5. Scope of Work

5.1 GENERAL SCOPE OF WORK

The bids are invited for total 2.0 MW Solar PV project, 1MW at Idar & 1 MW at Dhansura Chilling Centers of Sabar Dairy, which comprises of minimum 1.0 MW AC equivalent to cumulative capacity of all solar PV modules under Standard Test Conditions (STC) as per IEC61215 at each chilling center. The Contractor shall provide maximum output considering the given land as per best technical proposal. **For technical ratings, we will prefer to have highest solar generation with respect to commercial as per the clause given in our financial chapter.** Wherever we are mentioning 1.0 MW to be considered as a minimum output capacity in AC at each chilling center..

i. Required statutory approval for Solar Plant installation, Testing & Commissioning shall be in scope of bidder like Registration with GEDA, Approval of GETCO/DISCOM for feeding power into concern S/S, ROW approvals require for lay line/cables and Any other approvals as considered necessary by Government authority etc for installation, Testing & Commissioning.

ii. As per GETCO/DISCOM norms/requirement/standard guide line, Laying of under ground Cable or Overhead line from Solar Plant location to GETCO S/S bay shall be in scope of bidder.

iii. The general scope of work for the 2.0 MW solar PV power plant (1MW at Idar & 1 MW at Dhansura Chilling Centers of Sabar Dairy) involves Engineering, Procurement & Supply and Construction (EPC) of the grid-connected solar photovoltaic power plant, commissioning and evacuation of power up to Sabar Dairy.

iv. Evacuation of Power & Metering Point:

   a) For the purpose of this project, the evacuation voltage shall be at 11 kV AC (three phase) wherein evacuating point cum metering point shall be installed at 11 kV interconnection point at GETCO S/S Bay about approx. 500 meter far from Dhansura and idar Chilling center Solar Plant location. All such kind of work is in supplier‘s scope.

b) Bidder is advised to visit GEDA /GETCO/ UGVCL/SITE and finalised evacuation of power & metering point before submission of bid.

c) Evacuation of Power & Metering Point decision shall be as per guide line of GEDA /GETCO/ UGVCL and same shall be bound to bidder at any time during project.

v. Operation and Maintenance (O&M):

vi. The scope of work includes Operation and Maintenance (O&M) of the plant for five (5) years extendable for another five (5) years, wherein the plant shall generate at least equivalent to the guaranteed Performance of Plant. The Bidder shall submit in the Bid a comprehensive project execution schedule as well as Operation and Maintenance (O&M) schedule with resource planning in the form of Gant chart and shall be liable for abiding by the schedule. It is the responsibility of the Contractor to perform the necessary maintenance/ timely replacement of all Civil /Mechanical or Electrical components of the project during this O&M period such that the guaranteed performance of the plant is not compromised. **Any damage to CIVIL/ ELECTRICAL/ MECHANICAL components of the plant is to be reworked/ replaced/ supplied without any extra cost and time by the Contractor during complete O&M period.** The Operation and Maintenance shall be comprehensive. The maintenance service provided shall ensure project functioning of the Solar PV system as a whole and Power Evacuation System to the extent covered in the Contract. All preventive/ routine maintenance and breakdown/ corrective maintenance required for ensuring maximum uptime shall have to be provided. Accordingly, the Comprehensive Operation and Maintenance shall have two distinct components as described below:

a. Preventive / Routine Maintenance: This shall be done by the Contractor regularly and shall include activities such as cleaning and checking the health of the Plant, cleaning of module surface, Inverter filter cleaning once every week, tightening of all electrical connections, and any other activity that may be required for proper functioning of the Plant as a whole. Necessary maintenance activities, preventive and routine for Transformers and associated switchgears also shall be included. It is of most importance to carryout thorough cleaning of Switchgears i.e. ACB, VCB, MCCB

etc. once every year to avoid deposition of sulphur from ash due to avoid any kind of breakdown i.e. corona effect. The contractor to keep a note of this point as it is site specific to Sabar Dairy.

b. Breakdown/ Corrective Maintenance: Whenever a fault has occurred, the Contractor has to attend to rectify the fault, the fault must be rectified within 24 hrs time from the time of occurrence of fault failing which the Contractor will be penalized as per terms and conditions of this Tender.

The date of Comprehensive Operation and Maintenance Contract period of the Plant shall begin on the date as defined in the NIT of this Tender. Detailed scope of comprehensive operation & maintenance has been described in the later sections of this Chapter of this document. However, operation of the Power Plant means operation of system as per bidding schedule and workmanship in order to keep the project trouble free .

5.2 Electrical Work:

Consisting of installation of solar PV modules, junction boxes, grid-tied inverters, isolation transformers, meters, control panel, 11 kV switchgear for evacuation, interconnection through wires, cables, bus bars, etc.; plant lighting system, automatic weather station, SCADA and remote web-based communication & monitoring hardware, software etc.; plant and human safety and protection equipment including danger signs etc.

Civil and Other Non-Electrical Work:

Module Mounting Structures (MMS): The Contractor shall design, fabricate, supply and install module mounting structures with all required accessories like clamps, nuts, bolts, cable ties etc. Structure will be GI Composites like pultruded with Density (107 – 120 lb/ft^3).

Foundations: The Contractor shall design and construct appropriate civil foundations for MMS, prefabricated structures/RCC, transformers, substation equipment, feeder bay etc.

Storm Water Drainage System: The Contractor shall provide storm water drainage system for entire plant.

Solar PV Module Cleaning System: The Contractor shall plan for two (1) no. of washes i.e. 1 cycles of all solar PV modules on weekly basis. The site is prone to dust conditions for numerous days in a year. For this, the purchase shall provide water storage tank without pump for the water cleaning system. Pump and required necessary accessories shall be in scope of supplier.For module cleaning, the contractor can provide new pump; water jet and hose pipe or establish a pipeline network with valves.

Cable Trenches: Construction of RCC cable trenches with cable trays and covers in inverter and control rooms, earthen excavated cable trench with alternate layers of sand and brick as per relevant IS from PV arrays to inverter room to control room to substation shall be provided by the Contractor.

Site levelling: The Contractor shall level the site, as required, so as to compact the plant in minimum possible area and also minimize shading losses because of solar PV module structures.

1.Communication:

The Contractor shall provide complete plant SCADA with SCADA server having string level monitoring capabilities over remote server. Contractor shall lay the cable in appropriate cable trench, connect with suitable connectors and terminate to the SCADA server inside control room. The Contractor shall also provide necessary internet connection through GPRS enabled modem along with LAN connectivity for data communication over remote server and shall bear the cost of the same during the Contract period including O&M.

Type Code
Power Entry Characteristics
AC input voltage range ($V_{ac,\,min}$ $V_{ac,\,max}$)
Nominal AC input voltage ($V_{ac,n}$)

Rated frequency (f_r)
DC Input Voltage Range ($V_{dc,min}..V_{dc,max}$)
Nominal DC input voltage ($V_{dc,n}$)
RS485 Section
Serial interface type
Baud rate
Protocol
Number of devices
Line biasing resistor (wherever necessary)
Termination resistor
RS485 MODBUS section
Serial interface type
Baud rate
Protocol
Number of devices
Line biasing resistor (wherever necessary)
Termination resistor
Physical and Environmental
Environmental protection rating
Ambient temperature range
Relative humidity
Compliance

Isolation
Marking
Safety and EMC standard

2.1.1.

Essential list of I/O and equipment is given herewith, but scope is not limited to the Essential List, contractor is fully responsible to provide complete SCADA System which can be extensible / communicable with add additional / future solar plant.

Sr.	Equipment to be monitored	Data to Be Monitor (Real Time)	Type of IO
1	String Monitoring / Array Monitoring	Each PV string needs to be monitored	Through Communication with SJB PLC/Card
2	String Junction Box / Array Junction Box (SJB = AJB)	SJB internal temperature and SJB Bus Voltage and Current	Through Communication with SJB PLC/Card
3	Inverter	All Electrical Parameters of Inverter along with Scanning, Records & Error communication	Through Communication with SJB PLC/Card
4	Inverter Transformer	Oil and Winding Temp Monitoring, Magnetic Oil Gauge, Pressure release Valve (PRV)	Analog Input
5	11 KV Breakers	ON/OFF and Trip Position of Each Breaker and Energy Meter communication	DI and Communication

6	Weather Monitoring Station	Two no. of Class I Pyranometer (one for GHI, one at PV plane collector angle), Two numbers of contact type temperature sensors one at module front and the other at backside of the module. Ambient temperature sensor, Wind velocity and speed sensor.	Through Communication
7	11 KV VCB panel	ON/OFF and Trip Position of CB	Analog and Digital
8	Main and Check Meter	All electrical parameters recorded by energy meter	Through RS-485/MODDBUS communication

2. Plant Safety Equipment:

i. The Contractor shall provide appropriate numbers of foam type fire extinguishers / CO_2 extinguishers, sand buckets and transformer discharge rod at Control Room, Security Cabin and Substation/Substation. Further, all high voltage places to be provided with danger sign boards with appropriate size and material to last for 25 years.

ii. Statutory Requirements: All construction, operation and maintenance procedures shall be carried out through appropriate relevant standards, regulations laid by Sabar Dairy / GETCO / UGVCL / CEI / MNRE and / or any other agency as and when applicable. Further, this shall comply with the applicable labor laws. The Bidder shall make themselves aware of such requirements and shall not solely depend on the Company to avail full information.

3. Planning and Designing:

i. The Contractor shall plan and design for the electrical / mechanical / civil requirements including but not limited to plant configuration, space optimization, distance between rows of modules, sufficient passage for vehicle and man-power movement in the plant, mounting structures, location of inverter room, cable routing, selection of equipment and items, procurement plan etc. to enhance plant output.

ii. The Contractor refer enclosed Soil Testing Reports for designing of various civil structures. The design of all civil foundations, R.C.C structures, GI Module Mounting Structure, buildings etc. will be carried out considering appropriate seismic zone of the area. All appropriate loads, wind velocity, seismic factors etc. will be considered as per the relevant IS Specifications while designing any civil structure. Also, the environmental conditions, soil characteristics, atmospheric effect, ground water table level, rain water data, land profile, etc. Must be considered as per site actual condition and accordingly appropriate precautions and preventive measures will be taken while designing the structures. RCC structures will be adopted considering surrounding weather and soil conditions of site and as per the relevant IS codes. The concrete mix design test of minimum M25 grade of cement shall be carried out in Govt. certified laboratory or NABL accredited laboratory.

iii. The Contractor shall take into consideration all parameters like wind speed, seismic zone, safety factor and safe Soil Bearing Capacity (SBC), water will be drop in this area continuously etc. for the purpose design and construction of civil foundations for all civil work as per relevant IS codes.

iv. The Contractor shall carryout Shadow Analysis at the site and accordingly design strings and arrays layout considering optimal usage of space, material and labor.

v. All designs & drawings have to be developed based on the governing standards and requirements of the project and also keeping in mind basic design specifications. Company may approve minor deviations or suggest required modifications in the same which are meant for increasing plant performance without sacrificing quality / workmanship norms.

vi. All designs, specifications, reports, etc. submitted or used by the Contractor at any point in time shall first be approved by the Company /Consultant and revised by Company /Consultant, if required, prior to execution.

vii. The Contractor shall provide following data for losses for Solar Power Generation at 11 KV end and drawal power at 66 KV consumer end at Sabar Dairy.

viii. **The technology offered shall be commercially established technology and at least one Project based on this technology shall be satisfactorily operational for at least one year in India.** Details of the Project with location and the successful operational period of the Project utilizing this technology shall also be mentioned before the submission of first set of drawings for approvals.

Losses/Charges	Expected (Per KWh)	Committed by Bidder
Transmission Charges	87 Paisa	
Transmission Losses	15 Paisa	
Wheeling Charge	08 Paisa	
Wheeling Losses	23 Paisa	

ix. The Company reserves right to modify the specifications at any state as per local site conditions / requirements and EPC contractor shall comply with modification without any extra cost and time.

x. The Contractor has to arrange the facility for testing bulk material at site such as cube-testing machine for testing the strength of cube samples etc, sieve analysis assembly, flakiness and elongation index assembly, slump cone, cube moulds, core cutter assembly, sand replacement assembly, micro-meter, cube curing tank, torque wrench etc.

xi. The Contractor has to send samples of the material to Govt. accredited / NABL accredited laboratory for testing as when required by the Company.

4. Approval of Designs / Drawings

i. The following procedure has to be followed for assessment and approval of designs, specifications and drawings during the course of the project: The Contractor shall submit to the Company the documents in hard copy and soft copy to both with proper reference and drawing numbers. The respective documents for selection, supply, installation, erection, commissioning of equipment/ structures have to be submitted at least 15 days in advance to the planned start of the activity as per Contractor's project schedule. The Contractor shall submit documents as required for this project according to his design and specifications. The Company will assess and approve the documents within 10 days of submission of documents; and only after the approval the Contractor shall release the documents on site for execution. The documents shall be revised by the Contractor as per instructions /comments given by the Company if required, prior to execution. Subsequent revisions and the final version of the documents shall also be submitted in hard and soft copy to the Company. The Contractor has to take into account the above mentioned process of revisions (if required) and adjust the preparation and delivery of the documents such that the overall planned project schedule is not affected.

ii. The Contractor has to submit all drawings, which are related to plant for approval and the Contractor, shall not claim any drawing as their intellectual property. Drawing which is developed for project will be the intellectual property of the Company.

iii. The Bidder shall submit in the Bid, basic engineering drawings of all civil work, including but not limited to, layout of the power plant indicating rows of photovoltaic modules, layout of different buildings, basic MMS design, civil foundations and anchoring design / details, electrical SLD, shading analysis and generation estimation report etc.

i. The bidder shall submit in the Bid technical specifications / drawings / designs and datasheets for all electrical work including but not limited to electrical component of the power plant including photovoltaic modules, cables, connectors, junction boxes,

inverters, transformers, monitoring and auxiliary systems, etc. for the 2.0 MW Solar PV project 1 MW at Idar & 1 Mw at Dhansura Chilling Centers.

iv. The Contractor shall submit a comprehensive maintenance schedule for operation and maintenance of the photovoltaic power plant along with checklists before commencement of work on site and shall be liable for abiding by the schedule. All construction, operation and maintenance procedures shall be carried out through appropriate relevant standards, regulations and labor laws.

5. Final Commissioning

The commissioning procedure shall be as per Sabar Dairy / GEDA/ EPD/ GETCO / UGVCL/Chief Electrical Inspector to Government (CEIG) requirements. The Contractor shall also ensure the following:

i. Obtaining written certificate of commissioning of the facility and permission to connect to the grid from the office of the Chief Electrical Inspector of the state and any other authorized representative from Government of India (GoI) / UGVCL / GETCO / Sabar Dairy.

ii. Inspection and successful electrical commissioning certificate from the Company.

iii. Obtaining all certificates required by Discom from agency appointed by them.

iv. Satisfactory completion certificate towards completion of all other contractual obligations by the Contractor as stipulated from the Company.

6. Comprehensive Operation and Maintenance Contract

The Bidder shall separately quote in Appendix 14 for Operation and Maintenance of the power plant for Five (5) Years (If sabar dairy need to extend O&M contract), wherein the plant should perform at a minimum annual Net Electrical Energy Guaranteed Generation (PR) de-rated every year by not more than 0.7 % referring to the installed DC capacity of the plant indicated by the Bidder. Any damage to CIVIL/ELECTRICAL/MECHANICAL components of the plant is to be

reworked/replaced/supplied without any extra cost and time by the Contractor during maintenance period. This means after completion of O & M period every component of the plant should be in good and working condition.

Bidder shall provide manpower information for Comprehensive Operation and Maintenance Contract,

Sr No.	Manpower information	Nos of Manpower
1	Skilled - Technical	Bidder shall provide
2	Semi skilled	Bidder shall provide
3	Unskilled	Bidder shall provide

Disclaimer: Any civil / electrical / other work, which is not mentioned or included in this Tender document but necessary for the construction and O&M of 2 MW Solar PV plant at Sabar Dairy plant shall be borne by the Contractor. The Contractor shall, unless specifically excluded in the Contract, perform all such works and /or supply all such items and materials not specifically mentioned in the Contract/ Tender Document but can be reasonably inferred from the Contract as being required for attaining completion, commissioning and performance of the facilities, delivering PR and maintaining the plant & achieving PR during O&M period of 2 MW Solar PV Power Plant 1 MW at Idar & 1 Mw at Dhansura Chilling Centers of Sabar Dairy as if such work and / or items and materials were expressly mention in the Contract without any extra cost implication and liability to Sabar Dairy. All specifications mentioned in this Tender indicates minimum technical requirement. The Contractor may propose alternate specifications or design though the final acceptance of the same is subject to the Company's discretion.

- **DETAILED ELECTRICAL WORK**

The proposed projects shall be commissioned as per the technical specifications given below.

A Grid-connected Solar Photovoltaic (SPV) power plant consists of SPV array, Module Mounting Structure, Power Conditioning Unit (PCU) consisting of Maximum Power Point Tracker (MPPT), Inverter, and Controls & Protections, interconnect cables and switches. PV Array is mounted on a suitable structure. Grid tied SPV system is without battery and should be designed with necessary features to supplement the grid power during day time. Components and parts used in the SPV power plants including the PV modules, FRP based structures, cables, junction box, switches, PCUs, WMS, Energy Meters etc., should conform to the BIS or IEC or international specifications, wherever such specifications are available and applicable. Solar PV system shall consist of following equipments/components.

i) **Solar PV modules consisting of required number of Mono PERC Crystalline PV modules.**

ii) Grid interactive Power Conditioning Unit with Remote Monitoring System

iii) Mounting structures

iv) Junction Boxes.

v) Earthing and lightening protections.

vi) IR/UV protected PVC Cables, pipes and accessories

vii) Step UP Transformer

viii) HT VCB Panel.

ix) Material required for completed the solar power plant.

- Photovoltaic modules
    - General

The Solar PV module comprises of PV cells connected in series combination to achieve the required module power output. PV cells directly produces DC power on receipt of solar irradiation. The PV cells in a module shall be protected by encapsulation between glass and back sheet. The glass shall be made of high transmissivity and front surface shall give high encapsulation gain.

Sr. No.	Description	Details
1.	Type of SPV Module	Mono PERC Crystalline Silicon
2.	Cell Technology	Mono PERC Crystalline

3.	Peak Power rating of Module	Shall not be less than 400 Wp
4.	Module Efficiency	Minimum 19 % at Standard Test Conditions
5.	Fill Factor	0.76 (Minimum)

- Standards

The mandatory applicable standards are as below for the Solar Module:

Standards	**Description**
IEC 61215 – Latest Edition	Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval
IS 14286: 2010	Crystalline Silicon Terrestrial Photovoltaic (PV) modules - Design Qualification and Type Approval: Bureau of Indian Standards
IS/IEC 61730 – 1– Latest Edition	Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction
IS/IEC 61730 – 2– Latest Edition	Photovoltaic (PV) module safety qualification – Part 2: Requirements for Testing
IEC 61701– Latest Edition	Salt mist corrosion testing of photovoltaic (PV) modules
IEC 62716– Latest Edition	Ammonia corrosion testing of photovoltaic (PV) modules
IEC 62804– Latest Edition	Potential Induced Degradation (PID)
IEC 62782 – Latest Edition	Dynamic (Cyclic) mechanical load testing
Factory Certifications:	
ISO 9001: 2015	Quality Management Systems

OHSAS 18001: 2007	Occupational Health and Safety Assessment Series
ISO 14001: 2015	Environmental Management System

- Minimum Technical Requirement

i. The PV modules used must qualify to the latest edition of IEC PV module qualification test or equivalent BIS standards Crystalline Silicon Solar Cell Modules IEC 61215/IS14286. In addition, the modules must conform to IEC 61730 Part-2- requirements for construction & Part 2 – requirements for testing, for safety qualification or equivalent IS.

ii. The total solar PV array capacity (kWp) should not be less than allocated capacity (kW) and should comprise of solar crystalline modules of minimum 400 Wp and above wattage. Module capacity less than minimum 400 watts shall not be accepted.

iii. For the PV modules to be used in a highly corrosive atmosphere throughout their lifetime, they must qualify to IEC 61701/IS 61701.

iv. Protective devices against surges at the PV module shall be provided. Low voltage drop bypass diodes shall be provided.

v. PV modules must be tested and approved by one of the IEC/MNRE authorized test centers.

vi. The module frame shall be made of corrosion resistant materials, preferably having anodized aluminum.

vii. The bidder shall carefully design & accommodate requisite numbers of the modules to achieve the rated power in his bid.

viii. The rated output power of any supplied module shall have tolerance upto + 3%.

ix. 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 by 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.

x. The module shall be provided with a junction box with provision of 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 IP-67 rated.

xi. IV curves at STC for each PV module should be provided by bidder.

xii. Plants installed in high dust geographies in Gujarat must have the solar modules tested with relevant dust standards (Applicable standard would be IEC 60068-2-68 or

xiii. SPV module shall perform satisfactorily under operational temperature between -40°C & +85°C and shall withstand at mechanical load design as per IEC standard. Each and every SPV module shall conform to above standards and no negative power tolerance shall be accepted.

xiv. The MONO PERC crystalline silicon-based modules supplied should be of Potential Induced Degradation (PID) free modules and the test certificate from third party lab complying with the same shall be provided. However, PID Test carried out at beyond/extended IEC criteria shall be preferred.

xv. The solar photo-voltaic module should be of minimum output of 400 Wp at STC with efficiency no less than 19 % with positive tolerance only. Bidder should clearly shown offered PV module net efficiency in bid.

xvi. Maximum reverse current protection rating should not be less than 25 Amp.

xvii. The interconnected cells shall be laminated in vacuum to withstand adverse environmental conditions.

xviii. The module frame shall be made of corrosion resistant materials, preferably having aluminum anodized finish. The anodizing thickness shall be 10 microns or better. The SPV module shall be made up of high transitivity glass & front surface shall give high encapsulation gain and the module shall consists of impact resistance, low iron and high transmission toughened glass.

xix. Module(s) shall be provided with minimum three (03) bypass diode with Split type Junction box only.

xx. The SPV module must conform to IS 14286, IEC 61215, IS/ IEC 61730 Part I and Part II, IEC 62716, IEC 61701, IEC 62804 and shall also conform to IEC 62782.

xxi. The modules shall be warranted for minimum of 10 years against all material/manufacturing defects and workmanship.

xxii. Each Solar PV modules used in solar power plants/systems must provide a linear power output warranty for their output peak watt rated capacity. Actual power output of the Product may reach at least 98 % of the nameplate power output specified on the Product during the first year. From the second year, the actual power output will decline annually by no more than 0.7 % for a period of 24 years, so that by the end of the 25th year, **an actual output of at least 81.2%** of the nameplate power output specified on the Product will be achieved. **Bidder should clearly shown offered PV module net actual annually power output declination in bid.**

xxiii. The bidder shall provide the sample solar PV module electrical characteristics including current-voltage (I-V) performance curves and temperature coefficients of power, voltage and current.

xxiv. The temperature co-efficient of power for the crystalline modules shall not be more than 0.38% /°C.

xxv. SPV module shall have module safety class-II and should be highly reliable, light weight and must have a service life of more than 25 years

xxvi. Each module should have two 4 sq.mm stranded UV resistant cables as per of TUV specification 2 Pfg 1169/08.2007 and terminated with DC plug-in connector directly. The positive (+) terminal has a male connector while the negative (-) terminal has a female connector. In case 1500 V modules are used, the connecting cable shall be as per or 2Pfg 1990/05.12.

xxvii. All the modules in the PV plant should be arranged in a way so as to minimize the mismatch losses.

xxviii. The SPV modules shall have suitable encapsulation and sealing arrangements to protect the silicon cells from environment. The encapsulation arrangement shall ensure complete moisture proofing for the entire life of solar modules.

xxix. Sabar Dairy or its authorized representative reserves the right to inspect the modules at the manufacturer's site prior to dispatch.

xxx. Modules only with the same rating and manufacturer shall be connected to any single inverter. Modules shall compulsorily bear following information in the form of ID encapsulated with solar cell in the manner so as not to cast shadow on the active area and to be clearly visible from the top.

xxxi. **Only those crystalline modules which are supplied for a capacity more than 1 GW in other projects across the world and are successfully operational for at least one year shall be considered for this Project.** On this account, the Contractor shall provide full information, to the satisfaction of Sabar Dairy, before placing final order for the modules. The Contractor shall also submit the proof of original purchase.

xxxii. The Bidder shall provide to the Company in the Bid, power performance test data sheets of all modules. The exact power of the module shall be indicated if the data sheet consists of a range of modules with varying output power.

xxxiii. The Bidder is advised to check and ensure the availability of modules prior to submitting the Tender Document.

- Warranties

i. Material Warranty:

ii. i. Material Warranty is defined as: The manufacturer should warrant the Solar Module(s) to be free from the defects and/or failures specified below for a period not less than twenty five (25) years from the date of sale to the original customer ("Customer")

iii. ii. Defects and/or failures due to manufacturing

iv. iii. Defects and/or failures due to quality of materials

v. iv. Non conformity to specifications due to faulty manufacturing and/or inspection processes. If the solar Module(s) fails to conform to this warranty, the manufacturer will repair or replace the solar module(s), at the Owners sole option.

vi. b. Performance Warranty:

vii. i. The predicted electrical degradation of power generated will be as per matual aggrriment arrived after technical analysis (Between Successful bidder & Purchaser). Bidder will provide the details of de-rating as demanded separately in this tender document.

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

Table 51 Information to be displayed on solar PV module

Sr.	Particulars
1	Name of the manufacturer of the PV module and RFID code
2	Name of the manufacturer of solar cells
3	Month & year of the manufacture (separate for solar cells and modules)
4	Country of origin (separately for solar cells and module)
5	I-V curve for the module at standard test condition (1000 w/m^2 , AM 1.5, 25^oC
6	Wattage, Imp, Vmp, Isc, Voc, temperature co-efficient of power and FF for the module
7	Unique Serial No. and Model No. of the module
8	Date and year of obtaining IEC PV module qualification certificate
9	Name of the test lab issuing IEC certificate
10	Other relevant information on traceability of solar cells and module as per ISO 9001 and ISO 14001

- Junction Box / Combiner Box

i. The Contractor shall provide sufficient no. of Array Junction Boxes / PV combiner boxes / DCDBs.

ii. All switch boards shall be provided with adequately rated copper bus-bar, incoming control, outgoing control etc. as a separate compartment inside the panel to meet the requirements of the Chief Electrical Inspector of Government (CEIG). All live terminals and bus bars shall be shrouded. The outgoing terminals shall be suitable to receive suitable runs and size of cables required for the Inverter/Transformer rating.

iii. The degree of protection for all the equipment shall be:

- Indoor Installation : IP 54
- Outdoor Installation : Min. IP 65 for specific case.

iv. All junction/ combiner boxes including the module junction box, string junction box, array junction box and main junction box should be equipped with appropriate functionality, safety (including fuses, grounding, etc.), string monitoring capabilities, and protection.

v. The terminals will be connected to copper bus-bar arrangement of proper sizes to be provided. The junction boxes will have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables. Suitable markings shall be provided on the bus-bars for easy identification and cable ferrules will be fitted at the cable termination points for identification. Each Array Junction Box shall have suitable Reverse Blocking Diodes / Fuses of maximum DC blocking voltage of 1000 V with suitable arrangement for its connecting. The Array Junction Box shall also have suitable surge protection device. In addition, over voltage protection shall be provided between positive and negative conductor and earth ground such as Surge Protection Device (SPD) or on-load DC disconnector with shoes. All incoming & outgoing cables must be terminated with Brass Gland for Cu Cables & Steel Gland for Al Cables. All Glands must be of Double Compression type for Outdoor duty & Single Compression type for Indoor duty. The rating of the Junction Boxes shall be suitable with adequate safety factor to inter connect the Solar PV array.

vi. The Junction Boxes shall have suitable arrangement for the followings

vii. Combine groups of modules into independent charging sub-arrays that will be wired into the controller.

viii. Provide arrangement for disconnection for each of the groups.

ix. Provide a test point for each sub-group for quick fault location.

x. To provide group array isolation

xi. The rating of the Junction Boxes shall be suitable with adequate safety factor to inter connect the Solar PV array.

xii. The junction boxes shall be dust, vermin, and waterproof and made of thermoplastic/ metallic in compliance with IEC 62208, which should be sunlight/ UV resistive as well as fire retardant & must have minimum protection to IP 65(Outdoor)/ IP 54(indoor) and Protection Class II.

xiii. The terminals will be connected to copper bus-bar arrangement of proper sizes to be provided. The junction boxes will have suitable cable entry points fitted with cable glands of appropriate sizes for both incoming and outgoing cables.

xiv. The current carrying rating of the Junction Boxes shall be rated with standard safety factor to interconnect the Solar PV array.

xv. Suitable markings shall be provided on the bus-bars for easy identification and cable ferrules will be fitted at the cable termination points for identification.

xvi. Adequate capacity solar DC fuses & isolating miniature circuit breakers / MCCB should be provided if required. The Junction Box must have space for the maintenance and 10% Spare Install Capacity for future integration.

xvii. Detailed junction box specifications and data sheet shall be provided in the Technical Bid document.

xviii. Other Sub systems and components used in the SPV power plants (Cables, connectors, Junction Boxes, Surge Protection devices, etc.) must also confirm to the relevant international /national standards for electrical safety besides that for quality required for ensuring expected service life and weather resistance. It is recommended that the interim, the cables of 600-1800 Volts Dc for outdoor installations should comply with the draft EN 50618 for service life expectancy of 25 years.

xix. If all protection is available inside the string inverter than no need to use DC Combiner box. DC fuse, DC SPD and String level monitoring must required.

- Inverter and Power Conditioning Unit (PCU)

i. Only those PCUs/ Inverters which are commissioned for 1 MW capacity in other solar PV projects till date shall be considered for this project. The Contractor has to provide sufficient information to the satisfaction of Sabar Dairy before placing the final order for PCUs/Inverters. Power Conditioning Unit (PCU) shall consist of an electronic inverter with latest technology available in the market along with associated control, protection and data logging devices and must be fully communicable to SCADA with OPEN Communication Protocol. If any software required for the communication & SCADA, the same to be made available within the EPC package by the Contractor.

ii. All PCUs should consist of associated control, protection and data logging devices and remote monitoring hardware, software for string level monitoring.

iii. Dimension and weight of the PCU shall be indicated by the Bidder in the Bid.

iv. PCU's shall house switch, dis-connector, semiconductor fuse and contactor, as per standard practice of manufacture. They shall have inbuilt features of MPPT (Maximum Power Point Tracking) operations with internal self-protection in case of any fault in grid. Number of PCU's proposed are 18-20 sets each of 80 KW and above. Indicative parameters of inverter are generally as indicated below:

o Capacity of each PCU : 80 KW AND ABOVE

v. No. of inverters to be supplied shall be worked out by Supplier based on DC rating of inverter, Pnom ratio (Pnominal array / Pnominal inverter ≤ 1.1) and limit on overloading capacity (i.e. overload losses ≤ 0.2%)

vi. The Bidder shall guarantee average annual power loss due to non-threshold condition to be less than 0.1% and shall support the claim with necessary document / data / graphs in the Bid.

vii. DC input terminals must be in enough numbers so as each terminal is connected to dedicated single input. Two DC inputs cannot be connected on the single input DC terminal of the inverter. If adequate number of input are not available in the selected inverter by the Contractor then a DC junction box with protection devices such as fuse DC disconnects may be incorporated in to design. The Bidder has to indicate the selected parameters in the Bid.

viii. The minimum European efficiency of the inverter shall be not less than 98% above measured at 100% load as per IEC 61683 standards for measuring efficiency. The Bidder shall specify the conversion efficiency of different loads i.e. 25%, 50%, 75% and 100% in the Bid. The Bidder should specify the overload inverter capacity in the Bid.

ix. The PCU shall be tropicalized and design shall be compatible with conditions prevailing at site. Provision of exhaust fan with proper ducting for cooling of PCU's should be incorporated in the PCU's, keeping in mind the extreme climatic condition of the site.

x. Three phase PCU/ inverter shall be used with each power plant system.

xi. PCU/inverter shall be capable of complete automatic operation including wake-up, synchronization & shutdown.

xii. The output of power factor of PCU inverter is suitable for all voltage ranges or sink of reactive power, inverter should have internal protection arrangement against any sustainable fault in feeder line and against the lightning on feeder.

xiii. Built-in meter and data logger to monitor plant performance through external computer shall be provided.

xiv. Anti-islanding (Protection against Islanding of grid): The PCU shall have anti islanding protection in conformity to IEEE 1547/UL 1741/ IEC 62116 or equivalent BIS standard.

xv. In PCU/Inverter, there shall be a direct current isolation provided at the output by means of a suitable isolating transformer.If Isolation Transformer is not incorporated with PCU/Inverter, there

shall be a separate Isolation Transformer of suitable rating provided at the output side of PCU/PCU units for capacity more than 100 kW if made mandatory by DISCOM.

xvi. The PCU/ inverter generated harmonics, flicker, DC injection limits, Voltage Range, Frequency Range and Anti-Islanding measures at the point of connection to the utility services should follow the latest CEA (Technical Standards for Connectivity Distribution Generation Resources) Guidelines.

xvii. The power conditioning units / inverters should comply with applicable IEC/ equivalent BIS standard for efficiency measurements and environmental tests as per standard codes IEC 61683/IS 61683 and IEC 60068- 2(1,2,14,30) /Equivalent BIS Std.

xviii. The MPPT units environmental testing should qualify IEC 60068-2(1, 2, 14,30)/Equivalent BIS std. The junction boxes/ enclosures should be IP 65(for outdoor)/ IP 54 (indoor) and as per IEC 529 specifications.

xix. The PCU/ inverters shall be tested from the MNRE approved test centres / NABL /BIS /IEC accredited testing- calibration laboratories. In case of imported power conditioning units, these should be approved by international test houses.

xx. Nuts & bolts and the PCU enclosure shall have to be adequately protected taking into consideration the atmosphere and weather prevailing in the area.

xxi. (Grid Connectivity) Relevant CERC/GERC regulations and grid code as amended and revised from time to time shall be complied. The system shall incorporate a uni-directional inverter and should be designed to supply the AC power to the grid at load end. The power-conditioning unit shall adjust the voltage & frequency levels to suit the Grid.

xxii. All three phases shall be supervised with respect to rise/fall in programmable threshold values of frequency.

xxiii. The inverter output shall always follow the grid in terms of voltage and frequency. This shall be achieved by sensing the grid

voltage and phase and feeding this information to the feedback loop of the inverter. Thus control variable then controls the output voltage and frequency of the inverter, so that inverter is always synchronized with the grid. The inverter shall be self-commutated with Pulse width modulation technology.

xxiv. This should be capable of synchronize maximum within 1 Minutes.

xxv. The PCU shall be capable of controlling power factor dynamically.

xxvi. The system shall automatically “wake up” in the morning and begin to export power provided there is sufficient solar energy and the grid voltage and frequency is in range.

xxvii. Sleep Mode: Automatic sleep mode shall be provided so that unnecessary losses are minimized at night. The power conditioner must also automatically re-enter standby mode when threshold of standby mode reached.

xxviii. Stand – By Mode: The control system shall continuously monitor the output of the solar power plant until pre-set value is exceeded & that value to be indicated.

xxix. Basic System Operation (Full Auto Mode): The control system shall continuously monitor the output of the solar power plant until pre-set value is exceeded & that value to be indicated.

xxx. The PCU shall include appropriate self-protective and self-diagnostic feature to protect itself and the PV array from damage in the event of PCU component failure or from parameters beyond the PCU’s safe operating range due to internal or external causes. The self-protective features shall not allow signals from the PCU front panel to cause the PCU to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the PCU, including commutation failure, shall be cleared by the PCU protective devices. In addition, it shall have following minimum protection against various possible faults.

a. Earth Leakage Faults: The PCU shall have the required protection arrangements against earth leakage faults and –Ve DC directional protection.

b. Over Voltage & Current: In addition, over voltage protection shall be provided between positive and negative conductor and earth ground such as Surge Protection Devices (SPD).

c. PCU shall have arrangement for adjusting DC input current and should trip against sustainable fault downstream and shall not start till the fault is rectified.

d. Galvanic Isolation: The PCU inverter shall have provision for galvanic isolation. Each solid state electronic device shall have to be protected to ensure long life of the inverter as well as smooth functioning of the inverter.

e. Anti-islanding (Protection against Islanding of grid): The PCU shall have anti islanding protection. (IEEE 1547/UL 1741/ equivalent BIS standard).

f. Unequal Phases: The system shall tend to balance unequal phase voltage.

xxxi. Reactive Power: The output power factor of the PCU should be of suitable range to supply or sink reactive power. The PCU shall have internal protection arrangement against any sustained fault in the feeder line and against lightning in the feeder line.

xxxii. Isolation: The PCU shall have provision for input & output isolation. Each solid-state electronic device shall have to be protected to ensure long life as well as smooth functioning of the PCU.

xxxiii. All inverters/ PCUs shall be three phase using static solid state components. DC lines shall have suitably rated isolators to allow safe start up and shut down of the system. Circuit breakers used in the DC lines must be rated suitably.

a. Sinusoidal current modulation with excellent dynamic response.

b. Compact and weather proof housing.

c. Direct use in the outdoors with outdoor housing.

d. Comprehensive network management functions (including the LVRT and capability to inject reactive power to the grid).

e. No load loss < 1% of rated power and maximum loss in sleep mode shall be less than 0.05%.

e. Unit wise & integrated Data logging

f. PCU shall have protection against over current, sync loss, over temperature, DC bus over voltage, cooling fan failure (if provided), short circuit, lightening, earth fault, surge voltage induced at output due to external source, power regulation in the event of thermal overloading,

xxxiv. Ground fault detector which is essential for large PV generators in view of appreciable discharge current with respect to ground.

xxxv. The power conditioner must be entirely self-managing and stable in operation. A self-diagnostic system check should occur on start up. Functions should include a test of key parameters on start up. Over voltage protection against atmospheric lightning discharge to the PV array is required.

xxxvi. **Standards and Compliances:**

The Bidder also has to confirm the PCU specifications in the Bid.

Table 52 Detailed Specifications of PCU

Sr. No	Description	Specification
1	Switching devices	IGBT
2	Control	Microprocessor /DSP

3	Nominal AC output voltage and frequency	415V, 3 Phase, 50 Hz (In case single phase inverters are offered, suitable arrangement for balancing the phases must be made.)
4	Output frequency	50 Hz
5	Grid Frequency Synchronization range	(+) 3 Hz or more
6	Ambient temperature considered	(-) 20° C to 55° C
7	Humidity	95 %
8	Protection of Enclosure	IP-54 (Minimum) for indoor / IP-65(Minimum) for outdoor
9	Grid Frequency Tolerance range	(+) 3 or more
10	Grid Voltage tolerance	(-) 20% & (+) 15 %
11	No-load losses	Less than 1% of rated power
12	Inverter efficiency (minimum)	> 97% (In case of 10kW or above)
13	THD at rated power	< 3%
14	PF	0.8 lag to 0.8 lead
15	LED/LCD Display : Indications	Display shall indicate system functional parameters and protection functional indicator i.e. Inverter ON, Grid ON, Inverter under/Over voltage, Inverter Overload, Inverter Over Temperature, etc.
16	Data monitor and display controls	RS485, Ethernet OR RS232 connectivity
17	Protections	i) Input over voltage ii) Low/high frequency iii) Short circuit iv) Under/over output voltage v) Over Temperature vi) Grid Input under voltage / over voltage with auto recovery vii) DC disconnect device viii) DC reverse polarity ix) Anti Islanding Protection as per the standard

		x) Earth fault
18	Standards	i) IEC 62103 : Electronic equipment for use in power installations. ii) IEC 62109 Part 1 & 2 iii) Galvanic Isolation at input & output through transformer iv) IEC 61727/ VDE 0126 For Grid Interface v) IEC 61683 for Efficiency of PCU vi) IEC 60068 for Environment Testing vii) IEC 62116 for Anti Islanding viii) IEEE 519-1992 for Harmonic Control in Electric Power Systems
19	Display on Front Panel	i) Instantaneous & cumulative array power (W), ii) Instantaneous & cumulative output power (W) iii) Cumulative energy (Wh), iv) DC voltage (V), v) DC current (A), vi) AC voltage (V) (all three phases) vii) AC frequency (Hz), viii) AC current (A),(all three phases) ix) Cumulative hours of operation (h), x) Daily energy produced xi) Power factor, xii) Ambient temperature, xiii) Solar radiation. xiv) Data logging facility
20	PCU Mounting	As per the design
21	Nominal AC Output Power	≥ 50 kW

22	Nominal AC Output Voltage	415 Volts +15%/-10% AC / 270 V / As per design
23	Maximum Input Voltage	1000 V DC
24	Wave Form	Pure Sine wave
25	DC voltage range, MPPT	4 to 850 volts DC
26	Minimum Efficiency at 100% load The rated European efficiency (Euro Eta Efficiency) and peak efficiency	> 98.6 % as IEC- 61683(Efficiency) ≥ 98.4 %, measured as per IEC 61683 standard for measuring efficiency. * Inverter No Load / Full Load Loss Calculation must be submitted by the Bidder.
27	Ambient dry bulb temperature range	0 to 55˚ deg C
28	Protection rating (as per IEC-60721-3-3)	Classification of chemically active substances: 3C2 Classification of chemically active substances: 3S2
29	Grid Specifications	IEC 61727, VDE 0126
30	Nominal Voltage & Frequency	415 Volts & 50 Hz

a. PCU shall confirm to IEC 60068-2 standards for Environmental Testing.

b. All inverters shall be IEC 61000 compliant for electromagnetic compatibility, harmonics, etc.

c. All inverters shall be safety rated as per IEC 62109 (1 &2), EN 50178 or equivalent DIN or UL standard.

d. Each PCU shall be compliant with IEEE standard 929 – 200 or equivalent. The Bidder should select the inverter (Central / String) as per its own system design so as to optimize the power output.

i. Display

a. The PCU shall have local LED display and keypad for system control, monitoring instantaneous system data, event logs, data logs and changing set points. Control and read-out should be provided on an indicating panel integral to the Inverter. Display should be simple and self-explanatory. Display to show all the relevant parameter relating to PCU operational data and fault condition in form of front panel meters/ LEDs .

b. PCU front panel shall be provided with display (LED or equivalent) to monitor the following

- Instantaneous DC power input
- DC input voltage
- DC Current
- Instantaneous active AC power output
- Instantaneous reactive AC power output
- AC voltage (all the 3 phases and line)
- AC current (all the 3 phases and line)
- Power Factor
- kWh Produced during entire day
- Total kWh produced during its life time

PCU must be provided with display and also the same has to be made available at the SCADA monitoring & controlling desk installed in Main Control Room through Universal Open Protocol of Communication.

ii. Documentary Requirements & Inspection.

a. The bill of materials associated with PCUs should be clearly indicated while delivering the equipment.

b. The Contractor shall provide to Sabar Dairy data sheet containing detailed technical specifications of all the inverters and PCUs. Operation & Maintenance manual should be furnished by the Bidder before dispatch of PCUs.

<u>Note:</u> The Company or its authorized representative reserves the right to inspect the PCUs/ Inverters at the manufacturer's site prior to dispatch.

- Cables and Wires

i. All cables and connectors for use for installation of solar field must be of solar grade which can withstand harsh environment conditions for 25 years and voltages as per latest IEC standards.(Note: IEC standards for DC cables for PV systems is under development, the cables of 600-1800 volts DC for outdoor installations should comply with the draft EN 50618 for service life expectancy of 25 years)

ii. Wires with sufficient ampacity and parameters shall be designed and used so that maximum voltage-drop at full power from the PV modules to inverter should be less than 1.5% (including diode voltage drop). PV Modules should be connected with USE-2/RHW-2 cables array to junction box conductors and junction box to photovoltaic disconnector with the THHN/THWN-2 sunlight resistant with 90ºC wet rated insulation cable. Due consideration shall be made for the de-rating of the cables with respect to the laying pattern in buried trenches / on cable trays, while sizing the cables. The Contractor shall provide voltage drop calculations in excel sheet.

iii. All cables shall be supplied in the single largest length to restrict the straight-through joints to the minimum number. Only terminal cable joints shall be accepted. No cable joint to join two cable ends shall be accepted. All wires used on the LT side shall conform to IS and should be of appropriate voltage grade. Only copper conductor wires of reputed make shall be used.

iv. All wires used for connecting the modules and array should conform to the NEC standards. Modules should be connected with USE-2/RHW-2 cables array to junction box conductors and junction box to photovoltaic disconnector with the THHN/THWN-2 sunlight resistant with 90ºC wet rated insulation cable.

v. All high voltage cables connecting the main junction box/string inverters to the transformers should be PVC insulated grade conforming to IS 1554 and cables shall also conform to IEC 60189 for test and measuring the methods.

vi. Irrespective of utilization voltage and current rating all type of power cables shall be minimum of 1100 V grade PVC insulated conforming to IS 1554 / IS 694 for working voltage less than 150 V control cable shall be of minimum 500 V grade, the control and power cable has to be laid separately. All LT XLPE cables shall confirm to IS: 7098 Part I & II. All HT XLPE Cables (11kV) shall confirm IS: 7098 PART-3 & IEC -60287, IEC-60332 and the Contractor to submit technical data sheet, Voltage drop calculation, and Power Loss Calculation and type test report for the approval of client / consultants. All control cable must be as per IEC 60502.

vii. The cables shall be adequately insulated for the voltage required and shall be suitably color coded for the required service. Bending radious for cables shall be as per manufacturer's recommendations and IS: 1255.

Table 53 Relevant Codes & Standards for Cable

Sr.	Item	Relevant IS	Relevant IEC
1	Conductors of Insulated Cables	IS: 8130 - 1984	**IEC: 228**
2	Impulse tests on cables and their accessories		**IEC: 230**
3	Extruded solid dielectric-insulated power cables for rated voltage from 1 KV up to 30 KV.		**IEC: 502**
4	Test methods for insulations and sheaths of electric cables and chords.		**IEC: 540**
5	Test on cable over a sheath which has special protective functions and are applied by extrusion.		**IEC: 229**
6	Calculations of continuous current rating of cables (100% load factor).		**IEC: 287**

7	Cross-linked polyethylene insulated PVC sheathed cable for voltage from 1.1 KV up to 11 KV.	IS: 7098 (Part II)	
8	PVC insulation & sheath of electrical cables.	IS: 5831 - 1984	
9	Mild steel wires, formed wires and tapes for armouring of cables.	IS: 3975	
10	Electrical test methods for electric cables partial discharge test.		**IEC: 885(2) - 1987 (Part II)**
11	Methods of test for cables.	IS: 10810	
12	Common test methods for insulating and sheathing materials of electric cables.		**IEC: 811**
13	Impulse test on cables & other accessories		**IEC: 230**
14	Cable termination for gas insulated switchgear.		**IEC: 859**

1.1.5. TECHNICAL SPECIFICATION OF LT XLPE CABLES

- **General Constructional Features**

  The medium voltage cables shall be supplied, laid, connected, tested and commissioned in accordance with the drawings, specifications, relevant Indian Standards specifications, manufacturer's instructions. The cables shall be delivered at site in original drums with manufacturer's name, size, and type, clearly written on the drums.

  Upto 10 Sq mm Cable size consider copper cable and above consider aluminium XLPE cable.

A. **Material**:

Medium voltage cable shall be XLPE insulated. PVC sheathed, aluminium or copper conductor, armoured conforming to IS: 7098 Part I.

B. Type:

The cables shall be circular, multi core, annealed copper or aluminium conductor, XLPE insulated and PVC sheathed, armoured.

C. Conductor:

Uncoated, annealed copper, of high conductivity up to 10 mm² size, the conductor shall be flexible and above 10 mm² shall be equal concentrated multi stranded as per IEC: 228.

D. Insulation:

XLPE rated minimum 70° c. extruded insulation.

E. Core Identification:

Two core	Red and Black
Three core	Red, Yellow and Blue
Four core	Red, Yellow, Blue and Black
Single core	Green cable with Yellow strips for earthing

A.

Black shall always be used for neutral.

F. **Assembly**:

Two, three or four insulated conductors shall be laid up, filled with non-hygroscopic material and covered with an additional layer of thermoplastic material.

G. Armour:

Galvanised steel flat strip / round wires applied helically in single layers complete with covering the assembly of cores.

- For cable size up to 25 Sq. mm. : Armour of 1.4 mm dia G.I. round wire
- For cable size above 25 Sq. mm. Armour of 4 mm wide 0.8 mm thick G.I strip

H. Sheath:

The cable shall be rated extruded for XLPE 90 deg.c. Inner sheath shall be extruded type and shall be compatible with the insulation provided for the cables.

Outer sheath shall be of an extruded type layer of suitable PVC material compatible with the specified ambient temp 50 deg. C and operating temperature of cables. The sheath shall be resistant to water, ultraviolet radiation, fungus, termite and rodent attacks. The colour of outer sheath shall be black. Sequential length marking required at every 1.0 meter interval on outer sheath shall be available. The contractor has to furnish resistance / reactance / capacitances of the cable in the technical datasheet.

I. Rating:

Up to and including 1100 Volts.

1.1.6. TECHNICAL SPECIFICATION OF HT XLPE CABLES

General Constructional Features

A. Conductors:

The conductor shall be of circular stranded Aluminium confirming to IS: 8130 & IEC: 228. It shall be clean, reasonably uniform in size & shape smooth & free from harmful defects. Any other form of conductor may also be accepted if in line with modern trends.

B. Semi-Conductor Barrier Tape/Tapes:

The semi-conducting barrier tape/tapes shall be provided over the conductors.

C. Conductor Screen:

The conductor screen shall consist of an extruded layer of thermosetting semi-conducting compound which shall be extruded simultaneously with the core insulation.

D. Insulation:

The insulation shall be super clean XLPE compound applied by extrusion and vulcanized to form a compact homogenous body.

E. Insulation Screen:

a. Each insulation have an insulation screen in two parts consisting of:
b. A water barrier tape/Non-metallic semi-conducting swellable tape part and a metallic screen part.

c. The non-metallic part shall be directly applied upon the insulation of each core and may consist of an impregnated but nylon/PVC tape or a similar approved material or, an extruded semi-conducting material extruded simultaneously with the conductor screen and insulation (triple extrusion).

d. The semi-conductor shall be readily strippable and must not be bonded in such a manner that it has to be shaved or scraped to remove.

e. The metallic part shall consist of a copper tape helical applied with a 30% overlap over the water barrier tape/blocking tape. A binder tape of copper shall be applied over the copper wire metallic screen.

F. Laying Up:

a. The cores shall be identified on the non-metallic part of the insulation screen by legible printing on the length of each conductor or, by the inclusion of a marker tape.

b. The cores shall be laid up with a right hand direction of lay.

a. Binder tape/Moisture barrier:

During layup, a suitable open spiral binder may be applied, at the manufacturer's discretion, before the application of an extruded inner covering.

G. Fillers:

Fillers shall be polypropylene.

H. Inner Covering/Sheath:

The inner covering shall be extruded over the laid up cores to form compact and circular bedding for the metallic layer.

I. Metallic Layer:

The metallic layer shall be galvanised steel wire.

J. Outer Sheath:

The tough outer sheath, black coloured best resisting PVC polyethylene compound type ST-2 as per IS: 5831 for the operating temperature of the cable shall be provided over the armour as specified in relevant standards by extrusion process.

K. Cable Marking:

a. <u>Embossing on outer sheath:</u>

The following particulars shall be properly legible embossed on the cable sheath at the intervals of not exceeding one meter throughout the length of the cable. The cables with poor and illegible embossing shall be liable for rejection.

- Voltage grade
- Year of manufacture
- Manufactures name
- Successive Length
- Size of cable
- ISI mark

viii. Packing and marking shall be as per clause No. 18 of IS 7098 amended up to date.

ix. Cables inside the control room and in the substation shall be laid in Galvanized Cable Trays mounted on mild steel supports duly painted, in constructed trenches with RCC raft and brick sidewalls and provided with removable RCC covers.

x. Cable terminations shall be made with suitable cable lugs & sockets etc, crimped properly and passed through brass compression type cable glands at the entry & exit point of the cubicles.

xi. All cable/wires shall be provided with Punched Aluminium tags only. The marking on tags shall be done with good quality letter and number ferrules of proper sizes so that the cables can be identified easily.

xii. The wiring for modules interconnection shall be in the GI pipe /HD Pipe of approved make.

xiii. Data sheets of individual cable sizes (HT & LT) shall be submitted for approval by the Company. Drum numbers and drum length details shall be submitted with each consignment.

xiv. Cable end terminations and joint kits shall comply with the latest version of the relevant IS standard.

xv. The cable ends shall be terminated with adequate size copper lugs and sockets etc, single/double compression cable glands. Cable glands shall be of robust construction capable of clamping cable and cable

armour (for armoured cables) firmly without injury to insulation. The metallic glands shall be earthed at two locations. Suitable lock type crimping lugs shall be used for cable end terminations. Where cables are raising from ground, suitable PVC pipe guarding shall be provided for cable raising with sealing of the guarding PVC pipe including a suitable clamp.

xvi. HT cable termination kits and straight through joints shall be selected as per the cable specifications. Installation shall be as per the instructions given in the manufacturer's manual. Heat shrinkable type kits only shall be used for HT and LT cables.

xvii. Data sheets of the joints and kits shall be submitted for approval by SABAR DAIRY.

1.1.7. Lightening Protection for PV Array

i. The source of over voltage can be lightning or other atmospheric disturbance. Main aim of over voltage protection is to reduce the over voltage to a tolerable level before it reaches the PV or other sub-system components as per IS: 2309 – 1989 (Reaffirmed – 2005), Edition 3.1 (2006-01).

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

iii. The lightning conductor shall be earthed through flats and connected to the earth mats as per applicable Indian Standards with earth pits. Two earth pits shall be provided for each lightening arrestor. Each lightning conductor shall be fitted with individual earth pit as per required Standards including accessories, and providing masonry enclosure with cast iron cover plate having locking arrangement, watering pipe using charcoal or coke and salt as required as per provisions of IS & Earth Resistance of Lightening System must be less than one (1) Ohm.

a. If necessary more numbers of lightning conductors may be provided. The Contractor is also free to provide franklin

rod / Early Streamer type of lightning arrestors on the MMS structure designed in such a way not to cast shadow on the next raw of solar PV modules. The Contractor to submit necessary calculations based upon rolling sphere method for the Lightening protection system.

iv. The Contractor shall submit the drawings and detailed specifications of the PV array lightning protection equipment to Sabar Dairy for approval before installation of system.

1.1.8. AC Network

i. AC converted by the inverter is transmitted through the appropriate cables from the Inverter to appropriately sized power transformer and from transformer to HT Panel of the next inverter unit in the loop. (Selection of Transformer 2.5 MVA is acceptable if the same technically approved and not incurring any extra losses.) HT panel should consist of adequate size indoor AC bus/ cable, which can handle the current and the voltage safely as per the relevant, IS standards. HT panel should be equipped with adequate protection relays, fuses, annunciations and remote operating and controlling facility from the Main Control Room. Relevant national & international codes to be follows :-

Table 55 Relevant National & International Code

Sr.	Item	Relevant IS	Relevant IEC
1	Power transformer	IS 2026	**IEC 76**
2	Fittings & Accessories	IS 3639	
3	Climate Proofing	IS 3202	**IEC 354**
4	Loading of Transformer	IS 6600	**IEC 296**
5	Oil	IS 335	**IEC 137**
6	Bushings	IS 20650	**IEC 144**
7	Degree of Protection	IS 2147	**IEC 76**
8	Testing, Tolerances on guaranteed Particulars	IS 2026	**IEC 76**

9	Buchholz Relay	IS 3637	
10	Electrical Insulation	IS 1271	**IEC 85**

ii. HT panel shall be provided in Control room. It shall have circuit breaker of suitable rating for connection and disconnection of PCU from grid. The bus bar shall connect the AC distribution board to the transformer. It shall have provision to measure bus voltage, current and power of the transformer.

iii. Bus-bars shall be of high conductivity Aluminium alloy or Copper of adequate size. The bus-bars shall be adequately supported by non-hygroscopic, non-combustible track resistant and high strength type polyester fibre glass moulded insulators. Separate supports shall be provided for each phase and neutral busbar. The bus-bars joints shall be provided with high tensile steel bolts, bellevelle washers and nuts, so as to ensure good contacts at the joints. The bus-bars shall be colour coded as per IS 375.

iv. The HT panel with thermal over current and earth fault releases. The incomer shall be selected one size higher than the required rating as per relay coordination and discrimination selection chart.

v. Removable gland plates with gaskets shall be provided in the cable alleys for glanding the power and control cables. The distance between the gland plate and the incomer terminals shall not be less than 450 mm.

vi. The Contractor should submit theoretical design calculations and detailed explanations along with drawings shall be provided and approved by the Company.

- **<u>11 kV SUBSTATION BLOCK: 1 MW at Idar & 1 MW at Dhansura Chilling Centers</u>**

- Step-Up Transformer

i. The Contractor shall provide the complete turnkey design, supply, erection, testing and commissioning of transformers and transformer substation to first step-up the output of the inverter to 11 kV at the location of the inverter; 1 MW solar plant shall be connected to control room. Hence, total 1.0 MW capacity of the solar plant with provision of rated 11 kV Vacuum Circuit Breaker panel with single outgoing of 1000 KW connected. Provision of ABT meter will be connected with 11 kV VCB panel. Power Flow and SCADA Communication Schematic Diagram. Appropriate size for the 1.0 MW solar photovoltaic power plant.

ii. 3 phase, Oil Filled, 11 kV, 50 Hz, Power Transformers with min power rating 1.25 times of the selected inverter rating and associated Switchgear of approved make should be utilized. 11 KV Inverter transformers can be off-load tap change type. The transformers shall be suitable for outdoor installation with 3 phase 50 Hz 11 KV system in which the neutral is effectively earthed and they should be suitable for service under fluctuations in supply voltage up to plus 10% to minus 15%.

iii. Power Transformer Losses is as per 1180 ,level-II

iv. ERDA testing for Power transformer is compulsory require.

v. Cumulative loss shall be as per IGBC / CBIP guidelines. All electrical equipment and installation shall confirm to the latest Indian Electricity Rules as regards safety, earthing and other essential provisions specified for installation and operation of electrical plants.

vi. Relevant national and international standards in this connection are mentioned in Table: 56 General Standards for Transformers.

vii. All working parts, insofar as possible, are to be arranged for convenience of operation, inspection, lubrication and ease of

replacement with minimum downtime. All parts of equipment or of duplicate equipment offered shall be interchangeable.

viii. The quality of materials of construction and the workmanship of the finished products/ components shall be in accordance with the highest standard and practices adopted for the equipment covered by the specification.

Table 56 General Standards for Transformers

IS: 2026 (Part 1 to 4)	Specifications for Power Transformer
IS: 2099	Bushings for alternating voltage above 1000 V
IS: 3639	Fittings and accessories for power transformer
IEC: 60076 (Part 1 to 5)	Specifications for Power Transformer
IS: 9921 Part 1 to 5	Alternating currents disconnectors (isolators) and earthing switches rating, design, construction, tests etc.
IS: 2705 Part 1 to 4 & IEC: 185	Current transformer
IS: 3156 Part 1 to 4	Voltage Transformer
IS: 3070 part 1 to 3	Lightning arrestors
IS: 2544	Porcelain insulators for system above 1000 V
IS: 5350	Part III – post insulator units for systems greater than1000 V
IS: 5621	Hollow Insulators for use in electrical equipment
IS: 5556	Serrated lock washers – specification
IEC: 186	Voltage transformer

i. All items of equipment and materials shall be thoroughly cleaned and painted in accordance with relevant Indian Standards.

The finish paint shall be done with two coats of epoxy based final paint of colour Shade RAL 7032 of IS:5 for indoor equipment

ii. Any fitting or accessories which may not have been specifically mentioned in the specification but which are usual or necessary in the equipment of similar plant or for efficient working of the plant shall be deemed to be included in the contract and shall be provided by the Contractor without extra charges. All plant and apparatus shall be complete in all details whether such details are mentioned in the specifications or not.

iii. All equipment shall be designed for operation in tropical humid climate at the required capacity in an ambient air temperature of 55°C. Equipment shall be suitable for an ambient temperature of 55°C. Maximum relative humidity of 100% shall also be taken into consideration for design of equipment.

iv. The reference ambient temperatures for which the transformers are to be designed are as mentioned in Table 57.

v. The rating and electrical characteristics of the MV / 11 kV Outdoor type transformer (typical) shall be as mentioned in Table 58.

Table 57 Reference Weather Conditions for Transformer Design

Sr.	Particulars	Specifications
	Maximum ambient temperature	50 degree C
	Maximum daily average ambient temp	45 degree C
	Maximum yearly weighted average ambient temp	40 degree C
	Minimum ambient air temperature: (Cooling medium shall be Air)	Minus 5 degree C
	CLIMATIC CONDITIONS :	
5.1	Maximum relative humidity	85%
5.2	Yearly average number of thunder	Varies from 30 to 50

	storms	
5.3	Average no. of rainy days per annum	60 days
5.4	Fog	The atmosphere is subject to fog for two month in winter
5.5	Number of months during which tropical monsoon conditions prevail	4 months
5.6	Dust storms	occur at frequent intervals
5.7	Average annual rainfall	60 cms
5.8	Maximum wind speed	180 kmph

Table 58 Rating and electrical characteristics of 11kV Power Transformer

Sr.	Particulars	Details
1	Continuous kVA ratings	1.25 times the rated power output of Inverter MVA
2	Type	Oil immersed
3	Frequency	50 Hz
4	Type of cooling	ONAN
5	No. of phases	Three
6	Rating voltage H.V. side	11 kV
7	Highest System voltage on H.V. side	12 kV r.m.s.
8	Rated voltage on L.V. side	LV (Output of the Inverter) kV r.m.s.
9	Vector Group	Dyn11 (As per EPC Design)
10	Connections a) H.V. Winding b) L.V. winding	 Delta Star
11	Off load taps on H.V. Side (for H.V.Variation)	+ 10 to – 10.0 % (in steps of 2.5%)
12	Impedance voltage (%)	As per IS 2026

13	Minimum Creepage distance at 32 mm/kV	400mm phase to earth
14	Transformer connections	LV side – Bus Duct with weather proof enclosure, HV Side –Bushing with enclosure
15	Losses of Transformer	As per 1180 level-II

1.1.10. Current Transformer

i. Current transformers may be either of the bushing type or wound type. The bushing types are normally accommodated within the transformer bushings and the wound types are invariably separately mounted. The location of the current transformer with respect to associated circuit breaker has an important bearing upon the protection scheme as well as layout of, substation. Current transformer class and ratio is determined by electrical protection, metering consideration.

ii. Technical specifications – Current ratings, design, Temperature rise and testing etc. should be in accordance with IS: 2705 (part I to IV)

- **Type and Rating**

a. The current transformer should be of outdoor/ indoor type, single phase, oil immersed, self-cooled and suitable for operation in 3 phase solidly grounded system.

b. Each current transformer should have the following particulars under the site conditions for the system under design (typical values for 11 kV systems are given).

c. General Parameters: 11 kV CT.

d. Each current transformer should have the following particulars under the site conditions for the system under design (typical values for 11kV system are given).

Table 59 General parameters for 11 kV CT

Sr.	Particulars	Details
1	Highest system Voltage (Um)	12 kV rms
2	Rated frequency	50 Hz
3	System Neutral Earthing	Effective earthed
4	Installation	Outdoor/indoor(IP 65)
5	Rated short time thermal current	40 kA for 1 sec or appropriate thermal current as per design calculations
6	Rated dynamic current	63 kA (Peak) appropriate dynamic current as per design calculations
7	Rated min power frequency withstand voltage (rms value)	28 kV
8	Rated lightning impulse withstand voltage (peak value)	75 kV
9	Minimum Creepage distance at 32 mm/kV	As per IEC 60444-1 / IS 2705
10	Temperature rise	As per -IS 2705/1992
11	Type of insulation	Class A
12	Number of cores	Two (2) with One (1) protection core and one (1) metering core of accuracy 0.2 s class
13	CT secondary current	Protection cores – 1 Amp. Metering Core – 1 Amp (With Highest Accuracy Class)

14	Number of terminals in marshalling box	All terminals of control circuits wired up to marshalling box plus 20 terminals spare
15	CT ratio & Rated VA Burden, short time thermal rating ,class of accuracy	Minimum burden required : 1. Metering core – 50 VA 2. Protection core – 10 VA

1.1.11. General Parameters of 11 kV VT

The Bidder has to furnish the specifications of 11kV VT with the Bid.

Table 510 General parameters for 11 kV VT

S	Particulars	Details
1	Highest system voltage (Um)	12 kV
2	System neutral earthing	effective earthed
3	Installation	Outdoor (IP 65)
4	System fault level	Appropriate
5	Rated min power frequency withstand voltage (rms value)	28 kV
6	Rated lightning impulse withstand voltage (peak value)	75 kV
7	Standard reference range of frequencies for which the accuracy are valid	96% to 102% for protection and 99% to 101% for measurement
8	Rated voltage factor	1.2 continuous & 1.9 for 30 sec
9	Class of Accuracy	0.5 / 3P, IS3156/1992
1	Minimum Creepage distance at 32 mm/kV	As per IEC 60444-1 / IS 2705

1	Stray capacitance and stray conductance of LV terminal over entire carrier frequency range	As per IEC:358
1	One Minute Power frequency Withstand voltage for secondary winding	3 kV rms
1	Temp. rise over an ambient temp. of 50 deg. C	As per IS 3156/1992
1	Number of terminals in control spare.	All terminals of control circuits wired Cabinet up to marshalling box plus 10 terminals
1	Rated total thermal burden	350 VA
1	Number of cores	2 (two) – 1 for protection and one for metering with 0.5 class accuracy.
1	Rated Output, insulation level, transformation ratio, rated voltage factor	Should be provided by the Contractor.

- Circuit Breaker

i. The circuit breakers shall be capable of rapid and smooth interruption of currents under all conditions completely suppressing all undesirable phenomena even under the most severe and persistent short circuit conditions or when interrupting small currents or leading or lagging reactive currents. The circuit breakers shall be 'Restrike-Free' under all operating conditions. The details of any device incorporated to limit or control the rate of rise of restriking voltage across, the circuit breaker contacts shall be stated. The over voltage across, the circuit breaker contacts shall be stated. The over voltage caused by circuit breaker while switching inductive or capacitive loads shall not exceed 2.5 times the highest phase to neutral voltage. The actual make and break times for the