Technical Specifications

Contents

1. Grid Connected Solar PV with Energy Storage System

The bidder must clearly response the technical specifications and standards asked for the system components in their technical proposal. The bidder must provide the data sheet and technical specifications of all the components including IV curve, efficiency curves, test certificates/reports, warranty certificate, international standards.

1.1 Solar Photovoltaic (PV) Module

The total required PV array capacity must be at least 500kWp. The capacity of individual PV array for 3 different sites must be as follows.

S.N.	Description	Minimum PV Capacity (kWp)
1	Ground Mounted	420
2	GPB 1 Roof Mounted	40
3	GPB 2 Roof Mounted	40

The PV modules shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in manufacturing PV modules: At least 10 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015, OHSAS 18001:2007 or OHSAS 18001:2017 or ISO 45001:2018 Certificates and must be Tier 1		
4	Peak Power of Individual Module at STC: At least 400 Watt-peak		
5	Array Capacity: At least 500kWp		
6	PV Module Efficiency: At least 20%		
7	Module Type: Monofacial		
8	Cell type: Mono PERC Crystalline		
9	No. of Cells per Module: At least 72		
10	Power Tolerance: 0 to +3%		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
11	Fill Factor: At least 75%		
12	The cable connected to the module junction box must be of copper multi-strand, PVC insulated and UV resistant and be provided with minimum cross section of 4mm^2 and length of at least 1 meter with PV connectors		
13	Degree of Protection (Junction Box): At least IP68 according to IEC 60529		
14	Degree of Protection (PV Connectors): At least IP68 according to IEC 60529 The PV connectors must comply with IEC 62852.		
15	Operating Temperature: Minimum range of -20^{o}C to +85^{o}C		
16	Nominal Module Operating Temperature: 42±3 ^{o}C		
17	System Voltage: At least 1000 VDC		
18	A letter provided by principal PV module manufacturer in their letter head stating the warranty period for their PV module. Product Warranty: ≥ 10 years Power Output Warranty: First year: ≥ 97% of STC power 10 years: ≥ 90% of STC Power 25 years: ≥ 80% of STC Power and linear warranty ≤ 0.6% per year from year 2 and onwards		
19	Local Certification required: RETS Certificate (PIT Certificate must be submitted with Bid and RST Certificate must be submitted before the installation)		
20	International Certification: IEC 61215-1:2016, IEC 61215-2:2016 or IEC 61215-1:2021, IEC 61215-2:2021, IEC 61730-1:2004, IEC 61730-2:2004 or		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	IEC 61730-1:2016, IEC 61730-2:2016 and IEC 62804-1:2015 The test certificates must be provided. The Test Certificates from IEC accredited independent laboratory must be provided. The PV Module must be certified by Certification Body Testing Laboratory (CBTL) or National Certification Body (NCB) enlisted in the IECEE website. The enlisted CBTL or NCB must have Scope of PV Module Testing.		
21	The Datasheet and Name Plate Information of PV Module must comply as per EN 50380.		
22	The PV Module must comply as per IEC 60904.		
23	The manufacturer must have accreditation for conformity to ISO/IEC 17025 or IEC 62941. The document/certificate must be provided.		
24	All PV modules offered for the project must be of same type, same model, same power rating and from the same manufacturer.		
25	The PV modules must be packed in a box made from triple strength cardboard resting on a wooden or plywood Pallet. There must be at least 15mm spacing gap between the modules during the packaging.		
26	The Bidder must submit the technical datasheet of PV Module and PV Connector.		

1.2 Weather Station

The weather station along with the data logger shall be provided for adequate meteorological data to evaluate system performance and shall have capability of recording and storing data into the

data logger. The weather station shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in meteorological measurement system: At least 5 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015 Certificate		
4	Pyranometer (Horizontal and POA)		
	Type: Spectrally Flat Class A Secondary Standard		
	Calibration Uncertainty: <1.2%		
	Non Stability: < 0.5%		
	Non Linearity < 0.2%		
	Temperature Sensor: 10kΩ Thermistor		
	Sensor Type: Thermopile		
	Cable: At least 5m cable with connector		
	IP Protection: At least IP67 according to IEC 60529		
	Operating Temperature: Minimum range of -20°C to +50°C		
	Humidity Range: 0 to 100%		
	Fitting Arrangement: The mounting structure for Pyranometer should be parallel to the earth surface provided with stainless steel nut and bolts at the highest point of PV Module		
	Compensated Calibrated Cell with internal temperature compensation: • At least 2 numbers with minimum dimension of 266mm x266mm x35mm • Voltage Radiation Relation: 65 mVdc per output = 1000W/m2 ±2,1% • Measurement Error: ±0.1%		
	International Certification:		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	Comply with ISO 9060:2018, IEC 61724		
5	Pyrheliometer with Sun Tracker		
	Direct Normal Irradiance (DNI) measuring sensor (Pyrheliometer) with Dual Axis Sun Tracker which can be used in combination with any pyranometer to measure the DNI and Global Horizontal Irradiance (GHI) should be provided. • Range: 0-2000 W/m^2 • Drift: upto +/- 2% /year • Accuracy: +/- 5% of Full scale • Operating Temperature: -40 -65C • Spectral response: 300-3000 nm • Degree of Protection: At least IP67 according to IEC 60529		
6	Wind Speed Sensor		
	• Range: 0 to 125 mph (0 to 57 m/s) or more • Accuracy: ±2mph (3km/h, 1m/s) or ±5 %, whichever is greater • Resolution: 1mph (1Knot, 0.1m/s, 1km/hr)Time Constant: no more than 2 seconds		
7	Wind Direction Sensor		
	• Operating Range: 360° mechanical; 355° electrical (5° open) or • Range: 0°to 360°or 16 compass points • Accuracy: +/- 7^o • Resolution: 1^o, 22.5^o between compass points.		
8	Air Temperature Sensor		
	• Resolution: +/- 0.04 (min) to max +/- 0.01		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	• Typical accuracy: +/- 0.3 (maximal is +/- 1.5) Repeatability is (+/-) 0.1 celsius • Operating Range: -10 to +60 Celsius. • Long term drift: < 0.04 Celsius/year.		
9	Wet-Bulb Temperature Meter		
	Stevenson screen including stands and other related materials and items to house dry bulb/air temperature thermometer/ Wet bulb temperature thermometer • Measurement ranges: 0 to 100% r.h., -30 to 100°C • Resolution: 0.01% r.h. 0.01°C • Accuracy: ±2.0% r.h. at 25°C, ±0.5°C at 25°C		
10	Relative Humidity Sensor		
	• Range: 0 to 100%, non-condensing • Accuracy: + 1% RH from 3 to 95%; • Response time: less than 20s		
11	Rain Precipitation Sensor		
	• Temperature: 0 to + 50^{o} C • Diameter of aperture: 225mm • Orifice: 400cm^{2} • Resolution/Sensitivity: 0.2mm • Rainfall capacity: Unlimited • Capacity per Minute: Max. 30 tips (3 resp. 6mm) • Accuracy: ± 1% (at 25 mm/hr.)		
12	Pressure Sensor		
	• Range is 300-1100 hPa, • Resolution is 0.06 hPa to 0.02hPa. • Operating range is -40C to 85C. Best results in 0C to 65C range. • Long term stability is		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	+/- 1 hPa/year.		
13	Soil Temperature Sensor and Soil Moisture Sensor		
	Soil Temperature Sensor: • Measuring surface-soil temperatures WMO standard • The sensor levels should correspond to the WMO instructions (WMO No. 8), with additional sensors at ground level and 5 cm above it • Measurement range: -20 to +60 °C • Resolution: 0.1 °C • Accuracy: ± 0.1		
	Soil Moisture Sensor: • Soil water content measurements between 10cm and 1m • Precision: < ±0.2% volume • Operating range: - 10° to 60°C		
14	Evaporation Pan Sensor		
	• Range: 0 to 250 mm water gauge • Accuracy: 1mm of water dept		
15	Mounting Structure		
	• Single Pole - 3.5-meter installation (SS Pole) • Concrete work to be done to provide more stability to the system • All the related accessories to be provided		
16	Data Logger		
	• A multipurpose Meteorological Data Measurement Logger to receive data from at least 12 meteorological sensors. Capacity to store recorded values for a minimum of one year on disconnection of the network • Data synchronization in case of non-availability of network, data is		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	stored locally which is pushed further when network is available • The software must support WMO compliant measuring methods, especially for wind gust monitoring (4 samples per second) and wind vector monitoring • Local RTC - Local I2C based RTC with low drift with respect to time. • PC software for SD card - PC software for reading data from SD card of at least 8GB • The stored data must be able to be retrieved by direct connection to the logger with laptop computer. Data is also transmitted to a central data receiving system via a GPRS modem which, ideally, should be housed within the logger enclosure/case • 8 Bit micro-controller with low power consumption and functionality to go in deep sleep mode to consume less power. Controller should have 10-bit ADC resolution, 8 Analog inputs I2C port, UART port, Ability to change data push interval • Data protocol - Bencode based data protocol should be used to transfer data from weather station to Webserver in real time. • Power: It should run either from 12V DC power supply or Solar power • Battery Back-up: 4.4 Ah Lithium Polymer battery which should at least give back-up of 7 days without recharge		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	• Enclosure: At least IP65 based weatherproof enclosure with MX connectors to connect the sensor so that the logger is totally insulated from the surrounding environmental conditions • Compatibility: Window 10 or Linux or better		
17	Web Dashboard and Web Server		
	• Webserver to receive, store and analyse data. • Weekly and Monthly reports on the mail. • SMS/Email based alert mechanism. • REST API for further integration or development of institute own dashboard. Visualization of data on last 6 hour, last 24-hour, last week • Functionality to download data between a specified date intervals. • Public access - If requested, same data should be made available to public also		
18	Power Supply from Solar: PV module capacity: At least 75Wp Charge controller: At least 6A Battery: At least 40Ah		
19	Communication Interface: RS485 or Ethernet or USB-C		
20	Monitoring: Remote data sensing		
21	The Bidder must submit the technical datasheet of all the measurement system of Weather Station		

1.3 Grid Connected Inverter

The total required Grid connected inverter capacity must be at least 450kVA. The Grid connected inverter shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in manufacturing inverters: At least 10 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015, OHSAS 18001:2007 or OHSAS 18001:2017 or ISO 45001:2018 Certificates		
4	Warranty: Manufacturing warranty of at least 5 years from inverter manufacturer in their letter head signed and stamped		
5	Inverter type: Three Phase Grid Connected and Multi-MPPT String		
6	Maximum No. of PV Strings per MPPT: 2 No. of Independent MPPT Inputs: At least 8 for 110kVA and at least 4 for 40kVA		
7	AC Output Power: Total Cumulative Capacity of at least 450kVA@45ºC No. of Inverters: At least 6 Ground Mounted: At least 3 x 110kVA + 1 x 40kVA GPB 1 Roof Mounted: At least 40kVA GPB 2 Roof Mounted: At least 40kVA		
8	AC output Voltage: Three Phase 400±10% Vac (L-L), Single Phase 230 ±10% Vac (L-N)		
9	Isolation: Transformerless		
10	Output Frequency: 50 Hz ± 2.5%		
11	Output Wave form: Pure Sine Wave		
12	Peak efficiency: At least 97%		
13	Euro efficiency: At least 97%		
14	Inverter efficiency: The efficiency when operating loads at power levels within 40% to 90% of the rated load must be greater than 90%. The bidder		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	must submit efficiency curve of the inverter to justify operational efficiency.		
15	Total Harmonic Distortion (THD): < 3%		
16	Power factor at nominal power: >0.99 Power factor range: 0.85 lag to 0.95 lead		
17	Degree of Protection: At least IP66 according to IEC 60529		
18	The inverter must be provided with • SPDs at both DC and AC side • DC Isolator at DC side • AC Isolator at AC Side (if not included inside the inverter, external isolator with at least IP65 enclosure must be provided and must have IEC 60947-3)		
19	Protection: DC reverse polarity, grid monitoring, PV string current monitoring, overvoltage, AC short circuit		
20	Grid support: LVRT, HVRT, Active and reactive power control		
21	Operating Temperature: Minimum range of -20ºC to +50ºC		
22	Communication Interface: Modbus or RS232 or RS485 or Ethernet, must communicate with other equipment & monitoring system and must have data logging features		
23	International Certifications: IEC 61727:2004, IEC 62116:2014, IEC 62109-1:2010 & IEC 62109-2:2011, IEC 61683:1999, IEC 60068 and IEC 61000, IEC 60947-3 for AC Isolator The test certificates must be provided.		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	The Test Certificates from IEC accredited independent laboratory must be provided. The Inverter must be certified by Certification Body Testing Laboratory (CBTL) or National Certification Body (NCB) enlisted in the IECEE website. The enlisted CBTL or NCB must have Scope of Inverter Testing.		
24	The Datasheet and Name Plate Information of Photovoltaic Inverter must comply as per IEC 62894.		
25	All Grid connected inverters offered for the project must be of same type and from the same manufacturer.		
26	The Bidder must submit the technical datasheet of Grid Connected Inverter and AC Isolator (if provided externally).		

1.4 Bidirectional Storage Inverter

The total required bidirectional storage inverter capacity must be at least 250kVA. The inverter shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in manufacturing inverters: At least 10 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015, OHSAS 18001:2007 or OHSAS 18001:2017 or ISO 45001:2018 Certificates		
4	Warranty: Manufacturing warranty of at least 5 years from inverter		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	manufacturer in their letter head signed and stamped		
5	Inverter type: Three Phase and AC interactive		
6	AC Output Power: Total Cumulative Capacity of at least 250kVA		
7	Battery Chemistry: LiFePO4		
8	AC output Voltage: Three Phase 400±10% Vac (L-L), Single Phase 230 ±10% Vac (L-N)		
9	Isolation: Transformer		
10	Output Frequency: 50 Hz ± 2.5%		
11	Output Wave form: Pure Sine Wave		
12	Peak efficiency: At least 95%		
13	Total Harmonic Distortion (THD): < 3%		
14	Power factor at nominal power: >0.99 Power factor range: 0.85 lag to 0.95 lead		
15	Degree of Protection: At least IP20 according to IEC 60529		
16	Surge Handling Capacity: At least 150% for 3 sec		
17	Low battery disconnect/cut off voltage: Configurable		
18	The inverter must be provided with • DC Isolator at DC side • AC Isolator at AC Side • SPD at AC side		
19	STS Cabinet		
	The inverter must be provided with Static Transfer Switch (STS) Module or Cabinet to achieve automatic switching between on-grid and off-grid mode. The STS module built-in in inverter cabinet or external STS cabinet shall be provided.		
	Input Voltage Range: -25%±15% Output Voltage Range: -25%±15%		
	Switching Time: < 20ms		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	Conversion Efficiency: At least 99% at full load		
	Protection: AC overvoltage/undervoltage, over frequency/under frequency, AC phase reverse, overload, over temperature		
	Communication Interface: Modbus or RS232 or RS485 or Ethernet		
20	Protection: AC overvoltage/undervoltage, over frequency/under frequency, AC phase reverse, Ground fault, overload, over temperature		
21	Operating Temperature: Minimum range of -20ºC to +50ºC		
22	Features: Bidirectional function, capable to support in battery backup and must be compatible with Grid connected inverter.		
23	Communication Interface: Modbus or RS232 or RS485 or Ethernet, must communicate with Battery Management Unit (BMU) and Energy Management System (EMS) and must have data logging features		
24	International Certifications: IEC 62477-1:2012 or IEC 62109-1:2010 & IEC 62109-2:2011, IEC 61000 The test certificates must be provided. The Test Certificates from IEC accredited independent laboratory must be provided. The Inverter must be certified by Certification Body Testing Laboratory (CBTL) or National Certification Body (NCB) enlisted in the IECEE website. The enlisted CBTL or NCB must have Scope of Inverter Testing.		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
25	The Bidder must submit the technical datasheet of Bidirectional Storage Inverter and STS Cabinet.		

1.5 Lithium Iron Phosphate Battery

The total required lithium iron phosphate (LiFePO4) battery system size must be at least 400kWh. The battery shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in manufacturing LiFePO4 Battery: At least 5 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015, OHSAS 18001:2007 or OHSAS 18001:2017 or ISO 45001:2018 Certificates		
4	A letter provided by principal battery manufacturer in their letter head stating the warranty period for their battery. Product Warranty: ≥ 5 years Performance Warranty: ≥ 10 years		
5	Battery Type: Lithium Iron Phosphate (LiFePO4)		
6	Battery Capacity: At least 400kWh		
7	The battery system must be supplied with battery rack, battery management unit for each battery cluster, master battery management unit for whole battery system, integrated with EMS, properly sized cables & accessories.		
8	The battery management system must be integrated inside each battery module and battery management unit		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	must be configured for each battery cluster.		
9	Battery Management System Function: voltage, current, temperature monitoring on cell level		
10	Battery Management Unit Function: collect battery data, monitor and control the cluster of batteries		
11	Cycle usage: At least 5,000 cycles at 90% DoD		
12	Average Self Discharge: ≤3% per month at 25^{o}C		
13	Operating Temperature: Minimum range of -10^{o}C to +50^{o}C		
14	The battery rack and enclosure cabinet shall be rated for installation suitable inside the room and must be rated for at least IP20 according to IEC 60529.		
15	The installation materials for each battery set must be supplied complete in all including mounting racks, enclosure cabinet, cell connecting copper flexible cables of suitable size, stainless steel screws, bolts, washers, insulated terminal post covers, cable shoes, fixing accessories.		
16	International Certification: IEC 62619:2017 for Cell and Battery Cluster The test certificates must be provided. The Test Certificates from IEC accredited independent laboratory must be provided. The battery must be certified by Certification Body Testing Laboratory (CBTL) or National Certification Body (NCB) enlisted in the IECEE website. The enlisted CBTL or NCB must have Scope of Battery Testing.		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
17	All batteries offered for the project must be of same type, same model, same capacity rating and from the same manufacturer.		
18	The Bidder must submit the technical datasheet of LiFePO4 Battery System and Material Safety Data Sheet.		

1.6 Support Structure for PV Modules

The Support Structure shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name		
2	Manufacturer's experience in manufacturing support structure: At least 5 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015 Certificates		
4	Tilt angle and orientation: Optimum PV production angle at given latitude/longitude of the site, oriented towards south		
5	The support structure design and foundation or fixation mounting arrangements shall consider all static and dynamic loads suitable for site. The support structure design and foundation or fixation mounting arrangements must withstand wind speed up to 170 km/hr. The wind + snow load analysis must be provided.		
6	The PV module structure must be made of MS hot dip galvanized suitable sections of rectangular		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	tubes, angles and channels. The minimum standards to be followed are: Vertical leg (Main leg): Minimum 80mmx40mmx2mm Rectangular Hollow Section Rafter: Minimum 80mmx40mmx2mm Rectangular Hollow Section Purlin: Minimum 80mmx40mmx2mm Rectangular Hollow Section Column bracing or supporting bracing:Minimum 40mmx40mmx5mm angle The horizontal spacing between 2 vertical legs must be between 1.5-2 meters as per load conditions. The PV array must be designed with cross section with maximum 2 numbers for vertical placement and maximum 4 numbers for horizontal placement. There must be minimum of 25mm uniform spacing between the modules. The minimum thickness of galvanization must be at least 90 microns throughout the surface. The test report for random sampling of structure members must be provided from authorized test laboratory.		
7	The support structure and its accessories shall be able to resist at least 25 years of outdoor exposure without suffering damage or corrosion.		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
8	The support structure shall be installed in such a way that PV array shading is minimized as much as possible considering site condition		
9	The minimum clearance between ground level and bottom edge of the PV modules/arrays must be at least 50cm.		
10	Stainless Steel (SS 304) nuts, bolts, washers must be used for fixing modules with the structure. Stainless Steel (SS 304) or Galvanized nuts, bolts, washers, mounting clamps should be used for fixing structure and compatible with materials which it is being fixed. In case of welding structure, the galvanization must be done after the fabrication work.		
11	For ground mounted system, the foundation of PV structure shall be minimum 0.8 meter deep with 0.3(L) x 0.3(B) size with 0.3m thick stone soling with sand filling and 0.3(L) x 0.3(B) x 0.8(H) pillar in 1:2:4 PCC with 0.3m pillar above ground.		
12	For roof mounted system, the foundation of PV structure shall be 1:2:4 RCC of minimum 0.3(L) x 0.3(B) x 0.3m(H) above the roof floor level and anchor plate with minimum 200mmx200mmx6mm (GI with at least 90 microns) & galvanized anchor bolt with minimum 100mmxø12 with galvanized nuts, washers.		

1.7 Junction Box

The junction boxes are to be provided in the PV array for the termination of PV string connecting cables. The Junction box shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in manufacturing junction boxes: At least 5 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015 Certificates		
4	Warranty: Manufacturing warranty of at least 5 years from junction box manufacturer in their letter head signed and stamped		
5	The Junction box must be rated for exterior installation suitable for the site conditions, shall be UV and weather resistant. Degree of Protection: At least IP65 according to IEC 60529		
6	The junction box installation must be protected from direct rain, sun and dust. The junction box must be suitable for mounting on the module support structures.		
7	If the fuses are not provided at input side of grid connected inverter (inside the inverter), each junction box must include the PV string fuses as recommended by PV module manufacturer. The PV string fuse must be provided in both positive & negative sides in the box and must have IEC 60947-3.		
8	Fuses must be cylindrical type mounted on appropriately sized non exposed type DC fuse block or DC fuse holders. The fuse holders/block may be DIN rail adapted. Degree of Protection: At least IP20 according to IEC 60529		
9	The Fuse must be designed for at least nominal voltage of DC 1000V.		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
10	The junction box must be provided with copper bus bars with suitable termination blocks.		
11	The junction box must be provided for each PV String.		
12	The junction box must be provided with IEC 62208 hinged door with EPDM rubber gasket to prevent water entry.		
13	All cables must be connected properly and cable entering/outings into/from the box must be sealed properly (use of cable glands, copper cables lugs, cable ties) so that dust and insects, mice cannot enter the box.		
14	The PV Connectors to be used connecting to the MPPT input of the Inverter must be compatible with the original PV module connector. Only the connector type supplied by the module manufacturer or approved by the module manufacturer must be used and must comply with IEC 62852.		
15	The PV Connectors must be provided with degree of protection of at least IP68 according to IEC 60529.		
16	The cable glands must be provided with degree of protection of at least IP66 according to IEC 60529.		
17	International Certification: IEC 61439-1:2011, IEC 61439-2:2011 or IEC 61439-1:2020, IEC 61439-2:2020, IEC 60947-3 for PV string fuse The test certificates must be provided. The Test Certificates from IEC accredited independent		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	laboratory must be provided. All the components must be certified by Certification Body Testing Laboratory (CBTL) or National Certification Body (NCB) enlisted in the IECEE website. The enlisted CBTL or NCB must have Scope of Testing.		
18	The Bidder must submit the technical datasheet of Junction Box and PV String Fuse.		

1.8 Grid Connected AC Combiner Box

The Grid connected AC combiner box shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in manufacturing combiner boxes: At least 5 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015 Certificates		
4	Warranty: Manufacturing warranty of at least 5 years from combiner box manufacturer in their letter head signed and stamped		
5	The Grid Connected AC combiner box must be rated for exterior installation suitable for the site conditions, shall be UV and weather resistant. Degree of Protection: At least IP65 for outdoor and at least IP54 for indoor according to IEC 60529		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
6	The combiner box must be provided with copper bus bars with suitable termination blocks.		
7	The combiner box must be provided with IEC 62208 hinged door with EPDM rubber gasket to prevent water entry		
8	The combiner box must have AC 4P Isolator: At least 200A & 80A connecting the output of 110kVA & 40kVA Grid Connected Inverters respectively and Isolator must have IEC 60947-2.		
9	The combiner box must have AC 4P MCCB: At least 200A & 80A connecting the output of 110kVA & 40kVA Grid Connected Inverters respectively AC 4P MCCB: At least 800A connecting the input of AC Distribution Board and MCCB must have IEC 60947-2.		
10	The MCCB must be used to isolate each output of Inverter and the output of AC combiner box. Degree of Protection: At least IP20 according to IEC 60529		
11	The combiner box must have appropriately sized AC surge protection device for each inverter output. The SPD must have IEC 61643-11:2011 and grounded adequately.		
12	The SPD must be Type 1+2, 20kA nominal discharge and 40 kA maximum discharge current. Degree of Protection: At least IP20 according to IEC 60529		
13	The MCCB and SPD must be designed for at least nominal voltage of AC 400V.		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
14	The following parameters shall be displayed in combiner box for all incoming and outgoing feeders • Indicators for each phase • Voltage, Current and Power (kVA, kW, KVAr) • Power Factor and Frequency • Energy • Protection:AC overvoltage/undervoltage, over frequency/under frequency, AC phase reverse, overload, earth fault All the instrumentation above must be digital with accuracy class of 0.5 and RS485 or Modbus communication port.		
15	All cables must be connected properly and cable entering/outings into/from the box must be sealed properly (use of cable glands, copper cables lugs, cable ties) so that dust and insects, mice cannot enter the box.		
16	The cable glands must be provided with degree of protection of at least IP66 according to IEC 60529.		
17	International Certifications: IEC 60947-2 for AC MCCB, IEC 60947-3 for AC Isolator, IEC 61643-11:2011 for AC SPD IEC 61439-1:2011, IEC 61439-2:2011 or IEC 61439-1:2020, IEC 61439-2:2020 for AC Combiner Box The test certificates must be provided. The Test Certificates from IEC accredited independent laboratory must be provided. All the components must be certified by Certification Body Testing		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	Laboratory (CBTL) or National Certification Body (NCB) enlisted in the IECEE website. The enlisted CBTL or NCB must have Scope of Testing.		
18	The Bidder must submit the technical datasheet of Grid connected AC combiner box, AC Isolator, AC MCCB, AC SPD and 3-Phase Digital Meter.		

1.9 AC Distribution Board

The AC Distribution Board shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in manufacturing distribution board: At least 5 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015 Certificates		
4	Warranty: Manufacturing warranty of at least 5 years from distribution board manufacturer in their letter head signed and stamped		
5	The AC Distribution Board must be rated for installation suitable inside the control room. Degree of Protection: At least IP65 for outdoor and at least IP54 for indoor according to IEC 60529		
6	The distribution board must be provided with copper bus bars with suitable termination blocks.		
7	The distribution board must be provided with hinged door with EPDM rubber gasket.		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
8	The distribution board must have AC 4P ACB: At least 800A connecting the output of Grid Connected AC Combiner Box AC 4P ACB: At least 1000A connecting the system output to grid and ACB must have IEC 60947-2.		
9	The distribution board must have 4 number of AC 4P ACB or appropriate switchgears, each of at least 250A for supplying power to four feeders of different priority level.		
10	The ACB must have remote electronic tripping and making function with protection system such as AC overvoltage/undervoltage, over frequency/under frequency, overload, earth fault		
11	Degree of Protection for ACB: At least IP20 according to IEC 60529		
12	The distribution board must have appropriately sized AC surge protection device. The SPD must have IEC 61643-11:2011 and grounded adequately.		
12	The SPD must be Type 1+2, 20kA nominal discharge and 40 kA maximum discharge current. Degree of Protection: At least IP20 according to IEC 60529		
13	The ACB and SPD must be designed for at least nominal voltage of AC 400V.		
14	The following parameters shall be displayed in combiner box for all incoming and outgoing feeders • Indicators for each phase • Voltage, Current and Power (kVA, kW, KVAr) • Power Factor and Frequency		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	• Energy • Protection:AC overvoltage/undervoltage, over frequency/under frequency, AC phase reverse, overload, earth fault All the instrumentation above must be digital with accuracy class of 0.5 and RS485 or Modbus communication port.		
15	All cables must be connected properly and cable entering/outings into/from the box must be sealed properly (use of cable glands, copper cables lugs, cable ties) so that dust and insects, mice cannot enter the box		
16	The cable glands must be provided with degree of protection of at least IP66 according to IEC 60529.		
17	International Certifications: IEC 60947-2 for AC ACB, IEC 61643-11:2011 for AC SPD IEC 61643-11:2011 for AC SPD IEC 61439-1:2011, IEC 61439-2:2011 or IEC 61439-1:2020, IEC 61439-2:2020 for AC Distribution Board The test certificates must be provided. The Test Certificates from IEC accredited independent laboratory must be provided. All the components must be certified by Certification Body Testing Laboratory (CBTL) or National Certification Body (NCB) enlisted in the IECEE website. The enlisted CBTL or NCB must have Scope of Testing.		

1.10 Cables and Accessories

The cables and accessories shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand		
2	Manufacturer's experience in manufacturing cables: At least 5 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015 Certificates		
4	PV String Cable:		
	The cables sizes shall be selected considering the power loss, current carrying capacity, voltage drop, and the period of short circuit to meet the anticipated currents.		
	The PV string cable must be copper multi-strand, PVC insulated and UV resistant. The string cable must be PV1-F type and must comply with IEC 62930 or EN 50618, IEC 60228, IEC 60332-1 or EN 50575, IEC 60754-1 or EN 50525		
	The PV string cable must be specific for PV application with double insulation layers.		
	The PV string cable must be 1100 V (minimum) grade, single/multi core.		
5	Cabling for DC Cables:		
	The cables must be laid underground in trenches and through suitable size of flexible HDPE Pipe with minimum PN6 Class wherever required and necessary according to relevant		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	IEC standards and best installation practice.		
	The underground installation cables must be laid at depth not less than 0.8m below ground level. Prior to cable laying, the bottom of the trench shall be well compacted and bedded with fine sand of at least 75mm. Subsequently the second layer of fine sand of at least 75mm shall be spread over the cable and then covered by brick and compacted soil.		
6	AC Cable from Grid Connected Inverter to Grid Connected AC Combiner Box & Grid Connected AC Combiner Box to AC Distribution Board to Transformer		
	The cables sizes shall be selected considering the power loss, current carrying capacity, voltage drop, maximum short circuit duty and the period of short circuit to meet the anticipated currents.		
	The cable from Grid connected inverter to Grid connected AC combiner box, must be 1100V (minimum) grade, multi core, aluminium XLPE insulated with extruded PVC inner sheath.		
	The conductor shall be high conductivity annealed copper and shall be smooth, uniform in quality and free from scale and any defects.		
	The maximum conductor temperature for PVC insulation shall not exceed 70^{o}C during continuous operation at full rated current. The temperature after short circuit for 1 second shall not		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	exceed 160^{o}C with initial conductor temperature of 70^{o}C.		
	The cable from Grid connected AC combiner box to AC distribution board to transformer must be 1100V (minimum) grade, multi core, aluminium XLPE insulated with extruded PVC inner sheath.		
	The maximum conductor temperature for XLPE insulation shall not exceed 90^{o}C during continuous operation at full rated current. The temperature after short circuit for 1 second shall not exceed 250^{o}C with initial conductor temperature of 90^{o}C.		
	The cables shall be armoured with mild steel wires or strips as required for underground and in trench installations.		
	The cables must comply with IEC 60502-1 and IEC 60228.		
7	Cabling for AC Cables:		
	The cables must be laid underground in trenches and through pipe sleeves wherever required and necessary according to relevant IEC standards and best installation practice.		
	The underground installation cables must be laid at depth not less than 0.8m below ground level. Prior to cable laying, the bottom of the trench shall be well compacted and bedded with fine sand of at least 75mm. Subsequently the second layer of fine sand of at least 75mm shall be spread over the cable and then covered by brick and compacted soil.		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	In case of road crossing, all cables must be installed in conduit, suitable flexible HDPE Pipe with minimum PN6 Class and 1:2:4 RCC concrete.		
	All cable terminations must be mechanically and electrically sound and shall comply with relevant standards.		
	All the excavation and back fill required for the installation of the cables must be carried out. The contractor must restore all surfaces, roadways, side walls, curbs, walls, landscaping or other works cut for excavation to their original condition. Underground cables and cable joints shall be marked on the surface by markers generally manufactured and tested to the requirements of relevant standards.		
8	The fiber/other communication cables must be laid separately from DC and AC cables according to relevant IEC standards and best installation practice.		
9	The allowable voltage drop from • PV Module or PV Array to Grid connected inverter must not exceed 3% • Bidirectional storage inverter to LiFePO4 battery system must not exceed 1% • Grid connected inverter/Bidirectional storage inverter to AC distribution board must not exceed 5% • AC distribution board to transformer must not exceed 3%		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
10	The cross section of DC and AC cable must be as follows. PV String Cable: At least 4mm^2 AC Cable from Grid Connected Inverter to Grid Connected AC Combiner Box (Ground Mounted Solar): At least 3.5C x 240mm^2 and 3.5C x 120mm^2 for 110kVA and 40kVA inverters respectively AC Cable from Grid Connected Inverter to Grid Connected AC Combiner Box (Roof Mounted Solar): At least 3.5C x 120mm^2 AC Cable from Bidirectional Storage Inverter: 2 numbers with each of at least 3.5C x 240mm^2 AC Cable from Grid Connected AC Combiner Box to AC Distribution Board to Transformer: 4 numbers with each of at least 3.5C x 240mm^2		
11	International Certification: IEC 62930 or EN 50618 for PV String Cable The test certificate must be provided. The Test Certificate from IEC accredited independent laboratory must be provided. The cables must be certified by Certification Body Testing Laboratory (CBTL) or National Certification Body (NCB) enlisted in the IECEE website. The enlisted CBTL or NCB must have Scope of Testing.		
12	The Bidder must submit the technical datasheet of DC and AC Cables, HDPE Pipe.		

1.11 Earthing System

The earthing system shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in manufacturing Earthing System: At least 10 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015 Certificates		
4	Warranty: Manufacturing warranty of at least 5 years from earthing system manufacturer in their letter head signed and stamped		
5	All the metallic parts of the PV modules frame must be interconnected by insulated multi-stranded copper earth wire of minimum cross section of 16mm^2 and tinned copper compression lug		
6	The PV array connected to each Grid connected inverter, must have separate equipotential bonding system.		
7	The PV modules frame, array structure, SPDs, junction boxes, must be connected to equipotential bonding system by insulated multi-stranded copper earth wire of minimum cross section of 16mm^2.		
8	The equipotential bonding system must be connected to the earth termination system by insulated multi-stranded copper earth wire of minimum cross section of 25mm^2. The maximum allowable earth resistance is 5 Ohms.		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
9	Each Grid connected inverter must be connected to separate earth termination system by insulated multi-stranded copper earth wire of minimum cross section of 25mm^2. The maximum allowable earth resistance is 5 Ohms.		
10	The Grid connected AC combiner box, Bidirectional storage inverter, LiFePO4 battery system, AC distribution board, operation control panel board and other associated system must be connected to separate earth termination system by insulated multi-stranded copper earth wire of minimum cross section of 25mm^2. The maximum allowable earth resistance is 5 Ohms.		
11	The underground earth cable must be of bare copper earth conductor with minimum cross section of 25mm^2.		
12	The cables must be laid underground in trenches and through suitable size of flexible HDPE Pipe with minimum PN6 Class wherever required and necessary according to relevant IEC standards and best installation practice.		
13	The underground installation cables must be laid at depth not less than 0.8m below ground level. Prior to cable laying, the bottom of the trench shall be well compacted and bedded with fine sand of at least 75mm. Subsequently the second layer of fine sand of at least 75mm shall be spread over the cable and		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	then covered by brick and compacted soil.		
14	Earth Termination System:		
	The earth electrode must be of Pipe-in-Pipe technology and the inner space must be filled with highly conductive and corrosion resistant compound.		
	The length of earth electrode must be at least 2.5 meters.		
	The earth electrode must be made of copper.		
	The earth electrode must have outer diameter of at least 50mm and inner diameter of at least 25mm.		
	A hole of minimum 100mm diameter or as per manufacturer's recommendation must be dug for the length of electrode.		
	The earth wire must be connected to the individual earth electrode with the use of tinned copper compression lug.		
	The certified low resistivity earth enhancement material must be used to fill the hole with the electrode.		
	The earth enhancement material must be at least 50kg for each earthing electrode.		
	The maximum allowable earth resistance is 5 Ohms.		
	The earth inspection pit of each earthing electrode must be made of solid concrete with the minimum dimension of 300m x 300mm x300mm. The cover must be marked with the word "Earth".		
	The earth termination system must comply with IEC 62305.		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
15	Earthing 1: PV modules frame, array structure, junction boxes, Grid connected AC combiner box (Ground mounted system) Earthing 2,3,4&5: Grid connected inverter (Ground Mounted) Earthing 6: PV modules frame, array structure, junction boxes, Grid connected inverter (GPB 1) Earthing 7: PV modules frame, array structure, junction boxes, Grid connected inverter (GPB 2) Earthing 8: Grid connected AC combiner box, Bidirectional storage inverter, LiFePO4 battery system, AC distribution board, Operation control panel board and other associated system (Control Room)		
16	Earthing 1: At least 2 nos of earth electrode for ground mounted system Earthing 2,3,4&5: At least 1 no of earth electrode for each Grid connected inverter Earthing 6&7: At least 1 no of earth electrode for each roof mounted system Earthing 8: At least 1 no of earth electrode		
17	Separation between earthing system: At least height of earthing electrode		
18	The Bidder must submit the technical datasheet of Earthing System and HDPE Pipe.		

1.12 Lightning Protection System

The lightning protection system shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model:		
2	Manufacturer's experience in manufacturing Lightning Protection System: At least 10 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015 Certificates		
4	Warranty: Manufacturing warranty of at least 5 years from lightning protection system manufacturer in their letter head signed and stamped		
5	The lightning protection system must be designed according to the IEC 62305.		
6	Air Termination System		
	The air terminal rod must be at a minimum height of 2 meter above the highest point of the PV array to be protected.		
	The length of air terminal rod must be at least 1 meter.		
	The air terminal rod must be made of solid copper.		
	The diameter of air terminal rod must be at least 15mm.		
	The air terminal rod must have at least 4 spikes at minimum angle of 25^{o} with the horizontal surface and arrester base.		
	The air terminal rod must be rated to withstand a discharge current capacity of 200kA.		
	The air terminal rod must be installed on a separate concrete base as a free standing air terminal mast. The mast must be made of solid GI pipe of at least 75mm diameter and 3mm thickness.		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	At least one air terminal rod must be used for each LPS.		
	The separation distance between the air terminal rod and the closest metallic part of PV array must be as per IEC 62305.		
	The separation distance between the air terminal rods must be at least the height of earthing electrode.		
	Each terminal rod must have separate earth termination system.		
	The air termination system must comply with IEC 62305.		
7	Down Conductor:		
	The size of down conductor must be at least 25mm width x 6mm thickness copper strip, connecting the lower extremity of air terminal rod to the earthing electrode of earth termination system		
	The cable must be buried at minimum 0.5 height at ground level.		
	The copper strip must be connected to the earth electrode with the use of copper compression lug.		
	The earth termination system must comply with IEC 62305.		
8	Lightning Counter		
	The lightning counter must be rated to withstand a discharge current capacity of 200kA.		
	Count Number: At least 4 digits		
	The mounting arrangement of counter must be compatible with the size of down conductor.		
	Working mode: Without battery		
	Degree of protection: At least IP67 according to IEC 60529.		
9	Earth Termination System:		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	The earth electrode must be of Pipe-in-Pipe technology and the inner space must be filled with highly conductive and corrosion resistant compound.		
	The length of earth electrode must be at least 2.5 meters.		
	The earth electrode must be made of copper.		
	The earth electrode must have outer diameter of at least 50mm and inner diameter of at least 25mm.		
	A hole of minimum 100mm diameter or as per manufacturer's recommendation must be dug for the length of electrode.		
	The certified low resistivity earth enhancement material must be used to fill the hole with the electrode.		
	The earth enhancement material must be at least 50kg for each earthing electrode.		
	The maximum allowable earth resistance is 5 Ohms.		
	The earth inspection pit of each earthing electrode must be made of solid concrete with the minimum dimension of 300mm x 300mm x300mm. The cover must be marked with the word "Earth".		
	The test link must be provided and connected to the down conductor at minimum 1 meter height from the ground level. The test link must be made up of phosphorous bronze.		
	The earth termination system must comply with IEC 62305.		
10	LPS 1,2,3&4: Ground mounted system LPS 5: Control Room		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	LPS 6: GPB 1 LPS 7: GPB 2		
11	The number of earth electrodes must be at least 3 for each LPS.		
12	The Bidder must submit the technical datasheet of Air Termination System, Down Conductor, Lightning Counter and Earth Termination System.		

1.13 Monitoring System and Data Acquisition System

The Monitoring System and data acquisition system shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in manufacturing monitoring system: At least 5 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015 Certificates		
4	Warranty: Manufacturing warranty of at least 5 years from monitoring system manufacturer in their letter head signed and stamped		
5	RS485 or Modbus communication port for receiving data from PV strings, grid connected inverters, bidirectional storage inverter, Master BMU with EMS, AC distribution board etc		
6	RS232 or LAN port or Modbus for local monitoring or network monitoring		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
7	Internet connection via GSM modem, CDMA, GPRS, 3G, 4G, ADSL, VSAT		
8	The system must have remote monitoring software with the latest software/hardware configuration and service connectivity for online/real time data monitoring. The following parameters shall be accessible via the operating interface display in real time. • Array DC Voltage, Current & Power • Battery voltage, current, temperature • Inverter AC Output Voltage and Current (all 3 phases and lines) • AC Power (Active and Apparent) • Power Factor • Frequency • AC Energy (all 3 phases and cumulative)		
10	The system must have plant control and monitoring station with necessary software/app compatible with the overall system.		
11	The plant monitoring station must be provided as follows. Processor: At least Intel Core 10th Generation i7 Memory: At least 16GB Hard Drive: At least 1TB SSD Wireless LAN: Dual band LED Monitor: At least 32" FHD		
12	The communication medium from PV Plant location to Control Room must be of Optical Fiber Cable with fiber switch, splice box and all necessary accessories for complete		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	system operation. The fiber cable must be of at least 12 Core.		
13	The fiber/other communication cables must be laid underground in trenches and through pipe sleeves and suitable size of flexible HDPE Pipe with minimum PN6 Class according to relevant IEC standards and best installation practice.		
14	The bidder must submit the technical datasheet of Monitoring System, Data Acquisition System, Fiber Optics System and HDPE Pipe.		

1.14 Operation Control Panel Board

The 500 kWp grid-connected solar PV with 400 kWh energy storage system (further referred to as a solar plant) is designed to provide uninterrupted reliable power supply to the university when the grid fails and also export energy to the grid when there is surplus energy. The solar plant is constituent part of the planned microgrid comprising the solar plant and a 600 kW pump storage plant. At the initial stage the university power system will be fed by the solar plant and grid only. The solar plant, in principle, is also a microgrid as the university power system is designed to operate with or without a connection to the grid. Therefore, the proposed power plant should include controls required for smooth operation of the power system not withstanding fluctuations in the power demand and supply within the university and in various fault scenarios, including those related to the grid. Separate operation control panel board must be provided with all necessary instrumentation, control devices, accessories, compatible with system operation & control requirements. The control and protection requirements to be provided is described below.

Grid available

When the grid is available, energy export to the grid should be allowed only after batteries are fully charged. In the case of energy import, charging the batteries should remain the highest priority. This implies that when the power demand is higher than the power available from the grid and solar PVs the batteries should not be allowed to discharge. To fulfill this requirement the controller should be designed to switch off the lowest priority load (supply to the university system is provided through four feeders of different priority) till the batteries are fully charged. In the very unlikely event of the total of the first, second and third priority loads being higher than the total power available from the grid and solar PVs, the controller should also switch off the third priority feeder till the batteries are fully charged. In addition, batteries should not be allowed to supply energy when the grid is available.

Grid not available

When the grid is not available charging batteries should be the highest priority load. When the university load is higher than that of the PV power generation, the supply to other loads should depend upon the battery voltage (V), which is correlated with stored retrieval energy. Assume the following four battery voltage ranges:

- $(V_{min} + (V_{nom}-V_{min})/4) => V > V_{min}$ **(first priority feeder)**
- $(V_{min} + (V_{nom}-V_{min})/4) > V >= (V_{min} + (V_{nom}-V_{min})/2)$ **(first and second priority feeders)**
- $(V_{min} + (V_{nom}-V_{min})/2) > V >= (V_{min} + (V_{nom}-V_{min})*(3/4))$ **(for first, second and third priority feeders)**
- $> (V_{min} + (V_{nom}-V_{min})* (3/4))$ **(for first, second and third priority feeders; selective loads of fourth priority feeder)**
  where, V_{min} - minimum permissible discharge voltage and V_{nom} – nominal voltage

The feeders receiving supply from the battery corresponding to various battery voltage ranges is indicated in bold alongside the voltage ranges above.

When PV power generation is higher than the university load, energy export will take place once the university power requirement is fully met that is all four feeders will be switched on.

Fault Scenarios

Grid failure

The university power system should be designed to respond to the grid failure, which is frequent at Chitlang, with minimal impact in terms of the reliability of the power supply. The following sequence of operation needs to be ensured for this purpose:

1. Switching off grid-tie inverters and bidirectional inverters resulting in supply failure in the university
2. Switching on bidirectional inverters at the earliest and resumption of supply to the university
3. Switching on grid-tie inverters if there is solar generation

Grid supply resumption

The following sequence of operation needs to be ensured for ensuring university supply with minimum interruption:

1. Wait for a predefined period of time after the supply resumption to ensure that there is a reliable supply
2. Once supply is found to be reliable, switching off the bidirectional inverter and grid tie inverters (if on)
3. Switching on bidirectional inverter within the shortest period
4. Switching on grid tie invertors within the shortest period

A controller designed to meet above operational requirements and protect the system in case of various faults should be supplied. The controller should be programable to respond to changes in the system parameters such as the share of power of priority feeders, wait time when grid supply resumes etc.

The Operation Control Panel Board shall comply with following technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015 Certificates		
3	Warranty: Manufacturing warranty of at least 5 years from operation control panel board manufacturer in their letter head signed and stamped		
4	PLC Module must have High Speed Universal CPU module with Processing Speed < 3.9ns Storage capacity >520 kB		
5	PLC module must have sufficient IO points for the functional requirement described in 1.21 Operational requirement for control panel board.		
6	PLC module must be expandable up to 700 points.		
7	PLC module shall have overvoltage, over current, inrush current and momentary power failure protection.		
8	PLC module must have full communication support with ethernet TCP/IP.		
9	The control panel board must have local control, remote manual control and remote control through HMI.		
10	The required software for PLC, HMI must be provided with full single license.		
11	International Certifications: IEC 61000, IEC 55011, IEC 61131, IEC 60664, IEC 61010		

1.15 Containerized System (Control Room)

The containerized system shall comply with following technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in manufacturing containerized system: At least 5 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015 Certificates		
4	Warranty: Manufacturing warranty of at least 5 years from containerized system manufacturer in their letter head signed and stamped		
5	The Containerized System must be rated for exterior installation suitable for the site conditions, shall be UV and weather resistant. Degree of Protection: At least IP65 according to IEC 60529		
6	External Dimension: Minimum 6.09m (L) x 2.43m (W) x 2.59m (H) Internal Dimension: Minimum 5.89m (L) x 2.35m (W) x 2.38m (H)		
7	The container must be provided with double door design on both ends		
8	The containerized system must include the LiFePO4 Battery System, Bidirectional Storage Inverter, STS Cabinet, Grid Connected AC Combiner Box, AC Distribution Board, Monitoring System & Data Acquisition System,		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	Operation Control Panel Board, other associated system and all accessories.		
9	There must be separate containerized system for LiFePO4 Battery System. No. of Containerized System: At least 2 nos.		
10	The container must have a separate compartment for LV switchgears and separate for monitoring system & data acquisition system.		
11	The container must be made of corrugated steel and must comply as per Standard Shipping Container.		
12	The floor of the container must bear the floor loading of the equipment.		
13	The container must have ventilation louvres to maintain the inside temperature.		
14	The container must provide mounting board for AC Distribution Board, Monitoring System, Control System and all other accessories.		
15	The container must be protected by 2-pack paint system i.e. single coat of primer & top 2 coat (Standard color: RAL 9010)		
16	The Containerized System must comply with ISO/TC 104.		
17	The Bidder must submit the technical datasheet of Containerized System.		

1.16 Transformer

The transformer shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in manufacturing transformer: At least 10 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015 Certificate		
4	Warranty: Manufacturing warranty of at least 2 years from transformer manufacturer in their letter head signed and stamped		
5	Transformer type: Three phase and outdoor oil filled		
6	Rated Capacity: At least 630kVA		
7	Rated Voltage: Primary Voltage (LV): 400V Secondary Voltage (HV): 11000V		
8	Frequency: 50 Hz		
9	Type of Cooling: ONAN		
10	Impedance at 75^{o}C: 5%		
11	Tolerance on Impedance: ±10%		
12	Duty: Continuous		
13	Max. Temp. Rise over an ambient of 50^{o}C Oil (Temperature rise measurement by thermometer): 50^{o}C Winding Temperature rise measurement by resistance method): 55^{o}C		
14	Windings: System Apparent Short circuit level (kA): as per IEC 60076-1 Winding Connection: LV: Star HV: Delta		
15	Vector Group: Dyn11		
16	Insulation: Uniform		
17	Insulation Level: LV: At least 2 kVrms HV: At least 28 kVrms		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
18	Basic Impulse Level: HV: At least 75kVp		
19	Highest voltage (kV) for each winding: 12kV		
20	Method of earthing: Solidly earthed		
21	LV & Neutral Bushing: Rated Voltage: At least 1.1kV Rated current: At least 1000A Wet & Dry Power frequency Withstand Voltage: At least 2kVrms Min. Total Creepage Distance: 300mm Mounting: Tank / Transformer Body		
22	HV Bushing: Rated Voltage: At least 12kV Rated current: At least 100A Basic Impulse Level: At least 75kVp Wet & Dry Power frequency Withstand Voltage: At least 28kVrms Mounting: Tank / Transformer Body		
23	Terminal Details: LV & Neutral: Cable Box HV: Suitable for 11kV Cable or Over Head Conductor		
24	Min. Clearance in Air: Ph-Ph (LV/HV): 25/280 Ph-Earth (HV/LV): 25/140		
25	Factory Test:		
	All standard routine tests in accordance with latest issue of IEC: 60076 shall be carried out on each transformer.		
	In addition to all type and routine tests, transformer shall also conform to following additional type tests as per IEC: 60076. a) Measurement of zero sequence impedance b) Short circuit test		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	c) Measurement of capacitance and tan delta of transformer winding. d) Test on oil samples as per IS 60296		
	All auxiliary equipment shall be tested as per the relevant IS Test Certificates shall be submitted for bought out items.		
	High voltage withstand test shall be performed on auxiliary equipment and wiring after complete assembly.		
	Tank Tests: i) Routine Tests: As per IEC: 60076 Part-1		
26	The transformer must be supplied along with LA, DO Fuse, 11kV cable, cable termination kits and all accessories Cross section of 11kV aluminium cable: At least 3Cx25mm^2		
27	The transformer must be ground mounted with mounting foundation and fencing.		
28	On Load Tap Changer (OLTC)		
	The OLTC must be in HV side with 17th position of 2.5% steps.		
	Tap Range: -30%+10%		
	The OLTC must be supplied with Remote Tap Changer Control (RTCC) Panel and Automatic Voltage Regulator (AVR) with complete necessary control/protection system, all necessary cables & accessories.		
29	The HT Metering System (TOD Meter, CT, PT with all accessories) must be supplied as per NEA requirements.		
30	The Bidder must submit the technical datasheet of Transformer System, CT, PT, 11kV Cable.		

1.17 Earthing System for Transformer

The earthing system shall comply with following standards and technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in manufacturing Earthing System: At least 10 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015 Certificates		
4	Earthing Conductor:		
	The Body, Neutral of Transformer and LA must be connected to separate earth termination system by at least 25mm width x 6mm thickness copper strip.		
	The cable must be buried at minimum 0.5 height at ground level.		
	The copper strip must be connected to the earth electrode with the use of copper compression lug.		
5	Earth Termination System:		
	The earth electrode must be of Pipe-in-Pipe technology and the inner space must be filled with highly conductive and corrosion resistant compound.		
	The length of earth electrode must be at least 2.5 meters.		
	The earth electrode must be made of copper.		
	The earth electrode must have outer diameter of at least 50mm and inner diameter of at least 25mm.		
	A hole of minimum 100mm diameter or as per manufacturer's		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	recommendation must be dug for the length of electrode.		
	The earth wire must be connected to the earth electrode with the use of tinned copper compression lug.		
	The certified low resistivity earth enhancement material must be used to fill the hole with the electrode.		
	The earth enhancement material must be at least 50kg for each earthing electrode.		
	The maximum allowable earth resistance is 5 Ohms.		
	The earth inspection pit of each earthing electrode must be made of solid concrete with the minimum dimension of 300mm x 300mm x300mm. The cover must be marked with the word “Earth”.		
	The earth termination system must comply with IEC 62305.		
6	Earthing 9: Body Earthing 10: Neutral Earthing 11: LA		
7	Earthing 9,10&11: At least 1 no of earth electrode for each earthing		
8	Separation between earthing system: At least height of earthing electrode		
9	The Bidder must submit the technical datasheet of Earthing System.		

1.18 Fire Fighting System

The fire fighting system shall comply with following technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	Manufacturer Name/Brand/Model		
2	Manufacturer's experience in manufacturing fire fighting system: At least 5 years		
3	The manufacturer shall have: ISO 9001:2008 or ISO 9001:2015, ISO 14001:2004 or ISO 14001:2015 Certificates		
4	The Fire Extinguishers with wall mounting bracket must be set-up in the PV array location and in the control room.		
	Extinguisher: Portable CO_2 Fire Extinguisher		
	Type: Stored pressure operated		
	Capacity: At least 5 kg		
	Propellant Gas: CO_2		
	Throw Length: At least 4 meters		
	Suitability for electrical equipment: up to 1000V		
	Color: Red (RAL 3000)		
	Gross Weight: At least 14kg		
	Standard: EN3		
	PV array location: At least 2 numbers Control Room: At least 2 numbers GPB 1: At least 1 number GPB 2: At least 1 number		
5	The sand buckets with stand must be provided. Ground mounted system: At least 2 nos Control Room: At least 2 nos GPB 1: At least 1 no GPB 2: At least 1 no		
6	The installation of Fire Extinguishers should confirm to TAC regulations.		

1.19 Fencing

The fencing shall comply with following technical specifications.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	The chain link mesh size must be at least 2” x 2” of 10 guage.		
2	The metal post must be at least 1.5 m high from ground level with MS angle iron of minimum size 50mm*50mm*5mm, with the maximum spacing of 2 m center to center.		
3	The iron angle post must be at least 0.5m below ground level in M15 concrete (1:2:4) with 0.2m*0.2m cover.		
4	Fencing must include a MS iron lockable gate of 1.5m width and 2.5m height.		
5	All angle iron must be MS hot dip galvanized. The minimum thickness of galvanization must be at least 90 microns throughout the surface.		
6	There must be a free space of at least 3 m between the front of PV array and the fencing.		
7	There must be a free space of at least 3 m between the side of PV array and the fencing.		
8	There must be a free space of at least 2 m on the back of PV array and the fencing.		

1.20 Design and Drawings

The bidder shall prepare and include all the required design and drawings in the technical proposal document.

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
1	2D Layout of Solar PV System		
2	Single Line Diagram and Design of Grid Connected Solar PV with		

S.N.	Specifications Required	Specifications Offered with Compliance	Reference Document (Specify Document)
	ESS, Protection System and Cable Size (DC and AC both)		
3	Design and drawing of LiFePO4 battery system, including the Battery Management Unit (BMU), Master BMU integrated with EMS		
4	Design and drawing of Support Structure with Foundation (Ground Mounted and Roof Mounted)		
5	Design and drawing of Wind +Snow Load Analysis		
6	Shading Analysis		
7	Design and drawing of Remote Monitoring System and Data Acquisition System		
8	Design and drawing of Junction Box		
9	Design and drawing of Grid Connected AC Combiner Box		
10	Design and drawing of AC Distribution Board		
11	Design and drawing of Operation Control Panel Board		
12	Design and drawing of Containerized System (Control Room)		
13	Design and drawing of Earthing System		
14	Design and drawing of Lightning Protection System		
15	Design and Drawing of Fencing with Foundation		
16	Design and drawing of Transformer System		
17	Design and drawing of Grid Interconnection System		

1.21 System Operation and Maintenance

The Contractor shall provide the cleaning schedule and shall be fully responsible for any kind of operation and maintenance jobs, including the cleaning of PV modules. The contractor will depute one full time operator (Technical), equipment/tools, for operation of Grid Connected Solar PV with Energy Storage System for five (5) years from the date of commissioning. A minimum of half yearly site visit must be done by the contractor's engineer to make sure the preventative maintenance and assure that all the system components are fully functional. The site visit report shall be submitted to MBUST within a week of each visit.

1.22 Project Information Board

The project information board must be installed at the installation site. The minimum information to be shown are:

- Name of the Project
- Location of the Project
- Date of Commissioning
- Name of the Employer
- Name of the Contractor
- Name of the Consultant

1.23 Spare Parts

The bidder must provide the following minimum spare parts before the testing and commissioning.

S.N.	Items	Quantity
1	PV Module (0.5% of Total)	At least 6 Nos
2	PV Connector (5% of Total)	At least 10 Pairs
3	String Fuse	At least 10 Nos
4	Stainless Steel (SS 304) nuts, bolts, washers (1% of Total)	1 Set
5	Galvanized nuts, bolts, washers (0.5% of Total)	1 Set
6	AC SPD	At least 4 Nos
7	Cable Lugs of various sizes (5% of Total)	1 Set
8	Cable Glands of various sizes (5% of Total)	1 Set
9	Insulating Gloves	5 Pairs
10	Safety Helmets	5 Nos
11	Safety Boots	2 Pairs
12	Torque Wrench (Japan Make)	1 No
13	Spanner Set (Japan Make)	1 Set
14	Screw Driver Set (Japan Make)	1 Set
15	Allen Key Set (Japan Make)	1 Set

S.N.	Items	Quantity
16	Hydraulic Crimping Tool	2 Set
17	True RMS Clamp Meter (Fluke Make)	1 No
18	Insulation Tester (up to 1000V)	1 No
19	Earth Resistance Tester	1 No
20	Hammer	3 Nos
21	Insulating Tapes	20 Nos