General Technical Requirements

Table of Contents

[**PART 1 : BIDDING PROCEDURES 5**](#_heading=h.gjdgxs)

[*SECTION I. INSTRUCTIONS TO BIDDERS 6*](#_heading=h.30j0zll)

[A](#_heading=h.1fob9te) GENERAL 6

[A.](#_heading=h.1664s55) Introduction 31 31

[B.](#_heading=h.3q5sasy) Bidding Documents 31 31

[C.](#_heading=h.25b2l0r) Qualification Criteria 31 31

[D.](#_heading=h.kgcv8k) Preparation of Bids 31 31

[E.](#_heading=h.34g0dwd) Submission and Opening of Bids 32 31

[F.](#_heading=h.1jlao46) Evaluation and Comparison of Bids 33 31

[G.](#_heading=h.43ky6rz) Award of Contract 34 31

[or 37](#_heading=h.2afmg28)

[or 38](#_heading=h.11si5id)

[or 38](#_heading=h.pkwqa1)

[**Bid Submission Sheet 43**](#_heading=h.48pi1tg)

[**Price Schedule Forms 46**](#_heading=h.2nusc19)

[**Price Schedule: Goods Manufactured Outside the Purchaser’s Country, already imported 48**](#_heading=h.3mzq4wv)

[Date: 49](#_heading=h.319y80a)

[BID GUARANTEE No.: 49](#_heading=h.1gf8i83)

[**Manufacturer’s Authorization 50**](#_heading=h.40ew0vw)

[**INTEGRITY PACT 51**](#_heading=h.2fk6b3p)

[**Letter of Intent 54**](#_heading=h.upglbi)

[*Section V: Eligible Countries*](#_heading=h.3ep43zb)*55 55*

[*58*](#_heading=h.3s49zyc)*Section VI: Schedule of Supply 58*

[*Section VI: Schedule of Supply*](#_heading=h.meukdy)*59 59*

[**1.**](#_heading=h.1ljsd9k) **Project Information 62**

[*3.1*](#_heading=h.45jfvxd)*Solar Photovoltaic (PV) Modules 64*

[*3.2*](#_heading=h.2koq656)*Modules Mounting Structure 66*

[*3.3*](#_heading=h.zu0gcz)*Off-grid Inverter 66*

[*3.4*](#_heading=h.3jtnz0s)*Maximum Power Point Tracker (MPPT) 67*

[*3.5*](#_heading=h.1yyy98l)*Array Junction Box 67*

[*3.6*](#_heading=h.4iylrwe)*DC Distribution Box (DCDB) 67*

[*3.7*](#_heading=h.2y3w247)*AC Distribution Box (ACDB) 68*

[*3.8*](#_heading=h.1d96cc0)*Battery/Inverter room 68*

[*3.9*](#_heading=h.3x8tuzt)*Battery Bank 68*

[*3.10*](#_heading=h.2ce457m)*Protections and Switchgears 69*

[3.10.1](#_heading=h.rjefff) Earthing Protection 69

[3.10.2](#_heading=h.3bj1y38) Lightning Protection 69

[3.10.3](#_heading=h.1qoc8b1) Surge Protection & switchgears 69

[*3.11*](#_heading=h.4anzqyu)*Cables & Accessories 70*

[*3.12*](#_heading=h.2pta16n)*Energy Meter 70*

[*3.13*](#_heading=h.14ykbeg)*Miscellaneous 70*

[**Tools & Tackles and Spares 70**](#_heading=h.3oy7u29)

[**5**](#_heading=h.243i4a2) **Fire Extinguishers 71**

[*3.14*](#_heading=h.j8sehv)*Drawings and Manuals 71*

[**6.**](#_heading=h.338fx5o) **Contractor Responsibility: 71**

[*4.1*](#_heading=h.1idq7dh)*Access to Site 71*

[*4.3*](#_heading=h.2hio093)*Operation & Maintenance (O&M) Training 72*

[*4.4*](#_heading=h.wnyagw)*Personal Protection Equipment (PPE) 72*

[*4.5*](#_heading=h.3gnlt4p)*First - aid facilities 72*

[*4.6*](#_heading=h.1vsw3ci)*Labor Work Permits, Accommodation and Insurance 72*

[*4.7*](#_heading=h.4fsjm0b)*Protection of the Environment 72*

[*4.8*](#_heading=h.2uxtw84)*Emergency Planning/Emergency Response 73*

[**5.**](#_heading=h.1a346fx) **Design Review Meeting (s), Drawings and Documentations 73**

[**6.**](#_heading=h.3u2rp3q) **Erection, Testing and Commissioning 74**

[Contract Agreement](#_heading=h.2981zbj) 92 91

[Performance Security](#_heading=h.odc9jc) 94 91

[Bank Guarantee for Advance Payment](#_heading=h.38czs75) 95 91

[Letter of Acceptance](#_heading=h.1nia2ey) 96 91

[Attachment: Contract Agreement 98](#_heading=h.47hxl2r)

# **General Technical Requirements**

# **Project Information**

The Department of Energy(DoE), Ministry of Energy and Natural Resources (MoENR) (hereinafter refer as Purchaser) intends to set up a 3kWp solar PV ground-mounted for 10 households (3kWp x 10 HH = 30kWp) at Shangsa Village, Lunana Gewog, Gasa Dzongkhag under Bhutan For Life (BFL) funding.



*Figure 1: Existing household location in the google map.*

The site has no access to grid electricity except with standalone solar lighting and with motorable road up to Koina, Laya Gewog, Gasa Dzongkhag.

Location of the ground-mounted Solar PV plant is indicated below**:**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Parameters | Value |
| 1 | Name of the Implementing Agency | Department of Energy, Ministry of Energy and Natural Resources, Thimphu |
| 2 | Beneficiary of the System/Location | Shangsa village, Lunana Gewog, Gasa Dzongkhag |
| 3 | Geographical Coordinate (google map) | Latitude: 28o01’ 22”Longitude:90o04’40” |
| 4 | Altitude | >3,600 masl |
| 5 | Ambient Temperature |  20oC |
| 6 | Average annual rainfall | 62mm |
| 7 | Climate zone | Ranging from temperate to alpine with extremely cold winter and short pleasant summer |
| 8 | Relative humidity | 55-90% |
| 9 | Average Snow Incidence and Period | 240 mm (October to April) |
| 10 | Solar Insolation (GHI) | 4.322kWh/m2/day |

1. **Scope of Supply**

The scope of project consists of a total “turnkey contract” including Design, Supply, Transportation, Installation, Testing and Commissioning of ground-mounted 3kWp solar PV plant for existing 10 households (3kWp x 10 HH= 30kWp) including necessary civil works for mounting structures, wiring up to distribution board, control room for inverter/battery and barbed wire fencing.

The ground mounted solar PV system shall consist of following equipment and components but not limited to:

i. Solar PhotoVoltaic (SPV) module

ii. Module Mounting Structures

iii. Off-grid Inverter

iv. Battery bank

v. Array Junction Boxes

vi. AC Distribution Box

vii. Protections and switchgears-Earthing, Lightning, Surge, etc.

viii. Cables

ix. Energy Meter

x. Control room

xi. Miscellaneous items such as hardware, rack pipes, connecting pipes, brackets, ground lock, connectors, elbows, cable clips, etc.

xii. Barbed wire fencing

xiii. Drawing & Manuals

The Contractor shall be solely responsible for any shortages of materials during the execution of the contract. The Contractor shall submit the design and drawings of the proposed solar PV power plant to the purchaser along with the bidding documents.

The successful bidder (hereinafter referred to as the “Contractor”) shall provide one year warranty period for each equipment listed in the Bill of Quantity (BoQ) and provide Operation & Maintenance (O&M) training to the end users including the project team during the testing and commissioning.

The components and spare parts used in the solar PV system should conform to the IEC or other national/international specifications and standards, wherever such specifications are available and applicable.

1. **System Parameters**

Off-grid ground-mounted solar PV system comprises half cut monocrystalline (PERC) Si PV modules with intelligent inverter with Maximum Power Point Tracking (MPPT) charging technology which feeds uninterrupted quality AC power to electrical loads. Battery storage will be charged from solar energy by a charge controller integrated in the inverter or by an external charge controller with MPPT technology. *The balance of system (BOS) consists of module mounting structures, appropriate DC and AC cables, string combiner boxes (SCB), AC and DC distribution boxes with protection equipment, lightning arrester, earthing systems, etc.*

|  |  |  |
| --- | --- | --- |
| Sl. No. | Parameters | Value |
| 1 | Type of system | Off-grid Battery Storage Solar Photovoltaic Power system  |
| 2 | Total Capacity/system size | 3kWp x 10 HH = 30kWp |
| 3 | PV Module | Half cut mono-crystalline PERC panel  |
| 4 | Minimum peak power required at load per household  | 3.6kW |
| 5 | Minimum energy required by load per day per household | 8kWh/day |
| 6 | Storage days of autonomy | 1 day |

## **Solar Photovoltaic (PV) Modules**

The ground mounted solar PV plant comprises half cut monocrystalline (PERC) Si PV modules. The module type used must qualify to the latest edition of IEC standards or equivalent IS standards i.e. IEC 61215/IS 14286, IEC 61853- Part I/ IS 16170 – Part I and IEC 62804 (PID). For PV modules to be used in a high altitude throughout the lifetime, they must qualify to IEC 61730 Part-1 Part-2 for safety qualification, requirement for construction and testing. Certificate for module qualification from IEC or equivalent shall be submitted as part of the bid offer. Salt Mist Corrosion testing as per IEC 61701.

The provided PV module should be of best quality available in the market with cell efficiency >18% and the rated output power of any supplied module shall have tolerance of $\pm 3\%$. The PV module has an ability to function well with high-voltage input inverters/charge controllers.

The solar PV module shall perform satisfactorily in humidity up to 100% with temperature between -20C and +55C. Since the module would be used in a very high altitude and extreme cold weather conditions, the Contractor shall carefully design and accommodate requisite parameters to achieve the rated power in the project proposal submitted to the purchase. The Contractor shall carry out on each module high altitude tests and a test certificate must be submitted at the time of execution.

The predicted electrical degradation at the end of the period of ten (10) years shall be less than ten percent (10%) of the full rated original output.

The front glass shall meet the following specifications:

1. The facing glass must be Tempered, PV grade with Low iron and high transmission.
2. The transmission shall be > 93 %
3. Textured to trap more light
4. The glass shall have an Anti-reflective coating for the better transmission and light absorption.
5. Tempered glass to meet the external load conditions

Manufacturers/suppliers should confirm whether they are supplying PV modules using a RF identification tag (RFID), which must contain the following information. The RFID can be inside or outside the module laminate, but must be able to withstand harsh environmental conditions.

i. Name of the manufacturer of PV Module

ii. Name of the Manufacturer of Solar cells

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

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

v. I-V curve for the module

vi. Peak Wattage, open circuit voltage(Voc), Im, Vm, Isc and FF for the module

vii. Temperature coefficient (%/$°C$) and nominal operating cell temperature (NOCT)

viii. Module efficiency (%)

viii. Unique Serial No and Model No of the module

ix. Date and year of obtaining IEC PV module qualification certificate

x. Name of the test lab issuing IEC certificate

xi. Other relevant information on traceability of solar cells and modules as per ISO 9000 series.

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

1. Modules alignment and tilt angle shall be calculated to provide the maximum annual energy output. This shall be decided based on the location of array installation.
2. The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary more than three (3) percent from the respective arithmetic means for all modules and/or for all module strings, as the case may be.
3. Except where specified, the front module surface shall consist of impact resistant, low-iron and high-transmission toughened glass.
4. The module shall be provided with a junction box with either provision of external screw terminal connection or sealed type and with arrangement for provision of by**-**pass diode. The box shall have hinged, weather proof lid with captive screws and cable gland entry points or may be of sealed type and IP65 rated.
5. Solar panel should have packed properly for safe transportation to the project site.

## **Modules Mounting Structure**

Ground mounts shall be designed so that the fixed structure can withstand the load of the PV modules with an adequate strength for footing to meet site-specific soil types, snow load/thickness and high wind velocities. PV modules can be mounted in either portrait or landscape orientation, depending on the rack.

The Contractor shall design the PV arrays’ mounting systems based upon standard industry practice and the manufactures requirement, including the requirements of applicable codes, standards, as well as the specifications provided by the module manufacturer. The supporting structure shall be able to withstand strong wind gusts. The designs for wind velocity withstanding capacity has to be certified by a recognized Lab/institution/certified engineers and submit the wind loading calculation sheet to the purchaser.

The mounting structure shall be made of a corrosion-resistant material, which shall be electrolytically compatible with the structural material used in the frame, its fasters, nuts and bolts. The material for supporting structures of the PV panels is hot dip galvanized steel and should resist corrosion.

Structures shall be supplied complete with all members to be compatible for allowing easy installation. The structures shall be designed for simple mechanical and electrical installation. There shall be no requirement of welding or complex machinery at the installation site.

The Contractor shall specify installation details of the PV modules and the support structures with appropriate diagrams and drawings.

Regarding civil structures, the Contractor needs to take care of the load bearing capacity of the solar modules and need to arrange suitable structures based on the geographical location of the selected site. *Shading shall be avoided all over the year (around) from 30 minutes after the sunrise to 30 minutes before sun set and also to allow regular cleaning of the solar modules, they should be easily accessible for personnel (for installation purpose only).*

The ground-mounted structure has to be provided with proper fencing with wooden posts for safety purposes.

All drawings and installation details shall be approved by the purchaser prior to installation.

## **Off-grid Inverter**

All-in-one solar inverter with pure sine wave output. The off-grid inverter combines the function of battery charging, solar charging and power inverter into one unit. 48Vdc off-grid inverter should designed for a wide range of operating temperatures from $-20°C to+55°C$ and also come with a built-in MPPT charger controller and selectable charging current based on the applications and compatible with lithium-iron phosphate (LiFEPO4) batteries.

The inverter shall have the provision for GSM communication link.

Common Technical Specification:

Control Type : min. 3.6kW off-grid inverter, Voltage source, microprocessor

 assisted, output regulation

Output voltage : single phase, 230Vac
Frequency : 50 Hz (±2%)

Reactive Power : 0.95 inductive to 0.95 capacitive
DC link voltage range : 40-60V
Total Harmonic Distortion : less than 3 or 4% at maximum power output

(THD)

Inverter efficiency : 98% and above at full load
Power Control : MPPT

Overloading capacity :at least 120%
Protection degree : IP65 or better

The inverter shall include appropriate self-protective and self-diagnostic features to protect itself and the PV array from damage in the event of inverter component failure or from parameters beyond the inverter’s safe operating range due to internal or external causes. The self-protective features shall not allow signals from the inverter front panel to cause the inverter to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the inverter, including commutation failure, shall be cleared by the inverter protective devices.

The Contractor shall submit the assumptions, factors taken into consideration and calculations for the inverters and array sizing for approval by the Purchaser.

The Contractor shall provide a warranty of at least 10 years on inverters used in this project.

## **Maximum Power Point Tracker (MPPT)**

Maximum power point tracker shall be integrated in the Inverter to maximise energy drawn from the array. The MPPT should be microprocessor based to minimise power losses. The details of the working mechanism of MPPT shall be mentioned.

## **Array Junction Box**

The junction boxes are to be provided in the PV array for termination of connecting cables. The Junction Boxes (JBs) shall be made of GRP/FRP/Powder Coated aluminium/cast aluminium alloy with full dust, water & vermin proof arrangement. All wires/cables must be terminated through cable lugs. The JBs shall be such that input & output termination can be made through suitable cable glands. 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.

Copper bus bars/terminal blocks housed in the junction box with suitable termination threads Conforming to IP 65 or better standard and IEC 62208 Hinged door with EPDM rubber gasket to prevent water entry, Single/double compression cable glands should be provided.

Polyamide glands and MC4 Connectors may also be provided. The rating of the junction box shall be suitable with adequate safety factor to interconnect the Solar PV array.

Suitable markings shall be provided on the bus bar for easy identification and the cable ferrules must be fitted at the cable termination points for identification.

Junction boxes shall be mounted on the MMS such that they are easily accessible and are protected from direct sunlight and harsh weather.

## **DC Distribution Box (DCDB)**

##

DC Distribution Box are to be provided to receive the DC output from the PV array field.

DCDBs shall be dust & vermin proof conform having IP 65 or better protection, as per site conditions.

The bus bars are made of EC grade copper of required size. Suitable capacity MCBs shall be provided for controlling the DC power output to the inverter along with necessary surge arrestors. MCB shall be used for suitable current ratings.

## **AC Distribution Box (ACDB)**

AC Distribution Panel Board (DPB) shall control the AC power from inverter, and should have necessary surge arrestors, if required.

All switches and the circuit breakers, connectors should conform to IEC 60947:2019, part I, II and III/ IS 60947 part I, II and III.

All the Panel’s shall be metal clad, totally enclosed, rigid, floor mounted, air -insulated, cubical type suitable for operation on *1-φ*, 230 volts, 50 Hz (or voltage levels as per ERA regulations).

The panels shall be designed for minimum expected ambient temperature of 20 degree Celsius, 100 percent humidity and dusty weather.

All indoor panels will have protection of IP 54 or better, as per site conditions. All outdoor panels will have protection of IP 65 or better, as per site conditions.

Should conform to safety regulations of the Electricity Regulator Authority (till last amendment).

All the 415 or 230 volts (or voltage levels as per regulations of the ERA) AC devices/equipment like bus support insulators, circuit breakers, SPDs, Voltage Transformers (VTs) etc., mounted inside the switchgear shall be suitable for continuous operation and satisfactory performance under the following supply conditions.

i. Variation in supply voltage: as per ERA regulations

ii. Variation in supply frequency: as per ERA regulations

The inverter output shall have the necessary rated AC surge arrestors, if required and MCB/MCCB. RCCB shall be used for successful operation of the PV system, if the inverter does not have required earth fault/residual current protection.

## **Battery/Inverter room**

The battery bank should be housed in a vented compartment that prevents users from coming contact with batteries terminals. The compartment should be strong enough to accommodate the weight of the batteries. A mechanism to prevent opening and entry of the batteries should be provided.

The room should be well insulated to maintain the operating temperature of the battery and inverter.

## **Battery Bank**

The battery bank shall be stackable Lithium-Ferro-Phosphate (LiFePO4) sized according to the energy requirement and a separate Battery Management System is to be provided, if required.

Lithium-ion batteries of appropriate capacity with a complete battery management system should be used. The following information must be provided by the bidders:

i. Charging/Discharging efficiency

ii. Self-discharge

iii. the batteries must conform to the latest edition of IEC 62133 and/or IEC 61960 (whichever is applicable)

The battery must ensure safe and reliable operation in the whole range of ambient temperature of -20$°C to+50°C$ and the usable capacity of batteries is 90%.

The maximum permissible self-discharge rate is 5% of rated capacity per month at 25$°C$ and service life of the batteries must be greater than 6000 cycles of discharge down to depth of discharge (DoD) of 90% discharge rate.

Battery shall have a warranty of minimum 10 years.

Batteries should be packed properly to withstand or damage during the transportation to project site.

## **Protections and Switchgears**

The system should be provided with all necessary protections as per the standards, rules and regulations of the Electricity Regulator Authority (ERA) as describe below but not limited to:

### Earthing Protection

Each array structure of the PV yard should be grounded properly in accordance with latest standards. In addition, the lightning arrestor/masts should also be provided inside the array field. Provision should be kept for shorting and grounding of the PV array at the time of maintenance work. All metal casing/shielding of the plant should be thoroughly grounded in accordance with safety codes and rules of the ERA/IE Rules. The earthing arrangement shall be followed as per the electrical drawing and interconnected with a copper strip. The resistance value of the earthing should be less than 2 ohms.

Each array structure of the PV yard and all electrical equipment, inverter, lightning arrestor, all junction boxes, etc. shall be grounded properly as per IS 3043-2018.

The complete earthing system should be electrically and mechanically connected to ensure an independent return path through earth. AC lines must be provided with proper earth connections and all DC grounding from the array junction boxes grounded separately to an earth.

The Contractor shall provide details of the earthing drawing for approval.

### Lightning Protection

The Solar PV power plant shall be provided with lightning & over voltage protection. The entire space occupying the Solar PV array shall be suitably protected against lightning by deploying the required number of lightning arrestors. Lightning protection should be provided as per NFC17-102:2011/IEC 62305 standard.

Lightning protection shall be provided by the use of metal oxide varistors (MOVs) and suitable earthing such that induced transients find an alternate route to earth. Protection shall meet the safety rules of the ERA.

The current carrying cable from lightning arrestor to the earth pit should have sufficient current carrying capacity according to IEC 62305.

### Surge Protection & Switchgears

MCBs and surge protection devices on AC and DC side must be sized accordingly as per relevant standard.

All boxes/ panels should be equipped with appropriate functionality, safety (including fuses, grounding, etc.) and protection.

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

Adequate rating fuses & isolating RCD/RCCD/ ELCB should be provided.

The boxes/ panels shall be dust, vermin, and waterproof and made of thermoplastic/metallic in compliance with IEC 62208, which should be sunlight/ UV resistive (for outdoor) as well as fire retardant & must have minimum protection to IP 65(Outdoor)/ IP 20(indoor) and Protection Class II.

The proposed PV system shall include, at a minimum, one fused DC disconnect and one fused AC disconnect for safety and maintenance concerns. The AC disconnect switch should be installed next to the inverter.

## **Cables & Accessories**

Copper as per IS standard and design; calculations based on site conditions. Wire losses in DC circuits to be < 1.5% and in AC circuits to be < 1.5%. UV protected solar cablesmust be used. The length of cable should be kept as minimum as possible to reduce voltage drop. Cables should be protected with stainless steel/aluminium or equivalent appropriate pipes outside and flexible plastic/stainless steel/aluminium inside the building.

Cable should have an operating temperature range of -20C to + 80C and voltage rating of 660/1000V.

The electric cables for DC systems for rated voltage of 1500 V shall conform to BIS 17293:2020.

All cable/wires are to be routed in a RPVC pipe/ GI cable tray and suitably tagged and marked with proper manner by good quality ferrule or by other means so that the cable is easily identified. Any change in cabling schedule/sizes if desired by the Contractor be approved after citing appropriate reasons. All cable schedules/layout drawings have to be followed as per the electrical drawings provided. All cable tests and measurement methods should conform to IEC 60189.

## **Energy Meter**

A suitable single phase digital energy meter (0.2S Accuracy Class) shall be installed for the measurement of energy.

## **Miscellaneous**

Proposed tentative BOQ indicating major components shall be submitted

All items against which no make has been mentioned must confirm to ISI standards

For complete work, the Contractor shall carry out the work as per the drawings (both civil and electrical), technical specifications and instructions provided by the Purchaser.

Electrical safety of the installation(s) must be taken into account and all the safety rules & regulations applicable as per ERA safety codes must be followed.

1. **Tools & Tackles and Spares**

After completion of installation & commissioning of the solar power plant, necessary tools & tackles are to be provided free of cost by the Contractor for maintenance purpose. List of tools and tackles to be supplied by the Contractor for approval of specifications and make.

The contractor shall stock adequate recommended spares at site for operation and maintenance of solar PV plants.

1. **Fire Extinguishers**

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

1. Portable fire extinguishers for fire caused by electrical short circuits
2. Sand buckets
3. The fire extinguishers shall be inside the plant premise.
4. **Drawings and Manuals**

Bidders shall provide complete technical data sheets for each equipment giving details of the specifications along with reputed make/makes in their bid along with basic design of the power plant along with protection equipment.

For complete works, the Contractor shall carry out the work in accordance with the drawings (civil & electrical both), technical specifications and instruction provided by the Purchaser.

Operation & Maintenance manual/user manual, engineering and electrical drawings shall be supplied along with the power plant.

The manual shall include complete system details such as array lay out, schematic of the system, inverter details, working principle, etc.

The Manual should specify all Dos & Don’ts of solar power plant along with Graphical Representation with indication of proper methodology for cleaning, Operation and Maintenance, etc. including step by step maintenance and troubleshooting procedures.

1. **Contractor Responsibility:**

## **Access to Site**

The Project site (Shangsa village) is not accessible by motorable road. Therefore, the Contractor shall bear all expenses in connection with the transportation of materials to the project site including labour camp, site office, warehouse rent, handling and other charges, which may occur for the purpose of the Contract.

All expenses towards mobilization at project site and demobilization including bringing in equipment, workforce, materials, clearing of site after completion of work shall be deemed to be included in the offer and no separate payments shall be entertained. The Contractor shall leave the Site and work clean and safe to the satisfaction of the Project Manager, without which final invoice shall be withheld.

During the execution of the contract the contractor shall ensure a responsible person with authority to take decisions to be available at site. Such persons deputed by the contractor shall report to the Project Manager, DoE for smooth execution and timely completion of the works. The contractor shall abide by the instructions of the Project Manager/Project team, if given in this regard.

The Contractor shall make all arrangements for any temporary electricity supply and adequate supply of water for construction and drinking purposes that he may require for the execution of the works.

## **Electrical Studies**

The Contractor shall perform all necessary studies and detailed design drawings to conform equipment characteristics and to enable orderly and expeditious procurement, construction and ultimately installation and commissioning on site. The Electrical studies shall include but not be limited to the following:

i). Photovoltaic equipment sizing to meet the requirement of this tender;

ii). Inverter Sizing to meet the requirement of this tender;
iii). Cables Sizing;
v). Earthing system proposed PV solar plant;

vi.) Protection Studies for the proposed PV solar Plant;
vi) Any other studies deemed necessary to determine the choice of the different equipment and

materials;
vii). All studies and calculations shall be submitted by the Contractor for review and approval by the

Purchaser prior to manufacturing, ordering and installation.

viii) The Purchaser reserves the right to request the Contractor to carry out additional studies prior to ordering.

##

## **Operation & Maintenance (O&M) Training**

The Contractor shall provide a training plan for all aspects of operation and maintenance procedures, which shall after approval by Purchaser, from the basis of the training program. Contractor shall impart training on site to Purchaser’s engineers and at least one (1) person from each household in O&M of solar PV plant and its associated equipment. The Contractor shall ensure that the training imparted is sufficient for the operation and maintenance activities of the plant.

## **Personal Protection Equipment (PPE)**

As per the Labour and Employment Act of Bhutan and Regulation, the Contractor shall provide to his employee with appreciated Personal Protective Equipment (PPE) such as helmets, footwear, protective clothing, etc. to be used in the workplace and ensure employees use the PPE at all the times while performing work at site.

All PPE shall be periodically checked to ensure worn so that damaged equipment is replaced expeditiously.

## **First - aid facilities**

The contractor shall make available first-aiders/first-aid boxes at the work site for the project team. First-aides' names shall be prominently displayed.

The first-aid boxes shall display contents of medical and medicinal articles with quantity maintained. if the contents is exhausted, the Contractor shall replenish stock promptly.

## **Labor Work Permits, Accommodation and Insurance**

The Contractor shall be responsible to ensure that all grades of expatriate labour have the current and correct work permits and or Visas, and to comply in every way with the immigration and or emigration regulations. The contractor shall also ensure that they comply with the labour laws of the country and the requirements for leave, accommodation and insurance of all his employees and the employees of his sub-contractors. The Contractor in all dealings with labour in his employ shall have due regard to all recognized festival days of rest and religious or other customs.

## **Protection of the Environment**

The Contractor shall take all reasonable steps to protect the environment on and off the Site and to avoid damage or nuisance to persons or to property of the public or others resulting from pollution, noise or other causes arising as a consequence of his methods of operation, and shall preserve and protect all existing vegetation and trees on or adjacent to the Site which do not unreasonably interfere with the execution of the project. The Contractor shall be held responsible for all unauthorized cutting off and damage to trees, by careless operation of his plant, equipment or materials and stockpiling of materials etc. and Purchaser shall have no responsibility on this account.

## **Emergency Planning/Emergency Response**

Contractor shall designate his emergency team at work site to coordinate with Purchaser or local health staff for liaising with Government agencies and community during emergency. The contractor shall display the emergency telephone/mobile numbers of key contact person, police, ambulance, etc.

## **Design Review Meeting (s), Drawings and Documentations**

A design review meeting shall be held at the Purchaser’s premises at a suitable time in order to expedite agreement of the proposed layout and wiring diagrams of the solar PV plant.

All drawings shall be to scale and fully detailed with a preferred maximum drawing size of A1. All-important dimensions shall be given and the materials of which each part is to be constructed shall be indicated

All drawings shall be black or coloured lines on a white background with all revisions clearly marked and identified on the drawings.

All documents and drawings prepared by the contractor shall be clearly marked or stamped with one of the following indications:

i. For Approval ii. For Comments iii. Released for Construction iv. For Information v. As Built

Documents submitted to Purchaser without one of the above statuses will not be considered.

**List of data to be submitted at each stage of bidding process is given below:**

|  |  |  |
| --- | --- | --- |
| Sl. No | Particular | Number of copies to be submitted at |
| Time of Bidding | Approval Stage | As Built documents |
| Review | Record |
| 1 | List of manufacturer/supplier’s documents  | 1 |  | 2 |  |
| 2 | Detail design drawing with schematic layout  | 1 | 2 | 2 | 2 |
| 3 | Single line diagram (SLD)  | 1 | 2 | 2 | 2 |
| 4 | Catalogues  | 1 |  | 1 |  |
| 5 | Calculations for : panel sizing, inverter, battery, cables and protection, etc. | 1 |  | 2 | 2 |
| 6 | Installation, Operational and maintenance manual |  |  | 2 |  |
| 7 | Inspection & type test certificate for all equipment to be supplied | 1 |  | 1 |  |
| 8 | Technical deviation list, if any | 1 |  |  |  |

1. **Erection, Testing and Commissioning**

The scope of installation, testing and commissioning for the plant facilities shall include, but not limited to the following:

1. Erection of module structures and Installation of PV modules on module mounting structures and interconnection of PV modules.
2. Laying of solar cables through suitable conduit from PV Modules to off-grid inverter along with termination at both the ends.
3. Installation, testing and commissioning of solar PV panels, battery bank, inverters and switchgears panels.
4. Installation, testing and commissioning of energy meters, lightning protection system for entire plant facilities.
5. Earthing of PV modules, module mounting structures, inverters, switchgears, lighting arrestors, and all other electrical equipment.
6. Installation of fire protection system for the entire plant facilities.
7. Pre-commissioning checks and tests for all equipment.
8. All other works related to installation, testing and commissioning which are not mentioned but required to complete the solar power plant facilities in all respects.
9. The following inspections shall be performed upon receiving the components:

|  |  |  |
| --- | --- | --- |
| **Sl. No.** | **Particular** | **Inspection** |
| 1 | PV Modules | Physical inspection and validation with specification and datasheet provided |
| 2 | Inverter | Physical inspection and validation with specification and datasheet provided |
| 3 | Batteries and cables | Physical inspection and validation with specification and datasheet provided |
| 4 | Mounting structures | Physical inspection and validation with specification and datasheet provided |
| 5 | Switchgear and protection | Physical inspection and validation with specification and datasheet provided |
| 6 | Battery/Inverter Room | Physical inspection and validation with specification and datasheet provided |
| 7 | Barbed wire fencing  | Physical inspection and validation with specification and datasheet provided |

**Section II: The Standard Compliance Requirement is as follows:**

|  |  |
| --- | --- |
| **Particulars** | **International Standards** |
| Low voltage electrical installation | IEC 60364 Electrical Installations for Buildings |
| Design of solar PV systems | IEC-62738: General guidelines and recommendations for design and installation of ground mounted Solar PV plants IEC 62548: Safety and design requirements |
| Surge protection device | IEC 61643-12 Low-voltage surge protection devices – Part 12: Surge protection devices connected to low-voltage power distribution systems – Selection and application principles |
| Solar PV modules | IEC 61 215 Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approvalIEC 61 721 Photovoltaic (PV) module safety qualification – Part 1: Requirements for constructionThin Film Terrestrial PV Modules IEC 61646 (latest edition)Concentrator PV Modules & Assemblies IEC 62108 (latest edition) |
| Inverter | IS16221 Part II, clause 5 - All the Inverters should contain clear and indelible Marking Label & Warning Label.IEC 61000-3 Electromagnetic compatibility (EMC) IEC 62109 Safety of power converters for use in photovoltaic power systems - Part 1: General requirements - Part 2: Particular requirements for inverters |
| Battery | IEC 61427 - this series gives general information relating to the requirements for the secondary batteries used in photovoltaic energy systems (PVES) and to the typical methods of test used for the verification of battery performances.IEC 60896 - applies to all stationary lead-acid cells and Monobloc batteries of the valve regulated type for float charge applications, (i.e. permanently connected to a load and to a DC power supply), in a static location (i.e. not generally intended to be moved from place to place) and incorporated into stationary equipment or installed in battery rooms for use in telecom, uninterruptible power supply (UPS), utility switching, emergency power or similar applications.IS 15549:2005 - this standard specifies capacities and performance requirements and corresponding test methods for all types of high integrity series stationary Valve regulated lead acid batteries.IEC 62133 requirements and tests for the safe operation of portable sealed secondary lithium cells and batteries containing non-acid electrolyte, under intended use and reasonably foreseeable misuse.IEC 62620 defines marking, tests and requirements for lithium secondary cells and batteries used in industrial applications including stationary applications.IEC 61951-2  |
| Solar cables | IEC 60228 Conductors of insulated cablesIEC 60332-1 Tests on electric and optical fiber cables under fire conditions (category C2)IEC 61034-2: Measurement of smoke density of cables burning under defined conditionsIEC 60754 Test on gasses evolved during combustion of materials from cables (halogen-free)IEC 60216 Electrical insulating materials – Thermal endurance propertiesIEC 60 811-2-1 Common test methods for insulating and sheathing materials of electric and optical cables Part 2-1: Methods specific to elastomeric compounds– Ozone resistance, hot set and mineral oil immersion tests |
| Cables in trenches | IEC 60502-1: Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 1: Cables for rated voltages of 1 kV ((Um = 1,2 kV) and 3 kV (Um = 3,6 kV) |
| Hot-dip galvanization andanti-corrosion treatment | ISO 1461 Hot dip galvanized coatings on fabricated iron and steel articles -- Specifications and test methodsISO 12944: Paints and varnishes -- Corrosion protection of steel structures by protective paint systems |
| Design calculations standards | EN 1991: (Eurocode 1) Actions on structuresEN 1999: (Eurocode 9) Design of aluminium structuresEN 1993: (Eurocode 3) Design of steel structuresISO 4354 Wind actions on structuresISO 22111 Bases for design of structures – General requirementsISO 13823 General principles on the design of structures for durability |
| Cable trays | IEC 61 537 Cable management – Cable tray systems and cable ladder systems |
| Off-Grid Inverters | TS 62257-9-8 sets the baseline requirements for the quality, durability and advertising accuracy for stand-alone renewable energy products and amendment thereof.  |
| Switchgear | IEC 60439 Low-voltage switchgear and control gear assembliesIEC 60947 Low-voltage switchgear and control gear |

**Section III: Data Sheet to be submitted by Bidder with technical bid:**

**1. Solar PV Modules**

|  |  |  |
| --- | --- | --- |
| **Component** | **Technical Specification** | **Proposed by Bidder** |
| **PV panels/ modules** | 1. Name of the manufacturer of PV Module
2. Name of the Manufacturer of Solar cells
3. Total number of module per household
4. Month and year of the manufacture (separately for solar cells and module);
5. Country of origin (separately for solar cells and module)
6. I-V curve for the module
7. Peak Wattage, Im, Vm, I sc, Voc and FF for the module
8. Module Efficiency >18%.
9. Normal Operating cell temperature
10. Operating module temperature
11. Maximum voltage dc
12. Maximum load
13. Dimensions(mm)
14. Weight (kg)
15. X-pitch and Y-pitch
16. Unique Serial No and Model No of the module
17. Date and year of obtaining IEC PV module qualification certificate;
18. Name of the test lab issuing IEC certificate
19. Other relevant information on traceability of solar cells and modules as per ISO 9000 series.

The front glass shall meet the following specifications:1. The facing glass must be Tempered, PV grade with Low iron and high transmission.
2. The transmission shall be > 93%
3. Thickness shall be min 3.2 mm
4. Textured to trap more light
5. The glass shall have an Anti-reflective coating for the better transmission and light absorption.
6. Tempered glass to meet the external load conditions

Details in case of any deviation from the technical specifications as specified in the tender documentEnclosed/attached supporting documents, if any | ***Use Separate page with proper page no.***  |

**2. Battery**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Details regarding  | Proposed by Bidder |
| 1 | Name of the manufacturer & make/brand  |  |
| 2 | Battery/ Model Type  |  |
| 3 | Energy Storage per household, kWh |  |
| 4 | No. of battery |  |
| 5 | Battery Voltage, V |  |
| 6 | Battery capacity, Ah |  |
| 7 | No. of battery per household |  |
| 8 | Battery management system |  |
| 9 | Operating temperature & altitude |  |
| 10 | Dimension of Battery (size) |  |
| 11 | Enclosed supporting documents if any | From page no…….. to …. |
| 12 | Details in case of any deviation from the technical specifications as specified in the tender document |  |

**3**. **Off-Grid Inverter (all-in one)**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Details regarding | Proposed by Bidder |
| 1 | Name of the manufacturer & Make/brand |  |
| 2 | Size of the inverter, kW |  |
| 3 | Type  |  |
| 4 | Voltage range |  |
| 5 | Battery type |  |
| 6 | Operating temperature & altitude |  |
| 7 | Inbuilt MPPT (Yes/No) |  |
| 8 | Enclosed supporting documents if any | From Page No……. to …. |
| 9 | Details in case of any deviation from the technical specifications as specified in the tender document |  |

**4. Array Junction Boxes**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Details regarding | Proposed by Bidder |
| 1 | Name of the manufacturer & Make/brand |  |
| 2 | Model & Type |  |
| 3 | Number of cable entries |  |
| 4 | Rated dc voltage |  |
| 5 | Number of MCB |  |
| 6 | Size and number of input cable entry |  |
| 7 | Size and number of output cable entry |  |

**List of Bill of Quantity (BoQ)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Sl. No.** | **Particulars** | **Description** | **Qty.** | **Unit** |
| 1 | Solar PV Module | Half Cut Monocrystalline PERC Panel with minimum efficiency of 18% 300Wp,  | 10 | Number |
| 2 | Inverter | 3.6 kW, pure sine wave, Single-phase off-grid inverter with integrated MPPT charge controller/ battery charger. | 1 | Number |
| 3 | Battery/Inverter Room | Well insulated Battery/Inverter Room (To store battery and inverter), Complete set prefabricated material with high insulation & ventilation facility. Must be minimum 20 years warranty | 1 | Lumpsum |
| 4 | Module Mounting Structures | Complete set of GI frames with fittings for 10 modules | 1 | Set |
| 5 | Battery | Minimum of 10 kWh integrated LiFePO4 (Lithium-Iron Phosphate) Battery pack with integrated Battery Management System (BMS) | 3 | Number |
| 6 | Protection and accessories | DC SPD, Fuses, Isolators, MC 4 connectors, DC cables, AC cables, ACDB, Fasteners, Cable Tie, Earthing Kit, Lighting Arrestor, Crimping Tool, Earthing Kit, Lighting Arrestor, nut bolts.  |  | Set |
| 7 | Energy Meter | Smart energy meter with CTs (1 Phase) | 1 | Set |
| 8 | Solar PV Fencing | Barbed wire fence with wooden post | 1 | Number |

Certified that:

i. Above rates are in accordance with the specifications, various terms, conditions and requirements mentioned in the bidding document to perform the supply of goods satisfactorily.

ii. The rates are inclusive of all taxes and duties whatsoever.

(Signature of Bidder)

Seal