapsulation arrangement shall ensure complete moisture proofing during life of the solar modules.

g. All materials used shall have a proven history of reliable, light weight and stable operation in external outdoor applications and shall have service life of more than 25 years.

h. Weatherproof DC rated MC 4 connector and a connecting cable coming out as a part of the module, making connections easier and secure, not allowing for any loose connections.
The module shall be resistant to water, abrasion, hail impact, humidity & other environmental factors for the worst situation during its service period.

j. The offered module shall have a Power warranty of 25 years with degradation of power generated not exceeding 20% of the minimum rated power over the 25 years period and not more than 10% after ten years period. Necessary certificate to this effect shall be furnished.

4. ARRAY STRUCTURE

The array structure shall be so designed that it will occupy minimum space without sacrificing the output from SPV panels. Suitable clearance within the array shall be maintained for access for maintenance. The structure shall be designed to allow easy replacement of any module and shall be in line with site requirements.

The solar power plant shall be designed in such a way that the actual load of entire system acting on the roof top of the high rise building shall not exceed 150kg/Sq.M.

Structural material shall be corrosion resistant and electrolytically compatible with the materials used in the module frame, its fasteners, nuts and bolts. All fasteners shall be of stainless steel of grade SS 304. Mounting structure steel shall be as per IS: 2062:1992 with latest amendments and galvanization of the structure shall be hot dipped galvanized or equivalent and in compliance to IS: 4759 with latest amendments. Aluminium frame structures with adequate strength and in accordance with relevant BIS/international standards can also be used.

Structures shall be supplied complete with all members to be compatible for allowing easy installation at the rooftop site. The structure should be capable of withstanding a wind load for the worst condition of Wind storms encountered in Chennai. **The module mounting structure shall be rested on the roof top floor and should not be grouted to the floor. No damage should occur to the weather proof tiles on the roof top floor during the erection of the structures.** The array structure shall support SPV modules at a given orientation and absorb and transfer the mechanical loads to the rooftop columns properly. The module alignment & tilt angle shall be calculated to provide the maximum annual energy output. This shall be decided based on the location of array installation and the bidder shall clearly indicate the details in the Technical bid.

The structures shall be designed for simple Mechanical and electrical installation. There shall be no requirement of welding or complex machinery at the installation site.

The bidder shall specify installation details of the PV modules and the support structures with appropriate diagrams and drawings. Such details shall include, but not limited to, the following;

a. Determination of true south at the site;

b. Array tilt angle to the horizontal, with permitted tolerance;

c. Details with drawings for fixing the modules;

d. Details with drawings of fixing the junction/terminal boxes;

e. Interconnection details inside the junction/terminal boxes;

f. Structure installation details and drawings;

g. Electrical grounding (earthing);

h. Inter-panel/Inter-row distances with allowed tolerances; and

i. Safety precautions to be taken.

5. STRING INVERTER :

The String Inverter required should convert DC power produced by SPV modules, into 50 Hz AC power and adjust the voltage & frequency levels to suit the local grid conditions. The inverter shall interconnect and feed power to the LT power supply of the building and also shall have the provision to power critical loads. The local LT Grid is of 3 phase, 415 Volt.

TECHNICAL SPECIFICATIONS FOR STRING INVERTER :

Control Type	:	Voltage control microprocessor assisted
Output voltage	:	3 phase, 415 V ac
Output Frequency	:	50 Hz
Dc link voltage range	:	160 to 1000 V
Operating temperature Range	:	+10 ^{o}C to +55^{o}C
Inverter efficiency	:	98% and above at full load
Power Control	:	MPPT
Protection of Enclosure	:	IP 65 for outdoor installation

Nos. and minimum rating of string Inverter	:	_No(s). - not higher than 30KW and 1 No. - not lower than 5KW
Total Harmonics Distortion (Voltage)	:	Less than 3% (certificate to be Furnished at the time of supply of Materials Other important features/protection

Other important features/protections required in the inverter are detailed below.

- Automatic morning wake-up and shutdown at nights.
- Mains (Grid) over/under voltage and frequency protection, Lightning and transient protection.
- Fool proof protection against Islanding.
- Automatic tracking of the solar array's maximum power operation voltage(MPPT)
- Array ground fault detection.
- LCD display showing the operating parameters.
- Automatic fault conditions reset for all parameters like voltage, frequency and/or black out.
- MOV type surge arresters on AC and DC terminals for over voltage protection from lightning-induced surges.
- All parameters should be accessible through an industry standard communication link.
- The inverter shall be self commuted and shall utilize a circuit topology and components suitable for meeting the specifications listed above at high conversion efficiency and with high reliability.
- The inverter shall have a direct current isolation provided at the output by means of a Isolating Transformer of required rating.
- The inverter shall be capable of operating in parallel with the LT grid and shall be capable of interrupting line-to-line fault currents and line-to ground fault currents including multiple line and Grid faults.
- The inverter shall be able to withstand an unbalanced output load to the extent of 30%

- The inverter shall include appropriate self protective and self diagnostic features to protect itself and the PV array from damage in the event of safe operating range due to internal or external causes. Faults due to malfunctioning within the inverter, including commutation failure, shall be cleared by the inverter protective devices and not by the existing site utility grid service circuit breaker.

- The inverter Power factor at the point of utility service connection shall be 0.95 or more lagging or leading when operating at above 25 percent of the rated output.
- The internal copper wiring of the inverter shall have fame resistant insulation. Use of PVC is not acceptable. All conductors shall be made of standard copper.
- The inverter shall withstand a high voltage test of 2000 V rms, between either the input or the output terminals and the cabinet (chassis).
- Full protection against accidental open circuit and reverse polarity at the input shall be provided.
- The inverter shall not produce Electromagnetic Interference (EMI) which may cause malfunctioning of electronic and electrical instruments including communication equipment, which are located within the facility in which the inverter is housed. Certificate to this effect to be furnished.
- The inverter shall have an appropriate display on the front panel to indicate status of inverter and to display the instantaneous AC voltage, current, PF, power output and the DC voltage, current and power input. Each of these measurement displays shall have an accuracy of 1 percent or better. The display shall be visible from outside the inverter enclosure. Operational status of the inverter, alarms, trouble indicators and ac and the dc disconnect switch positions shall also be communicated by appropriate messages or indicator lights on the front cover of the inverter enclosure.

- The inverter shall go to shut down/standby mode, with its contacts open, under the following conditions before attempting an automatic restart after an appropriate time delay
- Insufficient Solar Power Input. When the power available from the
- PV array is insufficient to supply the losses of the inverter, the inverter shall go to a standby/shutdown mode. The inverter control shall prevent excessive cycling during night shut down or extended periods of insufficient solar radiation.
- Utility-Grid Over or Under Voltage. The inverter shall restart voltage has returned to within limits for minimum of two minutes.
- Utility-Grid Over or Under Frequency. The inverter shall restart after an over or under frequency shutdown when the utility grid frequency has returned to within limits for minimum of two minutes.
- Also the following operating modes are to be made available: Night or Sleep mode : Where the inverter is almost completely turned of, with just the timer and control system still in operation.
- Operational or MPP tracking mode : Maximum power point tracker shall be integrated in the Inverter to maximize energy drawn from the array. The MPPT should be micro processor based to minimize power losses. The details of the working mechanism of MPPT shall be mentioned. The control system shall continuously adjust the voltage of the generator to optimize the power available. The power conditioner must automatically re-enter stand-by mode when input power reduces below the standby mode threshold.
- Electrical safety, earthing and protection
- Internal Faults : Inbuilt protection for internal faults including short circuits, over loads, single phasing, two phasing, excess temperature, commutation failure, overload and cooling fan failure (if fitted) is obligatory.
- Galvanic Isolation: Galvanic Isolation by Isolation Transformer is required to avoid any DC component being injected into the grid and

the potential for AC components appearing at the array. The detailed specification of Isolation transformer is given below.

- Over Voltage Protection: Over Voltage Protection against atmospheric lightning discharge to the PV array is required. Protection is to be provided against voltage fluctuations in the grid itself and internal faults in the power conditioner, operational errors and switching transients.
- Earth fault supervision: An integrated earth fault device shall have to be provided to detect earth fault on DC side and shall send message to the supervisory system.

~~TECHNICAL SPECIFICATIONS FOR ISOLATION TRANSFORMER~~

~~Type~~	~~:~~	~~Dry Type transformer with copper windings~~	
~~Primary Voltage~~	~~:~~	~~415 V, Three Phase~~	
~~Secondary Voltage~~	~~: 400 V, Three Phase Four Wire~~		
~~Power rating &~~	~~:~~	~~capacity in kva,50HZ as listed in SECTION IV~~	
~~frequency~~		~~Sub clause 71.0,~~	
~~Vector Group~~	~~:~~	~~Dyn11~~	
~~Winding Connections~~	~~:~~	~~Primary~~	~~: Delta~~
		~~Secondary~~	~~: Star~~
~~Insulation Class & cooling~~	~~:~~	~~Class F insulation, Air Natural~~	
~~Ambient Temperature~~	~~: Max. 40 Deg. C~~		
~~No Load and Load loss~~	~~:~~	~~Max 100 & 500 Watts respectively~~	
Efficiency	÷	99 %	
Impedance %	÷	4% to 5	
Coil Winding	÷	~~Impregnated with insulating varnish by Vacuum press impregnation system. To be provided with electrostatic shield between primary and secondary winding. Terminals of Primary & Secondary windings need to be brought for external connection~~	
~~Enclosure Requirement~~	~~:~~	~~The transformer shall be provided in an enclosure of CRCA sheet steel of thickness minimum 2 mm and shall be suitable for cable entry through bottom. The degree of protection of the enclosure shall be decided by the manufacturer to suit air natural cooling floor mounting and indoor installation. The enclosure shall be Epoxy powder coated to shade RAL 7032~~	

Other Fittings & Accessories	:	Rating & Terminal marking plate Provision for connecting the cables for primary and secondary, Earthing Terminals, Lifting Lugs, Bidirectional flat rollers.
Testing	:	All routine tests to be carried out on the, as transformer recommended by respective IEC/IS.
Applicable Standards	:	IS 2026, IEC 60076

6. AC DISTRIBUTION PANEL BOARDS :

AC Distribution Panel Board shall control the AC power from Inverter and should have necessary surge arrestors. The output from the string inverters shall be combined at the ACDB And shall be connected to the Isolation Transformer. Also Isolator and Metering arrangement shall be provided at the roof top with a MCB shall be provided near the Inverter in the TANGEDCO Building where it will be connected to the LT bus. The energy meter shall be of class 0.5. The requirements/specifications of isolator, MCCB are given below.

A Single line diagram of the proposal is enclosed for reference.

SPECIFICATION OF MCCB PANEL:

Sl.No.	Description	Specification
1	Type	Wall mounted type panel made of 2mm thick CRCA sheet along with necessary mounting accessories
2	MCCB Specification	100A, Triple Pole, MCCB Suitable for 400V. The MCCB shall be suitable for fault level of 25KA,
3	Cable Terminal Suitability	4C x 35 Sq.mm for both incoming and out going

SPECIFICATION OF ACDB :

Sl.No.	Description	Specification
1	Type	Wall mounted type panel made of 2mm thick CRCA sheet or ABS enclosure along with necessary mounting accessories
2	Number of incoming & Outgoing	1 No. Of suitable rating of Incoming terminals with cable glands suitable for number of String

		Inverters and 1 No. Of outgoing with 4-Pole 63A MCCB and Surge-Protection Device (SPV).
3	Cable Terminal Suitability	Incoming: 4Cx25 Sq.mm Al, Cable(s) Outgoing : 4Cx25 Sq.mm Al. Cable.

SPECIFICATION OF MCCB CUM METERING PANEL:

Sl.No.	Description	Specification
1	Type	Wall mounted type panel made of 2mm thick CRCA sheet along with necessary mounting accessories
2	Specification of Isolator	100A, Triple Pole, MCCB Suitable for 400V. The MCCB shall be suitable for fault level of 25KA
3	Metering Requirement	Digital Energy meter with 0.5 accuracy class along with necessary Current transformer shall be provided. The voltage input for the meter shall be directly tapped from the 415V bus through fuse

7. SOLAR DC CABLES & AC POWER CABLES

SOLAR DC CABLE SPECIFICATION :

(FROM MODULES TO HARNESS & FROM HARNESS TO STRING INVERTER)

Size	4Sq.mm OR 6 Sq.mm To be decided based on power loss & Voltage Drop
Temperature Range	+10 °C to +120° C
Nominal Voltage	1000 V DC
AC Test Voltage	400V, 50 Hz.
Type	Annealed Tinned Copper Flexible type conductor Class-5
Properties	UV Resistive, Ozone & Flame resistant, Weather & Abrasion resistant
Colour Codes	Positive : Red

	Negative : Black
Applicable standard	IEC 60228

AC POWER CABLES:

- All AC power cables for use on medium voltage systems shall be heavy duty type, 1100 V grade with aluminium/copper conductor, PVC Insulated, inner sheathed, armoured and overall PVC sheathed. The construction of the conductors shall be 'stranded' for all cables. The core insulation shall be with PVC compound applied over the conductor by extrusion and shall confirm to the requirement of Type 'A' compound of IS:5831.The inner sheath shall be applied over the laid-up cores by extrusion and shall be of PVC confirming to the requirement of Type ST1 PVC compound of IS:5831.The extruded inner sheath shall be of uniform thickness of size not less than those specified in IS. The outer sheath for the cables shall be applied by extrusion and shall be PVC compound conforming to the requirement of type ST1 compound of IS:5831. To protect the cables against rodent and termite attack, suitable chemicals shall be added into the PVC compound of the outer sheath.

- All connections should be properly terminated, soldered and/or sealed from outdoor and indoor elements. Relevant codes and operating manuals must be followed. All connections are to be made through suitable cable/lug/terminals; crimped properly & with use of cable glands.

- All cable/wires are to be marked in proper manner by good quality ferrule or by other means so that the cable can be easily identified. All cable schedules/layout drawings have to be got approved from TANGEDCO prior to installation.

- The permissible voltage drop from the SPV Generator to the inverter shall not be more than 2% of peak power voltage of the SPV power source (generating system). In the light of this fact the cross-sectional area of the cable chosen is such that the voltage drop introduced by it shall be within 2% of the system voltage at peak power.

~~8. PLANT METERING AND DATA LOGGING :~~

- ~~PV array energy production : LT 415V energy meter shall be incorporated in the system.~~

- Weather Station : The environment conditions shall be measured by the Weather Station which consists of the following. Irradiance sensor

  - .Non-classified irradiance sensor (Silicon cell pyranometer, 5% accuracy)
  - …Secondary standard irradiance sensor (Thermopile pyranometer, 2% accuracy)

  PV module temperature sensor (Platinum RTD)

  Ambient temperature sensor (Platinum RTD)

  Wind Speed sensor (3 cup anemometer, output :4-20 mA, range : 0 – 50 m/s, accuracy : 0.09 m/s over the range 4.9– 24.6 m/s, operating voltage : 10 – 36V DC).

- Solar Irradiance : The pyranometer shall be provided with the sensor mounted in the plane of the array. The readings shall be integrated with data logging system.

- Temperature Sensor: Integrated temp sensors for measuring the module surface temp., inverter inside enclosure temp, and ambient temp to be provided with readings integrated with the data logging system.

- Software and communication compatibility :The project envisages a communication interface which shall be able to support

  Real time data
  logging Event
  logging
  Supervisory
  control
  Operational
  modes
  Set point editing

The communication interface shall be an integral part of inverter and shall be suitable to be connected to local computer/ Web

integrated using a standard modem.

One number Computer : i5 Intel processor with 500GB HDD, 4GB DDR4 RAM, 2 Parallel & 2 Serial Port, Wi-Fi LAN Card, DVD RW Drive, 20" LED, USB Scroll Mouse, along with 1 KVA UPS and one Laser Printer shall be supplied for plant data monitoring.

SPV WEB REMOTE MONITORING SOFTWARE

The Supplier shall supply necessary Software and Wi-Fi based hardware required to monitor the system performance make use of the Internet facility available in the site. The supplier shall also provide training for the use of software. The software should be compatible to Microsoft windows systems (Windows XP, VISTA or Higher Version system).

- Data logging system : A data logging system (Hardware and software) for plant control and monitoring shall be provided such that the following parameters shall be measured and displayed continuously.
    a. DC current and Voltages
    b. AC current and Voltages
    c. KW reading DC/AC i.e. input output (instantaneous power)
    d. KWh Energy reading

  Data logger/Web based Remote Monitoring Remote System must record these parameters for study of grid parameters on energy generated by the solar system and various analysis would be required to be provided through bar.

9. EARTHING PROTECTION & FIRE PROTECTION:

The farthing terminal of all PV modules shall be interconnected by using 2.5 Sq.mm PVC insulated copper wire, which shall be further interconnected to the module mounting structure at least at 2 points in each row of PV module. The earth mesh so formed shall be interconnected with 25x3 mm Cu. Bar mounted on the wall of the inverter room, through 2.5 Sq. mm PVC insulated copper cables at minimum two points. ll other equipment in the inverter room like ACDB, Inverter shall be

interconnected to this copper bar through 2.5 Sq. mm PVC insulated copper cables. The copper bar shall be connected to two number earth pits through 2.5 Sq. mm PVC insulated, through separate copper cables.

FIRE PROTECTION:

All the necessary fire fighting equipments required for the solar power plant should be provided as per the standard conditions.

DANGER BOARDS

Danger boards should be provided as and where necessary as per IE Act./IE rules as amended up to date. These signages shall be provided wherever considered necessary especially in solar array area.

10.TOLERANCE FOR MODULES

The bidder shall guarantee by photoflash certificates from the module manufacturer that the peak power of the PV Plant modules is equal to that contracted with a tolerance of plus/minus five percent (±5%) during the supply of materials.

11. GUARANTEE FOR EQUIPMENTS

The bidder shall guarantee that the design, the components and the assembly of the PV Plant, including the Modules and Inverters, shall be free of Defects (both hidden or evident) for a period of three years from the date of commissioning for the DC side

Equipments and materials (i.e. from the Modules to the Inverters, both included ("DC Equipment") and AC side Equipment and materials (i.e. after the Inverter and up to the interconnection point at the LT Grid ("AC Equipment") the respective periods being the "Guarantee Period" and the respective guaranties being the "Guaranty for Defects").

12. TOOLS , TACKLES AND SPARES:

After completion of installation & commissioning of the power plant, necessary tools & tackles are to be provided free of cost by the contractor for maintenance purpose. In addition the following instruments may also be supplied free of cost.

(i) Digital voltmeter.

13. DRAWINGS & MANUALS

Two copies of Engineering, electrical drawings, installation and O&M manuals are to be supplied. Bidders shall provide complete technical data sheets for each equipment giving details of the specifications along with makes in their bid along with basic design of the power plant and distribution.

For complete electro-mechanical works, bidders shall supply complete design, details and drawings for approval before progressing with the installation work.