Centre of Excellence, Renewable Energy Systems
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TECHNICAL SPECIFICATIONS FOR 100 kW PV MICRO-GRID EXPERIMENTAL SET-UP

ITEM 1

1. TECHNICAL SPECIFICATION FOR SOLAR MODULE, CABLES, PROTECTION SCHEME AND JUNCTION BOXES

1.1. ITEM DETAILS

Sl. No.	Brief Description	Units
1	**SPV modules for a total capacity of 100kWp along with mounting arrangement as per specifications**. SPV module mounting structure suitable for accommodating 100 KWp capacity SPV modules including foundation as per specifications on ground (Detailed descriptions given in section 1.2 and 1.3)	1 Set
2	**Cables requirement as per design** (Detailed descriptions given in section 1.4)	As required at site for full plant commissioning
3	**Earthing Protection** (Detailed descriptions given in section 1.5)	
4	**Fire extinguisher** in accordance with BIS codes for electrical short circuit fires along with sand buckets (Detailed descriptions given in section 1.6)	1 Set
5	**Lightning arrester** complete set as per specification (Detailed descriptions given in section 1.7)	1 Set
6	**DC Combiner Box and DC junction Box** (Detailed descriptions given in section 1.8)	As per require quantity
7	**DC fuse** (Detailed descriptions given in section 1.9)	As per require quantity
8	**Circuit Breaker** (Detailed descriptions given in section 1.10)	1

1.2. **SOLAR PHOTOVOLTAIC MODULES**

1.2.1. The total solar PV array capacity should not be less than 100 kWp and should comprise of solar mono crystalline modules of minimum 200 Wp and above wattage. Module capacity less than minimum 200 watts should not be supplied. The module type must be qualified as per IEC 61215 latest edition for crystalline silicon. SPV module conversion efficiency should be equal to or greater than 15% under STC. Modules must qualify to IEC 61730 Part I and II for safety qualification testing. Certificate for module qualification from IEC or equivalent to be submitted as part of the bid offer. Self undertaking from manufacturer / supplier that the modules being supplied are as per above.

1.2.2. The PV module shall perform satisfactorily in humidity up to 100% with temperature between – 40oC to + 85oC. 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 provided.

1.2.3. The predicted electrical degradation of power generated not exceeding 20% of the minimum rated power over the 25 year period and not more than 10% after ten years period of the full rated original output (As per MNRE Standards).

1.2.4. Other general requirement for the PV modules and subsystems shall be the following

1.2.5. 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 being supplied by the bidder.

1.2.6. The rated output power of any supplied module shall have tolerance of +/- 3% as per MNRE standard specs.

1.2.7. The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary more than 2 (two) per cent from the respective arithmetic means for all modules and/or for all module strings, as the case may be. The rated power of the module specified in “watt Peak” under STC may not have any negative tolerance.

1.2.8. Except where specified, the front module surface shall consist of impact resistant, low-iron and high-transmission toughened glass.

1.2.9. The module frame, if any, shall be made of a corrosion-resistant material which shall be electrolytically compatible with the structural material used for mounting the modules.

1.2.10. The module shall be provided with a junction box with either provision of external screw terminal connection or sealed type and with arrangement for provision of by-pass diode. The box shall have hinged, weather proof lid with captive screws and cable gland entry points or may be of sealed type and IP65 rated.

1.2.11. IV curves at STC and NOCT should be provided. The manufacturing process of the module and Major components of the module – solar cell, front glass, backsheet, encapsulant, sealant, their make and datasheet may be submitted by the bidder.

1.3. **ARRAY STRUCTURE:**

1.3.1. Wherever required, suitable number of PV panel structures shall be provided. Structures shall be of flat-plate design either I or L sections.

1.3.2. Structural material shall be corrosion resistant and electrolytically compatible with the materials used in the module frame, its fasteners, nuts and bolts. Galvanizing should meet ASTM A-123 hot dipped galvanizing or equivalent which provides at least spraying thickness of 70 microns on steel as per IS5905, if steel frame is used. Aluminium frame structures with adequate strength and in accordance with relevant BIS/ international standards can also be used.

1.3.3. Structures shall be supplied complete with all members to be compatible for allowing easy installation at the site.

1.3.4. The structures shall be designed to allow easy replacement of any module & can be either designed to transfer point loads on the roof top or UDL as per site conditions.

1.3.5. Each structure shall have a provision to adjust its angle of inclination to the horizontal as per the site conditions.

1.3.6. Each panel frame structure be so fabricated as to be fixed on the ground. The structure should be capable of withstanding a wind load of 200 km/hr after grouting & installation. The front end of the solar array must be one meter above the Ground. Grouting material for SPV structure shall be as per M15 (1:2:4) concrete specification.

1.3.7. 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. If prior civil work or support platform is absolutely essential to install the structures, the supplier shall clearly and unambiguously communicate such requirements along with their specifications in the bid. Detailed engineering drawings and instructions for such prior civil work shall be carried out prior to the supply of Goods.

1.3.8. The supplier 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;

1.3.8.1. Determination of true south at the site

1.3.8.2. Array tilt angle to the horizontal, with permitted tolerance

1.3.8.3. Details with drawings for fixing the modules

1.3.8.4. Details with drawings of fixing the junction/terminal boxes

1.3.8.5. Interconnection details inside the junction/terminal boxes

1.3.8.6. Structure installation details and drawings

1.3.8.7. Electrical grounding (earthing)

1.3.8.8. Inter-panel/Inter-row distances with allowed tolerances and Safety precautions to be taken.

1.3.9. The array structure shall support SPV modules at a given orientation and absorb and transfer the mechanical loads to the columns properly. All nuts and bolts shall be

of very good quality stainless steel.

1.3.10. The design of mounting structures with fixed tilt shall be provided. The array structure shall be so designed that it occupies minimum space without sacrificing the output from SPV panels due to shadowing, orientation or tilt at the same time.

1.4. **CABLES & WIRES**

1.4.1. Cabling in the yard and control room: Cabling in the yard shall be carried out as per IE Rules. All other cabling above ground should be suitably mounted on cable trays with proper covers.

1.4.2. Wires: Only FRLS copper wires of appropriate size and of reputed make shall have to be used.

1.4.3. Cables Ends: All connections are to be made through suitable cable/lug/terminals; crimped properly & with use of Cable Glands.

1.4.4. Cable Marking: All cable/wires are to be marked in proper manner by good quality ferule or by other means so that the cable can be easily identified.

1.4.5. Any change in cabling schedule/sizes if desired by the bidder/supplier be got approved after citing appropriate reasons, All cable schedules/layout drawings have to be got approved from ‘he purchaser prior to installation. All cable tests and measurement methods should confirm to IEC 60189.

1.4.6. Cable specifications:

- Multi strand, annealed high conductivity copper conductor
- PVC type ‘A’ pressure extruded insulation
- Overall PVC insulation for UV protection and confirm to IEC 69947
- Armoured cable for underground laying
- All cables shall conform to BiS standards (IS 694) and (IS 1554)
- The size of each type of cable selected shall be based on minimum voltage drop, however, the maximum drop shall be limited to 3%
- Selected cable should carry a current density of minimum 1.2Amp/Sq.mm
- All electrical cables / wires inside the building to be fixed in accordance with specifications for electrical works.
- Proper laying of cables have to be ensured in appropriate cable trays, pipes / trenches as per site requirement.
- A.C. supply cables to be terminated at the DB / LT bus bar.
- For laying / termination of cables, latest BIS / IEC codes / standards should be followed.

1.5. **EARTHING PROTECTION**

Each array structure of the PV yard should be grounded properly. The array structures shall be connected to earth pits as per IS Standards. In addition the lightning arrester/masts should also be provided inside the array field. Provision should be kept be provided inside the

array field. Provision should be kept for shorting and grounding of the PV array at the time of maintenance work. All metal casing/shielding of the plant should be thoroughly grounded in accordance with Indian electricity Act./IE Rules. Earth resistance should be tested in presence of the representative of DTU after earthing by calibrated earth tester. PCU ACDB & DCDB should be earthed properly.

1.6. **FIRE EXTINGUISHERS:**

The fire fighting system for the proposed power plant for fire protection shall be consisting of..

- Portable fire extinguishers in the control room for fire caused by electrical short circuits.
- Sand buckets in the control room

The installation of Fire Extinguishers should confirm to TAC regulations and BIS standards. The fire extinguishers shall be provided in the control room housing the batteries and PCUs as well as on the site where the PV arrays have been installed.

1.7. **LIGHTNING PROTECTION:**

There shall be the required number of suitable lightning arrestors installed in the array field. Lightning protection shall be provided by the use of metal oxide varistors or lightening arrestors and suitable earthing such that induced transients find an alternate route to earth. Protection shall meet the safety rules as per Indian Electricity Act. The Lightning conductor shall be earthed through flats and connected to earth pits as per applicable Indian Standards. Each Lightning conductor shall be fitted with individual earth pit as required.

1.8. DC COMBINER BOX AND DC DISTRIBUTION BOX:

1.8.1. A DC Combiner Box shall be used to combine the DC cables of the solar module arrays with DC fuse protection for the outgoing DC cable(s) to the DC Distribution Box.

1.8.2. DC Distribution Box shall be mounted close to the solar grid inverter. The DC distribution box shall be of the thermo-plastic IP65 DIN-rail mounting type and shall comprise the following components and cable terminations:

i. Incoming positive and negative DC cables from the DC Combiner Box.

ii. DC circuit breaker, 2 pole (the cables from the DC Combiner Box will be connected to this circuit breaker on the incoming side).

iii. DC surge protection device (SPD), class 2 as per IEC 60364-5-53.

iv. Outgoing positive and negative DC cables to the solar grid inverter.

1.8.3. As an alternative to the DC circuit breaker a DC isolator may be used inside the DC Distribution Box or in a separate external thermoplastic IP 65 enclosure adjacent to the DC Distribution Box. If a DC isolator is used instead of a DC circuit breaker, a DC fuse shall be installed inside the DC Distribution Box to protect the DC cable that runs from the DC Distribution Box to the Solar Grid Inverter.

1.9. SOLAR ARRAY FUSE:

The cables from the array strings to the solar grid inverters / DC-DC converter shall be provided with DC fuse protection. Fuses shall have a voltage rating and current rating as required. The

fuse shall have DIN rail mountable fuse holders and shall be housed in thermoplastic IP 65 enclosures with transparent covers.

1.10. CIRCUIT BREAKER:

Circuit breaker with mounting arrangement should be supplied as per below specification. Circuit Breaker will be used to connect microgrid with utility grid. Connection cable (As per applicable standard) between micro grid to breaker and breaker to utility grid is supplier scope.

Rated Voltage:	415 V AC.
Rated Current:	20 Amps.
Breaking Capacity:	36 MVA.
Short Time Current:	50 KA for 1 sec.
Peak making capacity:	105 KA
Symmetrical breaking capacity :	50KA
Frame Size:	OMA 12
No. of Pole:	3 pole.
Conforming to :	BS4752 , IS :2526
Spring Charging Motor:	110V DC.
Closing Coil:	Solenoid Coil
Trip release:	Shunt release
Rated Voltage:	415 V AC.

Item 2

2. TECHNICAL SPECIFICATION FOR INVERTER, CONVERTER, PCU, BATTERY, ACTIVE FILTER AND ANTI-ISLANDING PROTECTION SCHEME

2.1. ITEM DETAILS

Sl. No.	Brief Description	Units
1	**Voltage Source Inverter** SPV module mounting structure suitable for accommodating 100 KWp capacity SPV modules including foundation as per specifications on ground (Detailed descriptions given in section 2.2)	10 nos (2 without MPPT and 8 with MPPT)
2	**Boost Converter** (Detailed descriptions given in section 2.3)	1
3	**PCU** (Detailed descriptions given in section 2.4)	10 (1 nos for two stage configuration and 9 nos for single stage configuration)
4	**Shunt Active Power Filter Setup using CRIO based FPGA system** in accordance with BIS codes for electrical short circuit fires along with sand buckets (Detailed descriptions given in section 2.5)	1 Set
5	**Anti-Islanding Protection Scheme** (Detailed descriptions given in section 2.6)	1 Set
7	**AC Distribution Box** (Detailed descriptions given in section 2.7)	As per require quantity
8	**Bi-directional Converter** (Detailed descriptions given in section 2.8)	1
9	**Battery Bank** (Detailed descriptions given in section 2.9)	1 Set

2.2. SOLAR GRID INVERTER

The detailed specifications of the solar grid inverter are given below. Earting arrangement should be provided with inverter.

Total output power (AC)	10 kW
Input DC voltage range	As required for the solar grid inverter DC input.
Maximum power point (MPPT) tracking	Required in single stage configuration
Number of independent MPPT inputs	1 or more
Operation AC voltage	Three phase 415V (+ 12.5%, -20%)
Operating Frequency range	47.5 -52.5 Hz
Nominal frequency	50 Hz
Power factor of the inverter	>0.98 at nominal power
Total harmonic distortion	Less than 3%
Built-in Protection	AC high / low voltage; AC high /low frequency
Anti-islanding protection	As per VDE 0126-1-1, IEC 60255.5 / IEC 60255.27
Operating ambient temperature range	-10 Deg. Celsius to 60 Deg. Celsius
Humidity	0 - 95% Rh
Inverter efficiency Inverter weighted efficiency	>=95% >=94%

Protection degree	IP 65 for outdoor mounting, IP 54 for indoor mounting
Communication interface	RS 485 / RS 232 / RJ45 / CAN
Safety compliance	IEC 62109-1, IEC 62109-2

2.3. BOOST CONVERTER:

PCU will be as per below specification. Boost Converter will be suitable for MPPT control and it will be used before the grid interfacing inverter.

DC Input Voltage	50 to 200 Volt
O/P DC Voltage	100-300 Volt
O/P DC Power	10 kW
Switching Frequency	10 to 25 kHz
Type of Cooling	Forced Air
Ambient Temp	60 Deg. Celsius

2.4. PCU:

PCU will be as per below specification. For two stage configuration battery control (Applicable Battery: Section-9), MPPT control for Boost converter and Inverter control to be performed. For single stage configuration, only inverter control to be done.

Power Rating	10 KVA
Solar Voltage Range	50-150 VDC
Charge Controller	MPPT based Charge Controller
Grid Input	Three Phase
Grid Voltage Range	350-415 V
Type of Inverter	IGBT based PWM Inverter
O/P Waveform	Pure Sine wave, 50 Hz +-0.5%
O/P Voltage	415+ 10% (Three phase)
Frequency	50Hz
T.H.D	<3% on Linear Load
Inverter Efficiency	> 90%
Conforming to :	IEC 61683, IEC 60068-2

2.5. SHUNT ACTIVE POWER FILTER (FPGA BASED)

One set of Shunt Active Filter to be provided with below specification. Active filter will be connected with micro grid. It should be FPGA based. Earthing, Surge protection and all connection cable is supplier scope.

Line Voltage	415 +/- 15%
Phase & Wire System	# 3 phase, Three Wire
Frequency	50 Hz
Max. Compensating Current	25 A
Transient Response	<0 1 mS
Harmonic Standard	EN 61000-3-4, IEEE 519-1992
Design Standard	EN60146
Safety Standard	EN50178

2.6. ANTI-ISLANDING PROTECTION SCHEME

Anti-Islanding protection scheme should be provided between all inverter and micro grid. Necessary breakers, controller and cables are supplier scope.

2.7. AC DISTRIBUTION BOX

An AC distribution box shall be mounted close to the solar grid inverter. The AC distribution box shall be of the thermo plastic IP65 DIN rail mounting type and shall comprise the following components and cable terminations:

- 5-core (three-phase) cable from the solar grid inverter to distribution box and distribution box to microgrid.
- AC circuit breaker 4-pole
- AC surge protection device (SPD), class 2 as per IEC 60364-5-53
- Outgoing cable to the building electrical distribution board.

2.8. BI-DIRECTIONAL CONVERTER:

This converter will be suitable for charging/ discharging the below battery bank (Section-9). It will be based on IGBT / MOSFET.

DC Input Voltage	100 to 300 Volt
Switching Frequency	10 to 25 kHz
Type of Cooling	Forced Air
Ambient Temp	60 Deg. Celsius

2.9. BATTERY BANK:

One set of battery bank will be provided with below specification.

- Total capacity: 48VDC, 200 Ah
- Type: Valve Regulated Lead Acid (VRLA) tubular GEL type
- Applicable Standards: IEC-61427 & IS-15549
- Low Maintenance, stationary at C/10 rate

It will be staged in racks duly painted with acid resistant paint to cover less space.

ITEM-3

GRID EMULATOR PROGRAMMABLE AC SOURCE:

Programmable AC source will be with following specifications.

1	AC Input	1ϕ 215 V or 3ϕ 415 V, 50 Hz
2	AC Output	• Output Power: 10kVA • Output Voltage: Must be selectable in 0-500V range. • Output Current: In 3 phase mode, maximum current per phase must be 15A or more; In 1 phase mode, maximum current must be 45A or more. • Peak repetitive AC current: At least 3 times the rms current at full scale voltage. • The system must be capable of being used in constant power mode. • Load Regulation ≤ 0.2 % FS • Line Regulation ≤ 0.1% FS • THD: ≤ 0.3% @ 50Hz, 1% @ 1kHz
3	Protection	• Over-voltage, Over-current, Over-temperature, Over Power, The system should automatically shut down with indication.
4	Arbitrary waveform generation capability	• The system should have arbitrary waveform generation capability to • generate Sine, Pi: Sine, Square, Clipped sine, User definedwaveforms, it should also support harmonic from fundamental to at least 40th harmonic. The system must be capable of generating waveform anomalies, harmonics, transients etc. The system should have the GUI for programming and control, Window Graphical User Interface (GUI) is preferable.
5	Measurements	The system should also be capable of measurements such as Vrms, Irms, Inrush current, Peak current, frequency, Power, harmonics measurements ,THD , etc…
6	I/O Interfaces	The system should provide GPIB / RS 232 and USB or LAN interface for PC control
7	Standards Compliance	CE Mark and Major standards of 61000 series.