Section 6: Schedule of Supply

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| 1. List of Goods and Related Services |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Lot No.: Not applicable | | | | |
| Name: 1.5 MWp Rooftop Solar Photovoltaic systems | | | | |
| Item No. | Name of Goods or Related Services | Description | Unit of Measurement | Quantity |
| 1 | 1.5 MWp Grid-connected rooftop photovoltaic systems with mono-crystalline PV modules, grid-tied string inverters, module mounting structure and balance of system components and accessories | As per technical specifications given at  Sl. (3) | As per the list of systems to be supplied and bill of quantity given below | As per the list of systems to be supplied and bill of quantity given below |

1. **List of systems to be supplied:**

| **Sl. No.** | **Description** | **Qty.** | **Unit** |
| --- | --- | --- | --- |
| 1 | 5 kWp grid-connected rooftop photovoltaic systems with mono-crystalline PV modules, 5 kW single-phase grid-tied string inverter, module mounting structure and balance of system components and accessories. | 200 | sets |
| 2 | 5 kWp grid-connected rooftop photovoltaic systems with mono-crystalline PV modules, 5 kW three-phase grid-tied string inverter, module mounting structure and balance of system components and accessories. | 100 | sets |
|  | Total | 300 | sets |

1. **Bill of Quantity for 5 kW single phase system:**

| **Sl. No.** | **Description** | **Qty.** | **Unit** |
| --- | --- | --- | --- |
| 1 | Photovoltaic (PV) Modules with mono PERC half-cut cells of individual module capacity of 400 Wp – 550 Wp withfactory fitted4 mm2 DC lead cable with MC4 connector. | 5 | kWp |
| 2 | 5 kW grid-tied 1-phase string inverter with 2 MPPTs, online remote monitoring system with data logging facility and mounting accessories. | 1 | No. |
| 3 | Flush mount type module mounting structure of anodized aluminium for installation of PV modules on Lysaght trapezoidal sheets with mounting brackets and accessories. | 5 | kWp |
| 4 | 1 kV, 32 A, 2P, DC Isolator for string disconnection (Load breaking), din-rail type conforming to IEC 60947-2. | 2 | Nos. |
| 5 | 440 V, 32 A, 2P AC Isolators (MCB) to disconnect inverter, din-rail type conforming to IEC/EN 60898-1. | 1 | No. |
| 6 | Surge Protection Device, Type II (for DC), din-rail type. | 2 | Nos. |
| 7 | Surge Protection Device, Type II (for AC), din-rail type. | 1 | No. |
| 8 | 2P, 32 A RCCB, din-rail type conforming to IEC 61008-1. | 1 | No. |
| 9 | IP 65 enclosure for Din-rail mount devices (MCBs, RCBB, SPD, etc). | 1 | No |
| 10 | 2 IN - 2 OUT, string combiner box with cable entry flanges, cable glands, terminal block, IP 65 [DC isolator and SPD will be installed]. | 1 | No. |
| 11 | 1 Core, 4 mm2 DC cable, UV stabilized, multi-strand XLPE PVC insulated. | 100 | m |
| 12 | 2 Core, 6 mm2, 650/1100V, copper cable from Inverter to main supply board. | 25 | m |
| 13 | Copper, Earthing strip of 25 mm × 3 mm for equipotential bonding earthing. | 20 | m |
| 14 | Copper Earthing strip of 25 mm × 6 mm for inverter earthing. | 20 | m |
| 15 | Copper Earth Rod (3/4”, 6’), clamp and accessories for earth pit for equipotential bonding. | 1 | set |
| 16 | Copper Earth Rod (3/4”, 6’), clamp and accessories for earth pit for inverter. | 1 | set |
| 17 | All accessories such as MC4 connectors, WEEB for equipotential bonding, stainless steel cable clips, MC4 tools and O&M tools. | 1 | set |
| 18 | Design diagram, connection diagram, installation manual, O&M and troubleshooting manual. | 1 | set |

1. **Bill of Quantity for 5 kW three-phase system:**

| **Sl. No.** | **Description** | **Qty.** | **Unit** |
| --- | --- | --- | --- |
| 1 | Photovoltaic (PV) Modules with mono PERC half-cut cells of individual module capacity of 400 Wp – 550 Wp withfactory fitted4 mm2 DC lead cable with MC4 connector. | 5 | kWp |
| 2 | 5 kW grid-tied 3-phase string inverter with 2 MPPTs, online remote monitoring system with data logging facility and mounting accessories. | 1 | No. |
| 3 | Flush mount type module mounting structure of anodized aluminium for installation of PV modules on Lysaght trapezoidal sheets with mounting brackets and accessories. | 5 | kWp |
| 4 | 1 kV, 32 A, 2P, DC Isolator for string disconnection (Load breaking), din-rail type conforming to IEC 60947-2. | 2 | Nos. |
| 5 | 440 V, 32 A, 4P AC Isolators (MCB) to disconnect inverter, din-rail type conforming to IEC/EN 60898-1. | 1 | No. |
| 6 | Surge Protection Device, Type II (for DC), din-rail type. | 2 | Nos. |
| 7 | Surge Protection Device, Type II (for AC), din-rail type. | 1 | No. |
| 8 | 4P, 32 A RCCB, din-rail type conforming to IEC 61008-1. | 1 | No. |
| 9 | IP 65 enclosure for Din-rail mount devices (MCBs, RCBB, SPD, etc). | 1 | No |
| 10 | 2 IN - 2 OUT, string combiner box with cable entry flanges, cable glands, terminal block, IP 65 [DC isolator and SPD will be installed]. | 1 | No. |
| 11 | 1 Core, 4 mm2 DC cable, UV stabilized, multi-strand XLPE PVC insulated. | 100 | m |
| 12 | 4C x 6 mm2, 650/1100V, copper cable from Inverter to main supply board. | 25 | m |
| 13 | Copper Earthing strip of 25 mm × 3 mm for equipotential bonding earthing. | 20 | m |
| 14 | Copper Earthing strip of 25 mm × 6 mm for inverter earthing. | 20 | m |
| 15 | Copper Earth Rod (3/4”, 6’), clamp and accessories for earth pit for equipotential bonding. | 1 | set |
| 16 | Copper Earth Rod (3/4”, 6’), clamp and accessories for earth pit for inverter. | 1 | set |
| 17 | All accessories such as MC4 connectors, WEEB for equipotential bonding, stainless steel cable clips, MC4 tools and O&M tools. | 1 | set |
| 18 | Design diagram, connection diagram, installation manual, O&M and troubleshooting manual. | 1 | set |

1. **List of spare parts and components to be supplied:**

| **Sl. No.** | **Description** | **Qty.** | **Unit** |
| --- | --- | --- | --- |
| 1 | Photovoltaic (PV) Modules with mono PERC half-cut cells of individual module capacity of 400 Wp – 550 Wp withfactory fitted4 mm2 DC lead cable with MC4 connector | 25 | Nos. |
| 2 | 5 kW grid-tied 1-phase string inverter with 2 MPPTs, online remote monitoring system with data logging facility and mounting accessories | 6 | Nos. |
| 3 | 5 kW grid-tied 3-phase string inverter with 2 MPPTs, online remote monitoring system with data logging facility and mounting accessories | 3 | Nos. |
| 4 | PV module mounting brackets and accessories | 12 | sets |
| 5 | 1 kV, 32 A, 2P, DC Isolator for string disconnection (Load breaking), din-rail type conforming to IEC 60947-2 | 12 | Nos. |
| 6 | 440 V, 32 A, 2P AC Isolators (MCB) to disconnect inverter, din-rail type conforming to IEC/EN 60898-1. | 6 | Nos |
| 7 | 440 V, 32 A, 4P AC Isolators (MCB) to disconnect inverter, IP 65, din-rail type conforming to IEC/EN 60898-1 | 6 | Nos. |
| 8 | Surge Protection Device, Type II (for DC), din-rail type | 12 | Nos. |
| 9 | Surge Protection Device, Type II (for AC), din rail type | 12 | No. |
| 10 | 2P, 32 A RCCB, din-rail type conforming to IEC 61008-1 | 6 | No. |
| 11 | All accessories such as MC4 connectors, WEEB for equipotential bonding, stainless steel cable clips, MC4 tools and O&M tools. | 24 | sets |
| 12 | 4P, 32 A RCCB, din-rail type conforming to IEC 61008-1 | 6 | No. |

1. **List of Accessories**

A full list of required accessories is given below:

|  |  |  |
| --- | --- | --- |
| Item | Quantity | Unit |
| Non-Insulated Tinned Copper O-Lug (2.5sqmm - 6mm) | 15000 | Nos |
| Non-Insulated Tinned Copper I-lug (6sqmm) | 1800 | Nos |
| Non-Insulated Tinned Copper I-lug (10sqmm) | 1100 | Nos |
| Heat Shrink Sleeve (6sqmm, Red) | 300 | Meter |
| Heat Shrink Sleeve (6sqmm, Black) | 300 | Meter |
| Heat Shrink Sleeve (6sqmm, Yellow-Green) | 300 | Meter |
| Self-Drilling SS Screw (Flat-Head, 1/2") | 12000 | Nos |
| Self-drilling SS Screw (Hex Head, 2", Full Thread) | 2400 | Nos |
| Box Wall Plug (6mm) | 3600 | Nos |
| Box Wall Plug (8mm) | 3600 | Nos |
| PVC Trunking (1.5” x 1” x 6’, White) | 960 | Nos |
| Weatherproof Silicone Sealant (Sikaflex, White) | 360 | Nos |
| Weatherproof MCB Enclosure (4P) | 600 | Nos |

1. List of Special Tools

|  |  |  |
| --- | --- | --- |
| Item | Quantity | Unit |
| Irradiance Meter ( for analyzing performance), FLUKE® , MEGGER® or equivalent | 10 | Nos |
| Thermal Imager ( for identifying hotspots), FLUKE® , MEGGER® or equivalent | 10 | Nos |
| IR Thermometer, FLUKE® , MEGGER® or equivalent | 10 | Nos |
| Earth Tester, FLUKE® , MEGGER® or equivalent | 10 | Nos |
| DC Clamp meter , FLUKE® , MEGGER® or equivalent | 10 | Nos |
| Insulation Resistance meter , FLUKE® , MEGGER® or equivalent | 10 | Nos |
| Multifunction PV Tester and Performance Analyzer, I-V Curve Tracer, FLUKE® , MEGGER® or equivalent | 10 | Nos |

1. Delivery and Completion Schedule

The delivery period shall start as of **the date when the notification of award (Letter of Acceptance) is issued**.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Item No. | Description  of Goods  or  Related Services | Delivery Schedule  (Duration) | Location | Required Arrival Date of Goods or  Completion Date for Related Services |
| **1** | 1.5 MWp Grid-connected rooftop photovoltaic systems with mono-crystalline PV modules, grid-tied string inverters, module mounting structure and balance of system components and accessories | **4 (four) months** | **The successful bidder is required to supply the specified items to the designated islands listed below (subject to change), located within each designated atoll. The final delivery location will be Fenaka premises or another location as designated by Fenaka within the respective islands.** | **4 (four) months from contract award** |

|  |  |  |  |
| --- | --- | --- | --- |
| **ATOLL** | **Island To be supplied to (Tentative)** | **5 kW single-phase systems** | **5 kW three-phase systems** |
| **HA. ATOLL** | Hoarafushi | 17 | 6 |
| **HDH. ATOLL** | Kurinbi | 21 | 10 |
| **SH. ATOLL** | Maroshi | 12 | 6 |
| **N. ATOLL** | Manadhoo | 11 | 6 |
| **R. ATOLL** | Kinolhas | 15 | 7 |
| **B. ATOLL** | Eydhafushi | 11 | 6 |
| **LH. ATOLL** | Naifaru | 10 | 6 |
| **M. ATOLL** | Muli | 5 | 1 |
| **F. ATOLL** | Feeali | 3 | 1 |
| **DH. ATOLL** | Kudahuvadhoo | 7 | 3 |
| **TH. ATOLL** | Vandhoo | 11 | 6 |
| **L. ATOLL** | Gan | 13 | 7 |
| **GA. ATOLL** | Vilingili | 11 | 4 |
| **GD. ATOLL** | Faresmathoda | 15 | 7 |
| **GN. ATOLL** | Fuvahmulah | 11 | 6 |
| **S. ATOLL** | Hithadhoo | 23 | 15 |
| **K. ATOLL** | Huraa | 4 | 3 |
|  |  | **200** | **100** |

1. Technical Specifications

|  |  |  |
| --- | --- | --- |
| Item No. | Name of Goods  or  Related Services | Technical Description,  Specifications, and  Standards |
| **1** | 1.5 MWp Grid-connected rooftop photovoltaic systems with mono-crystalline PV modules, grid-tied string inverters, module mounting structure and balance of system components and accessories | As per technical specifications given below |

1. **General**

All equipment supplied under this tender must fulfil the technical specifications listed herein for each component.

Bidders are required to fill out *Bidding Forms* in sl. (11) and submit them with their bids, for the required components.

Ownership for all items supplied shall be transferred to the client’s name upon purchase of the goods. This includes all rights and privileges provided by the manufacturer, including warranties and preferential access.

Items supplied shall be designed to operate within the environmental conditions present at the site. Sites are located within 100m of coastline and the atmosphere is salty, dusty and corrosive. The following environmental conditions apply:

* Ambient Temperature: 25oC to 35oC
* Average Relative Humidity: 79.7% (10% to 100% variation)
* Wind Speed: Gusts up to 100 km/h

1. **Photovoltaic (PV) Modules**

PV modules made of monocrystalline silicon PERC half-cut cells that comply with IEC 61215 and are manufactured by Tier 1 manufacturers shall be supplied. Module efficiency should be more than 20%. All modules should include bypass diodes. Only “Class A” modules according to IEC 61730-1 and IEC 61730-2 are considered. The modules shall further conform to IEC 61215 ( Terrestrial photovoltaic (PV) modules - Design qualification and type approval) and IEC 61701 (Photovoltaic (PV) modules - Salt mist corrosion testing).

The capacity of a single module shall be 400 Wp – 550 Wp. All modules shall be from a single manufacturer with similar wattage and shall be with positive power tolerance only. Negative power tolerance shall not be accepted.

***Material Warranty:***

The manufacturer should warrant the Solar Module(s) to be free from (i) defects and/or failures due to manufacturing defects and/or failures due to materials, including PID defects and (ii) non-conformity to specifications due to faulty manufacturing and/or inspection processes for a period not less than ten (10) years from the date of sale. If the solar Module(s) fails to conform to this warranty, the contractor will replace the solar module(s) found defective.

***Performance Warranty:***

**Performance** of all PV modules shall be warranted with more than 95% power output for 5 years and 87% of minimum rated power for 25 years with not more than 0.6% degradation over a period of one year. If PV module(s) fail(s) to exhibit such power output in the prescribed time span, the Contractor will replace the PV Module(s) at their own cost.

***Test Certificates:***

Valid test certificates for PV modules issued by ISO 17025/ ISO 17065 certified test laboratories must be provided. The authenticity and validity of the certificates will be verified. The Contractor shall also provide a factory test certificate for the electrical characteristics, of each solar PV module including current-voltage (I-V) performance curves and temperature coefficients of power, voltage and current.

The following information must be mentioned in each module (this can be inside or outside the laminate, but must be able to withstand harsh environmental conditions).

* Name of the manufacturer of the PV module
* I-V curve for the module
* Wattage, Im, Vm and FF for the module
* Unique Serial No and Model No of the module
* Date and year of obtaining IEC PV module qualification certificate
* Name of the test lab issuing IEC certificate

1. **Grid-tied PV Inverter**

Grid-connected String Inverters complied with IEC 62109-1:2010,IEC 62109-2, IEC 62116 and IEC 61727 shall be supplied. Inverter Total Harmonics Distortion (THD) shall be below 3%. The inverter shall be tested for electromagnetic compatibility in accordance with standards IEC 61000-6-2 (interference immunity) and IEC 61000-6-4 (interference emission). Remote monitoring of various parameters at the inverter level should be made possible at the site by installing a suitable monitoring system. Any fault in the inverter could be recognizable by that system.

Technical parameters of the grid-tied inverters are given below:

| Inverter Technical Parameters | 5 kW (Single Phase) | 5 kW (Three Phase) |
| --- | --- | --- |
| Maximum DC Input Voltage | 1000 VDC | 1000 VDC |
| Maximum DC Input Power | > 5 kWDC | > 5 kWDC |
| MPPT minimum voltage | 200 V or less | 200 V or less |
| MPPT maximum voltage | 400 V or above | 400 V or above |
| Maximum Short Circuit Current per MPPT | >15 A | >15 A |
| Minimum number of MPPT | 2 | 2 |
| Nominal AC Output | 5 kW - 6 kW | 5 kW - 6 kW |
| Grid Frequency | 50 Hz (+/- 2.5 Hz) | 50 Hz (+/- 2.5 Hz) |
| Nominal Output Voltage (+/-5%) | 1/N/PE;  230 V | 3/N/PE;  400 V |
| Adjustable displacement power factor | 0.8 leading to  0.8 lagging | 0.8 leading  to  0.8 lagging |
| Safety Level | Class 1 | Class 1 |
| DC Connection Type | MC4 | MC4 |
| Efficiency | >98.2% | >98.2% |
| MPP adaptation Efficiency | >99% | >99% |
| Total Harmonic Distortion | <3% | <3% |
| Communication | RS485, Modbus | RS485, Modbus |
| Operating Ambient Temperature | Up to 60oC | Up to 60oC |
| Relative Humidity | 0-100% | 0-100% |
| Cooling | Air cool | Air cool |
| Protection Degree | IP 65 | IP 65 |
| Mandatory Features: • DC Insulation Measurement • DC side disconnector • Integrated string fuse holders • AC short circuit protection • Ground fault monitoring • Anti-islanding protection • Residual current monitoring • Reverse polarity protection • AC and DC Surge Protection | Mandatory | Mandatory |
| LCD touch screen (or with keypad) display with following minimum parameters: • String Voltage, Current • Output AC Active Power • Grid Voltage/ Frequency • Total Energy produced (kWh) • Daily Energy produced (kWh) | Mandatory | Mandatory |
| Online remote monitoring system with generation data analysis and fault diagnosis and reporting facility. | Mandatory | Mandatory |
| Standard: IEC 61000-6-2:2005; IEC 61000-6-4:2006; IEC 61727, IEC 62116 | Must comply | Must comply |
| Preferred Make: Fronius/Solis/SMA/Sungrow/Huawei/ABB/Hitachi/GoodWe/Delta | Acceptable | Acceptable |

***Warranty:***

The inverters shall be warranted for a minimum period of 10 (ten) years from the date of delivery. Provision of extended warrantee against payment shall be preferred.

***Test Certificates:***

Valid test certificates for inverters issued by ISO 17025/ ISO 17065 certified test laboratories must be provided. The authenticity and validity of the certificates will be verified. Complete documentation shall be provided for the design, manufacturing, testing, commissioning, start-up, operation, maintenance and repair of the inverters and their components.

The bidder shall provide as a minimum the following documentation:

* Technical data sheets
* Inverter installation manual
* Layout drawings for all devices
* Single line diagrams
* Wiring diagrams
* Operation and maintenance manual
* Reports of tests and commissioning with protocols

**Preferred Make:** Fronius, Solis, SMA, Sungrow, Huawei, Hitachi, ABB, GoodWe, Delta.

If a brand outside of the listed ones is proposed, inverters of that brand must be in use in North America and Europe for the past 5 years with > 10 MW shipped to countries in those regions in the past 2 years. Client letters/documents proving the same shall be provided. In addition, type certificates for the standards listed (or equivalent international standards) shall be provided for other inverter brands.

1. **Module mounting structure**

This Section describes the requirements for design, manufacturing and installation of the suitable mounting structure that shall be provided as supporting structure for the PV modules.

The PV module mounting structure shall meet and comply with the requirements of the PV module manufacturer.

The typical installation location is on top of existing roofs.

Roof coverings are generally made out of corrugated sheets of standing-seam type or trapezoidal/box type profile. Most roofs are Lysaght Trapezoidal Steel Sheets (0.47mm thick) with the following dimensions, but the selected systems shall be selected by the Bidders to be flexible enough to adapt to roofs sheets with potentially different measures:



*Figure 62: Typical Trapezoidal Roof Sheet*

Roof fasteners shall be multiple mountings onto the corrugated roof sheet profiles for better weight distribution. A clamp type system or specialised system compatible with the trapezoidal roof sheet profiles shall be used with inbuilt waterproofing mechanisms. The array mounting superstructure shall be bolted to roof fasteners.

The roof fasteners as well as fixing method are subject to prior approval of Employer.

The PV module mounting system shall be standard anodised aluminium structure or profile for clamp-mounting installation of modules. All aluminium parts shall be anodised.

All nuts, bolts, screws and other fasteners shall be made out of stainless steel, suitable to withstand the environmental conditions for 25 years.

Any contact between unlike metals shall be avoided by use of suitable insulation materials like plastic or rubber separation strips.

The PV module mounting structure shall be designed to withstand all environmental loads (wind speed of 100 km/h) and specified design loads.

The PV module mounting structure shall provide at least a distance of 100 mm to the roof in order to provide a sufficient natural ventilation of the PV modules.

1. **Solar DC cables**

The DC solar cable must be of copper with UV protection type insulation with a minimum voltage rating of 1000V DC as specified below:

|  |  |
| --- | --- |
| Voltage Rating | 1000 VDC |
| Number of Cores | 1 |
| Cross-sectional area | 4 mm2 |
| Conductor Material | Stranded Copper (Tinned coated) |
| Cable Type | PV 1-F / H1Z2Z2-K |
| Insulation | XLPE (double insulation) |
| Temperature Rating | 120oC |
| Dielectric Strength | > 6.5 kV, 1 s |
| Other Mandatory Features | * High Resistance to weathering * High UV resistance * High thermal endurance |
| Standard | EN 50618 or equivalent international standard |
| Certification | TUV/UL/CE |

1. **Plugs, sockets and connectors**

Plugs and socket (MC4) connectors mated together in a PV system shall be of the same type from the same manufacturer i.e., a plug from one manufacturer and a socket from another manufacturer or vice versa shall not be used to make a connection. In the event that plug and sockets are from different manufacturers, a compatibility test certificate must be provided by the manufacturer for the specific lot supplied for this project.

Plugs, sockets, and connectors shall comply with EN 50521; shall be rated for DC use; have a voltage rating of 1000V DC; shall be protected from contact with live parts in the connected and disconnected state; have a current rating equal to or greater than the current carrying capacity for the circuit to which they are fitted.

When installed outdoors, plugs, sockets and connectors shall be UV-resistant and be rated for IP 67 or above.

|  |  |
| --- | --- |
| Rated Voltage | 1000 V |
| Rated Resistance | < 0.5 mΩ |
| Contact material | Copper (tinned, cross-linked) |
| Cross-section area | 4 mm2 |
| Temperature Rating | Up to 90 degrees Celsius |
| Features | * High resistance to weathering * High thermal endurance * Anti-aging capability * Resistant to UV |
| Protection Classification | IP 67 |
| Safety Class | Class II |
| Standards | EN 50521:2008 or Equivalent |

1. **Combiner boxes**

A separate DC combiner box will be used to install DC isolators in each string and surge protection devices in each input to the inverter before connecting the PV array to the inverters. Combiner boxes shall be at least IP 65 compliant in accordance with IEC 60529 and shall be UV resistant. An over-current protection device (fuse) will be used when the module fuse rating is 25A or less and more than three (3) strings are connected in parallel. When overcurrent protection is incorporated, it shall be rated as per IEC 62548.

1. **Disconnectors**

All disconnectors shall comply with the following requirements:

1. It does not have exposed live metal parts in a connected or disconnected state;
2. They have a current rating equal to or greater than the associated overcurrent protection device, or in the absence of such a device, have a current rating equal to or greater than the minimum required current carrying capacity of the circuit to which they are fitted.

Switch disconnectors shall be certified to IEC 60947-1 and IEC 60947-3 and have mechanisms that have an independent manual operation.

In addition, circuit breakers and any other load-breaking switch-disconnectors used for protection and/or disconnecting means shall comply with the following requirements:

1. Do not be polarity sensitive.
2. Be rated to interrupt full load and prospective fault currents from the PV array, diesel generators and the grid.