

**BIDS AND AWARDS COMMITTEE  
SUPPLEMENTAL BID BULLETIN NO. 01**

**Rebidding for the Supply, Delivery, Installation, Testing and  
Commissioning of 25kWp Solar PV Rooftop System in Carmona Water  
District Admin Building**

**Invitation to Bid No. 2024-11-191**

The PNOB Bids and Awards Committee hereby adopts the following amendments in the Philippine Bidding Documents:

**1. Amendments:**

**a. Revised Technical Specifications attached (Annex A).**

**b. Checklist of Technical and Financial Documents:**

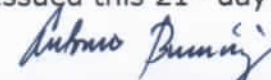

I. Technical Component Envelope  
Technical Documents:

	<b>From</b>	<b>To</b>
i	List with proof of completed Solar PV contracts with minimum aggregate installed capacity of 1MWp where at least two (2) contracts fully operational for the last two (2) years from the date of submission.	List with proof of completed Solar PV contracts with minimum aggregate installed capacity of <b>500 kWp</b> where at least two (2) contracts fully operational for the last two (2) years from the date of submission.
k	Project Schedule (Please refer to Item9 of the Term of Reference, p.45)	Project Schedule (Please refer to Item 9 of the Term of Reference, <b>p.43</b> )
l	Preliminary Design Drawing (Please refer to Item 9 of the Term of Reference, p.45)	Preliminary Design Drawing (Please refer to <b>Item 10</b> of the Term of Reference, <b>p.43</b> )

Amendments/inclusions/clarifications made herein shall be considered an integral part of the Bidding Document.

For guidance and information of all concerned.

Issued this 21<sup>st</sup> day of November 2024.

*for*   
**ATTY. JOSEPHINE CASSANDRA J. CUI**  
Chairperson 

# Annex A

## Technical Specifications

Bidders must state here either "Comply" or "Not Comply" against each of the individual parameters of each Specification stating the corresponding performance parameter of the equipment offered. Statements of "Comply" or "Not Comply" must be supported by evidence in a Bidders Bid and cross-referenced to that evidence. **Evidence shall be in the form of manufacturer's un-amended sales literature, unconditional statements of specification and compliance issued by the manufacturer, samples, independent test data etc., as appropriate. A statement that is not supported by evidence or is subsequently found to be contradicted by the evidence presented will render the Bid under evaluation liable for rejection.** A statement either in the Bidder's statement of compliance or the supporting evidence that is found to be false either during Bid evaluation, post-qualification or the execution of the Contract may be regarded as fraudulent and render the Bidder or supplier liable for prosecution subject to the applicable laws and issuances.

For line item that requires exact specifications, the Bidder shall specify.

Technical Requirements	Statement of Compliance (Bidder must state either "Comply" of "Not Comply")
<b>SOLAR PV MODULES</b>	
<b>1 General</b>	
1.1 Manufacturer : Supplier must specify	
1.2 Model Number : Supplier must specify	
1.3 Rated Capacity in Watt peak : Supplier must specify	
1.4 Cell Type : N-Type Monocrystalline	
1.5 Number of Cells : Supplier must specify	
1.6 Efficiency (Minimum) : 17%	
1.7 Guaranteed Output (Minimum) :	
after 1 Year : 97%	
after 5 Years : 95%	
after 10 Years : 90%	
after 25 Years : 80%	
1.8 Warranty : 10 Years (minimum)	
<b>2 Mechanical Characteristics</b>	
2.1 Dimension : Supplier must specify	
2.2 Front Cover : 3.2mm, High transmission, Tempered glass	
2.3 Frame : Anodized Aluminum Alloy	

2.4	Junction Box Enclosure (minimum)	: IP68 Rated	
2.5	Connectors	: MC4 or equivalent (1 male and 1 Female per module)	
2.6	Cables	: 1*4.0mm or equivalent	
<b>3 Electrical Parameters @ STC</b>			
3.1	Maximum system voltage ( $V_{max}$ )	Supplier must specify	
3.2	Nominal Operating Temperature	: Supplier must specify	
3.3	Maximum Power Voltage ( $V_{mp}$ )	: Supplier must specify	
3.4	Maximum Power Current ( $I_{mp}$ )	: Supplier must specify	
3.5	Open-circuit Voltage ( $V_{oc}$ )	: Supplier must specify	
3.6	Short-circuit Current ( $I_{sc}$ )	: Supplier must specify	
3.7	Temperature coefficient of $P_{max}$	: Supplier must specify	
3.8	Temperature coefficient of $V_{oc}$	: Supplier must specify	
3.9	Temperature coefficients of $I_{sc}$	: Supplier must specify	
<b>4 Standards and Certifications</b>			
4.1.	Manufacturer Category	: Must be Tier1 – CATEGORY LISTED BY Bloomberg New energy Finance Latest Report	
4.2.	Resilient in extreme weather condition	: Compliant with IEC 61215 or equiv.	
4.3	Negative Load Capacity	: 2400 Pa	
4.4	Positive Load Capacity	: 5400 Pa	
4.5	Salt Mist Corrosion Resistant	: Compliant with IEC 61701 or equiv.	
4.6	Ammonia Corrosion Resistant	: Compliant with IEC 62716 or equiv.	
4.7	PV Module Electrical and Mechanical Operating Safety Qualification	: Compliant with IEC 61730 or equiv.	
4.8	Quality Management System	: Compliant with ISO 9001 or equiv.	
4.9	Occupational Health and Safety Management System	: Compliant with ISO 45001 or equiv.	
4.10	Environment Management System	: ISO 14001: 2015 or equivalent	
<b>INVERTER AND CONTROLLER</b>			
<b>1 Inverter</b>			
1.1	Manufacturer	: Supplier must specify	
1.2	Model Number	: Supplier must specify	
1.3	Rated AC Power	: Supplier must specify	
1.4	Maximum AC Active Power	: Supplier must specify	
1.5	Type	: String Type	
1.6	Nominal Output Voltage	: <b><u>Three-Phase, 220V to 240V or 400V to 480V</u></b>	
1.7	Maximum Input Voltage	: Supplier must specify	
1.8	Operating Voltage/ Start Voltage	: Supplier must specify	

1.9	Maximum Input Current per MPPT / Maximum Short Circuit Current per MPPT	: Supplier must specify	
1.10	Number of MPPT Trackers/ Maximum Number of Inputs	: Supplier must specify	
1.11	Efficiency	: 98.5% (minimum)	
1.12	Dimension (W x H x D)	: Supplier must specify	
1.13	Weight	: Supplier must specify	
1.14	Operating temperature range	: -25°C to +60°C (-13°F to +140°F)	
1.15	Topology	: Transformer-less	
1.16	Degree of Protection	: IP66 (minimum)	
1.17	Protective Devices	: Anti-islanding Protection/AC Output Overcurrent/DC Reverse Polarity Protection/Strings Monitoring/DC Surge Protection (Type II)/AC Surge Protection (Type II)	
1.18	Display	: Graphic LCD/LED	
1.19	Warranty	: 5 Years	
<b>2</b>	<b>Inverter Controller</b>		
2.1	Manufacturer	: Supplier must specify (Must be same with Inverter)	
2.2	Model Number	: Supplier must specify	
2.3	Max. number of manageable device	: 20	
2.4	Power Supply	: 100 to 240 V	
2.5	Interaction	: Supplier must specify	
2.6	Operating temperature range	: Supplier must specify	
2.7	Communication Protocol	: Supplier must specify	
2.8	Mounting	: DIN top-hat rails or wall mounting	
2.9	Enclosure Protection	: IP65/NEMA 3R or equivalent (minimum)	
<b>3</b>	<b>Standards and Certifications</b>		
3.1	Inverter	: IEC 62109-1/IEC 62109-2 (Class I, grounded communication Class II, PELV)	
		: IEC 62116	
		: IEC 61727	
<b>MOUNTING STRUCTURE</b>			
<b>1.0</b>	<b>General</b>		
1.1	Manufacturer	: Bidder must specify	
1.2	Module Type Compatibility	: Framed or frameless	

1.3	Material	: Anodized structural grade aluminum alloy (AL6005-T5) and stainless-steel components (SS/SUS 304)	
1.4	Standard	: Compliant with AS/NZS1170.2:2011 AMDT 2-2012 or equiv.	
1.5	Warranty	: 15 Years	
<b>2.0 Major Components</b>			
2.1	L-clamp	: Bidder must specify	
2.1	End Clamp (part number)	: Bidder must specify	
2.2	Inter/Mid Clamp (part number)	: Bidder must specify	
2.3	Railing (part number)	: Bidder must specify	
2.4	Rail-Splicer (part number)	: Bidder must specify	
2.5	Mounting/L-Clamp (part number)	: Bidder must specify	
2.6	Other Components (if needed)	: Shall be determined as per actual site condition	
<b>OTHER COMPONENTS (refer to Section 21.2 Minimum PV System Components Specifications)</b>			
1.0	DC Combiner (if needed)		
2.0	AC Combiner		
3.0	Transformer (if needed)		
4.0	Transient Voltage Surge Suppressor with Isolation Switch		
5.0	PV Generation (Revenue) Meter Including CT/PT and Terminals		
6.0	ECB Main Disconnect Switch		
7.0	Cables		
8.0	Raceways (Cable Trays, Conduits, PVC Pipes and Fittings, Accessories)		
9.0	Lightning Arrester and Grounding System (if needed)		
10.0	PV Monitoring and Data Acquisition System		
11.0	CCTV/IP Surveillance Camera		
12.0	Communication and Control Cables, Radio Transmission or Fiber Optics or Equivalent		

# Terms of Reference

## 1. Project Description

The Philippine National Oil Company (PNOC), under its Three Arrows Strategy, is revolutionizing sustainable energy solutions by spearheading rooftop solar power projects for various government buildings. This initiative supports the government's strategy to reduce its dependence on international fuel markets and promote renewable energy use.

In line with the Inter-Agency Energy Efficiency and Conservation Committee (IAEECC) Resolution of 07 July 2023, government entities, including government-owned and controlled corporations (GOCCs), state universities and colleges (SUCs), and local government units (LGUs), are mandated to install at least 20% of their electricity requirements from Solar Photovoltaic (PV) systems or equivalent renewable energy technologies within three years.

Additionally, this project aligns with the Government Energy Management Program (GEMP), which encourages a minimum 10% reduction in electricity consumption across all government entities. By ensuring zero export of energy to the distribution grid, this forward-thinking project not only reduces costs but also elevates environmental stewardship, setting a new standard for green energy in the public sector.

PNOC invites submissions from reputable organizations (referred to as "the Contractor") capable of providing a comprehensive turnkey solution encompassing engineering, procurement, construction, commissioning, and testing and commissioning, and one-year operations and maintenance (referred to as "EPCTC") for the Project.

The project shall be named "**Supply, Delivery, Installation, Testing and Commissioning of 25kWp Solar PV Rooftop System at Carmona Water District Admin Building**". The project site is located at Cityland Subdivision, Brgy. Carmona, Cavite.

## 2. Objectives of the Contract

The intent of the Terms of Reference is to provide the general and technical requirements necessary for the implementation of the project. However, it is the Contractor's obligation to investigate and validate all information herewith as part of their work to be undertaken. Thus, any discrepancies in the TOR in accordance with applicable and generally accepted engineering and construction practices, government rules and regulation and the latest industry codes and standards for solar PV development shall not relieve the Contractor of the accuracy of their work.

- a. **Define Project Scope:** Clearly outline the scope of work for the turnkey EPC (Engineering, Procurement, and Construction) contractor, including project preparation, procurement, installation, construction, testing, commissioning, and operation and maintenance (O&M).
- b. **Establish Deliverables:** Specify the required deliverables, including documentation, performance guarantees, and O&M plans, to ensure comprehensive project execution and accountability.
- c. **Set Performance Standards:** Provide criteria for the performance and quality of the solar PV systems, ensuring they meet industry standards and regulatory requirements.

- d. **Detail Compliance Requirements:** Ensure the EPC contractor adheres to all relevant local, national, and international regulations and standards, promoting safety, reliability, and environmental responsibility.
- e. **Specify Evaluation Criteria:** Establish the criteria for selecting the EPC contractor, focusing on experience, technical expertise, financial stability, and the quality of the proposed solutions.
- f. **Ensure Zero Export Compliance:** Mandate that the solar PV systems operate with zero export to the distribution grid, ensuring on-site energy optimization and compliance with regulatory requirements.
- g. **Provide Maintenance Guidelines:** Include a comprehensive one-year O&M plan to ensure the longevity, efficiency, and optimal performance of the installed solar PV systems.
- h. **Promote Transparency and Reporting:** Require regular progress reports from the EPC contractor to PNOC, detailing project milestones, challenges, and resolutions, fostering transparency and effective project management.

### 3. Approved Budget for the Contract (ABC)

PNOC has an approved corporate budget in the amount of one million three hundred fifty thousand pesos (**Php 1,350,000.00**) for the Project.

### 4. Scope of Works

The scope of work for the Contractor includes:

#### 4.1. Project Preparation

The Contractor shall facilitate all preliminary and general works on time so that any issues or problems encountered can be addressed. If the Contractor fails to timely execute the works, then any delays due to pending issues and problems shall be of the Contractor's account.

- Kick-off Meeting

The Contractor shall schedule a kick-off meeting no later than ten (10) calendar days starting from the date of commencement as stated in the NTP. The kick-off meeting shall be held at site to discuss mobilization and construction schedules and other details necessary prior project execution. All key personnel must be available during the kick-off meeting.

- Mobilization

The Contractor shall facilitate the mobilization of manpower and equipment, including operating supplies and tools necessary for the project immediately after the kick-off meeting.

- Temporary Facilities and Storage/Staging Area

The contractor shall be provided with a temporary headquarters immediately after the kick-off meeting. The location of the headquarters and storage/staging area shall be determined with the consent of the building owner.

- Site Survey and Assessment

The Contractor shall undertake its own site survey, verification, and assessment, including actual measurements of voltage, current, frequency and power quality for a period of seven (7) calendar days upon mobilization, identification of access, etc., to identify all necessary information about the site conditions and design parameters. Additionally, the Contractor shall perform an energy yield assessment to estimate the potential solar energy generation in the installation site

The assessment shall also include the condition of roof and existence of roof leaks, and the safety and reliability of the existing electrical system(s) and the whole installation, and maintenance concerns. All findings and necessary engineering intervention shall be incorporated in the detailed project designs and engineering plans and shall be properly addressed during construction.

- Permits and Clearances

The Contractor shall secure the construction permit, safety permit, building permit and other approvals, clearances, and licenses necessary prior to the start of construction and installation.

The Contractor shall also secure necessary permits/documents as required by the Distribution Utility for the installation of the rooftop solar PV system on the installation site.

- Detailed Project Designs and Engineering Plans

The Contractor shall submit Detailed Project Designs and Engineering Plans no later than ten (10) calendar days starting from the date of commencement stated in the NTP. The Detailed Project Designs and Engineering Plans must reflect all additional requirements and information needed based on the reviewed preliminary design drawings.

The Detailed Project Designs and Engineering Plans shall be furnished using engineering standard templates, adequate, readable and must be written in English. The Contractor must use computer-aided design and drafting software (CAD) or equivalent. Likewise, electronic components with built-in programs and software shall be accompanied by their corresponding programs and ladder logic diagrams for submission to PNOC prior to the installation of the systems.

The Detailed Project Designs and Engineering Plans shall be signed and sealed by Professional Engineers (Electrical and/or Civil/Structural Engineer), and PNOC and building owner's authorized representatives. PNOC shall have the right to require the Contractor additional drawings or information as may be necessary.

The minimum number of original copies to be produced by the Contractor shall be 3 sets of A3 size and 2 electronic copies containing CAD and PDF files, as an advance copy. The Contractor must also submit a hard copy as an official document. PNOC reserves the right to reproduce any drawings or documents received from the Contractor as may be necessary.



To avoid revisions, the Contractor may submit first draft drawings or e-file via email before printing the Detailed Project Designs and Engineering Plans.

#### 4.2. Procurement

The Contractor shall be responsible for the procurement of all equipment and construction materials, including consumables, necessary to complete the project.

All delivered equipment and construction materials, including consumables, shall be subject to testing and inspection by PNOC. Testing and inspection includes visual checking, measurement, validation of specifications (in the nameplates) and other applicable testing methods as deemed necessary. PNOC shall release a Materials Inspection Report (MIR) for the findings of the inspected materials. Any damage or deficiency shall be rectified or replaced by the Contractor without additional charges to PNOC.

- **Equipment and Construction Materials**

The Contractor may source all equipment and construction materials, including consumables locally or abroad provided these shall conform to the required design specifications and standards. In case of changes in the source of supply or brand, the Contractor shall submit a letter of request stating the reasons for the changes for PNOC's review and approval.

- **Factory Acceptance Test (FAT)**

The Contractor must provide any proof that the manufacturer's factory or fabricator's shop has passed the FAT for the solar panels and inverters. All related testing expenses shall be of the Contractor's account. Receipt and acceptance of the Certified Test Reports and Inspection & Testing Certificate by PNOC shall in no way relieve the Contractor of its responsibility.

- **Handling and Delivery**

The Contractor shall perform proper packing, loading, transportation, hauling and unloading of equipment in accordance with the Manufacturer's standards and recommendations. All duties and taxes including export permits and clearances, insurances and warranties shall be of the Contractor's account. The equipment and construction materials shall be delivered directly to the project site(s).

The Contractor shall secure handling and delivery manuals from the Manufacturer.

The Contractor shall notify PNOC for all incoming materials and submit Delivery Receipt upon delivery for inspection and acceptance by PNOC prior to installation.

All equipment shall be delivered unbroken, not deformed and without cracks and scratches.

In general, the packaging of the equipment shall be based on generally accepted industry practices or standards. Packaging shall be adequate to prevent damage from any mechanical stresses that may occur and to ensure safety during loading, hauling, unloading, unpacking and storage.

Boxes shall contain barcode sheet/label showing the following information:

- ✓ Name of the Manufacturer;
- ✓ Model Number;
- ✓ Code No./Serial Number;
- ✓ Product Barcode; and
- ✓ Manufacturing Date.

- On-Site Storage

The Contractor shall perform on-site storage of equipment and construction materials in accordance with the Manufacturer's standards and recommendations. Equipment shall be placed at the designated storage/staging area.

The Contractor shall secure equipment on-site storage manuals from the manufacturer.

#### 4.3. Installation and Construction

The Contractor shall provide all consumables, tools, equipment, and manpower, including PPE, necessary to perform the necessary works.

The Contractor shall only be allowed to work at the designated area agreed upon with PNOC to avoid any interruptions to the on-going operations and activities at the site.

In case of concrete drilling or breaking, the Contractor must ensure that such work shall not compromise the integrity of the existing structures.

In the case of painting, appropriate painting shall be used for the structures to be painted in accordance with applicable standards. The painting shall be done with a primer and topcoat as a minimum.

In the case of earthworks and concreting, it shall be performed in accordance with applicable codes and standards. Concrete foundations must be designed using applicable mixtures and with reinforcing bars as per standards.

The PV system shall be designed for simple mechanical on-site installation with no requirement for welding or complex machinery at the Site. In extreme cases where welding or machinery is necessary, the Contractor shall submit welding methodology. Welding shall be tested as per standards.

The Contractor must also ensure minimal disruption to the daily operations of the installation site.

- Pre-Leak and Post-Leak Test

The Contractor shall conduct pre-leak test prior to, and after the installation of PV modules and appurtenances, respectively. Schedule of the leak test shall be properly coordinated with PNOC and building owner representatives.

The Contractor shall submit a leak test procedure for review and approval by PNOC prior to execution.

- Work Permit

The Contractor shall coordinate with PNOC representative for every work to be performed prior to execution. The work to be performed shall specify the following:

- ✓ Type of Work, such as: Hot works/Cold work/Working at Heights/Confined Space/Concrete Chipping/Excavation works;
- ✓ Target Start and End Dates;
- ✓ Methodology;
- ✓ Hazard associated with the Works;
- ✓ Safety and precautionary measures;
- ✓ Equipment and construction materials with attached approved brochures and/or drawings; and
- ✓ Equipment, Tools, and Personal Protective Equipment (PPE).

- Mounting and Installation of Equipment

All equipment shall be mounted in accordance with engineering and construction standards and practices and manufacturers' recommendations and standards and safety and health standards. Spacing, orientation, and location shall be based on the approved Detailed Project Designs and Engineering Plans.

- Cabling and Raceway Routing

DC cables shall be housed in a hot dip galvanized cable tray/ladder with cover. All AC cables shall be housed in rigid steel conduit. Instrumentation and communication cables shall be housed in a separate UV rated conduit.

For buried cables, it must be housed in a PVC pipe with concrete trench, warning tape or tiles placed above and marking posts at suitable intervals on the surface. The minimum depth of burial is 700mm depending on the location and condition of the ground surface.

Cables shall occupy less than 66% of the raceway space and properly loop, not too tight to avoid any damages to the wires.

DC cables shall be installed in a manner which minimizes induction loops between positive and negative cables. For string cables, large loops of excess DC cabling shall be avoided.

The raceway shall be placed in a manner that it will not create any obstructions or hazards to operations and maintenance.

The Contractor shall use pull box/junction box on all intersections and sharp curves or bends and provide rubber and bushing on all junctions and endings to avoid cut in the wire insulation. The Contractor shall apply silicone sealant, as applicable, on raceway openings to prevent access of dirt, water, and vermin.

The Contractor shall comply with the Distribution Utility (DU) Net-Metering requirements for the cable installation and other electrical components.

- Grounding, Termination, and Interconnection

All equipment shall have adequate grounding. All cables shall be properly dressed/secured/fixed and terminated using terminal lugs, clamps, crimps and solder. There should be no exposed conductors to avoid short circuits and arc flash.

The Contractor shall request a schedule for shutdown for the interconnection to the existing electrical distribution system.

The Contractor shall conduct a torque test after termination and interconnection.

- Lifting

Appropriate lifting equipment shall be utilized when performing heavy lifting. Access shall be identified to avoid obstructions. Schedule of lifting shall be properly coordinated with the building owner.

- Foundations and Structural Supports

Structural supports necessary for the mounting of equipment (e.g., inverters, enclosures, transformers, PV modules, etc.) shall be made of hot dip galvanized structural steel minimum of 2 mm metal thickness and minimum coating thickness of 3 mils as per ASTM A 386 or equivalent. In case the galvanized coating is damaged during installation, the Supplier shall apply the necessary rectification in accordance with ASTM A 780-01 (Standard Practice for Repair of Damaged and Uncoated Areas of Hot Dip Galvanized Coatings).

Reinforced (with deformed bars) concrete blocks/ballast or foundations may be provided to provide stability.

For penetrated supports, it shall be non-corrosive, and waterproof using flashings, gasket or other approved chemical sealing and coating material. In case of concrete penetration, the anchor bolts (dowel) shall be made also of hot-dipped galvanized or equivalent.

#### 4.4. Testing and Commissioning

The Contractor shall conduct testing and commissioning for a minimum of seven (7) days upon completion of the installation of the PV system, to be witnessed by PNOC and representatives of the building owner. The schedule and duration of the testing and commissioning shall be mutually agreed by the Contractor, PNOC and building owner. However, the testing and commissioning activities shall be satisfactorily completed within the time required under the contract.

Any corrections resulted from errors in the workmanship or design made by the Contractor which were found during the conduct of testing and commissioning or prior to the rooftop solar PV system operation thereon, with the resulting extra expenses due to repair or cost for the replacement for damaged equipment/materials shall be solely charged to the account of the Contractor.

Testing and commissioning shall be performed in a systematic process whereby all systems and equipment are tested and brought into operation and performed interactively according to the design intent and in accordance with the performance criteria set upon. Equipment and accessories shall be inspected to determine the completeness of the PV system and conformance in accordance with the Specifications. All testing instruments including consumables, temporary structures, and manpower required for the testing and commissioning activities shall be provided and at the account of the Contractor.

The Contractor shall ensure that the rooftop solar PV system operates with zero export to the Distribution Grid by configuring inverters to clip any excess energy generated.

The Contractor shall also arrange the joint inspection with the representatives of Distribution Utility and the Office of Building Official (if applicable) to conduct demonstration of the required features of the rooftop solar PV system. This is for the eventual acceptance of the system by the DU and LGU-OBO by furnishing the necessary certificates.

PNOC shall release a "Certificate of Project Completion" after the Testing and Commissioning provided that all works have been performed and all issues have been addressed.

- Testing and Commissioning Plan

The Contractor shall submit TCP/Procedures prior to the conduct of testing and commissioning for PNOC's review and approval.

The TCP shall include the following information:

- ✓ Itinerary (date) of the testing and commissioning;
- ✓ Detailed methodology and step-by-step procedures;
- ✓ List of tools and equipment, including PPE, to be used;
- ✓ Manpower requirement;
- ✓ Hazards and safety protocol; and
- ✓ Target results or acceptance criteria.

- Testing and Commissioning Works

The minimum testing and commissioning shall include the following:

- ✓ Inspection and calibration of tools and testing instruments;
- ✓ Visual and physical (quality and quantity) inspection of the installed equipment and appurtenances;
- ✓ Torque test of all terminations and mounting;
- ✓ Continuity test (open circuit and closed circuit) of all breakers, fuses, switches, protection devices and other equipment with circuitry;
- ✓ Insulation test of all DC and AC wires including grounding (line-to-line and line-to-ground);
- ✓ Open circuit voltage/ short circuit current string test;
- ✓ Polarity test;
- ✓ Phase sequence test;
- ✓ AC operating voltage test;
- ✓ Inverter synchronization test;
- ✓ Inverter frequency test;
- ✓ Inverter power generation test;
- ✓ Operating voltage and operating current string test;
- ✓ Thermal scanning;
- ✓ Optimizer Device Functionality;
- ✓ Voltage Harmonic Rise - should not be greater than 5% or inverter specification (whichever is lower);
- ✓ Lighting Arrester Grounding and Counter Tests;
- ✓ Anti-Islanding Test;
- ✓ Cease to Energize Test; and
- ✓ Other necessary tests

The minimum tools and equipment to be used shall include the following:

Torque wrench;  
Clamp Meter;  
Irradiance meter;  
Thermal scanner;  
Power Quality Analyzer;  
2-way radios;  
Insulation Resistance Tester;  
Earth Ground Tester; and  
Lock-out/tag-out

The Contractor may use a multi-function instrument that is capable of performing the testing and commissioning such as a solar PV installation tester.

Personnel who will conduct the testing and commissioning shall be equipped with the minimum PPE:

- ✓ Safety shoes (Electrical hazard compliant);
- ✓ Safety jacket;

- ✓ Safety pants;
- ✓ Electrical gloves (1kV); and
- ✓ Protective eye glass.

The Contractor shall also provide a first-aid kit and fire extinguisher (dry powder).

- Testing and Commissioning Report

The Contractor shall submit the TCR after the completion of the testing and commissioning. The TCR shall be reviewed and accepted by PNOC and building owner representative(s).

#### 4.5. Operation and Maintenance

The Contractor shall perform a one-year O&M support to PNOC. The Contractor shall provide a comprehensive one-year maintenance plan, which shall include, but not limited to, daily monitoring of system performance, preventive maintenance and repair works, technical support in case of unforeseen decreasing PV system performance, and end-user training.

The training shall include, but not limited to lectures and on-site strategy covering the methods of operation, maintenance, basic troubleshooting, and management of the facility. All costs and expenses for the training, except those incurred by PNOC which include, but not limited to their own transportation and accommodation expenses, shall be borne by the Contractor. A corresponding Certificate of Completion shall be issued to the participants in the training.

During the one-year O&M, the EPCC Contractor shall guarantee the minimum annual production of **30,132.00 kWh** for the rooftop solar PV system.

If ever the minimum annual PV production was not achieved mainly due to uncontrollable factors, then no penalty will be imposed on the Contractor. However, if defects in any of the system components, especially in the inverters, are found to contribute to the performance issues of the PV system, then the Contractor shall pay a corresponding compensation equivalent to the total amount of revenue lost to PNOC from the declared minimum annual production guarantee of **30,132.00 kWh**. Moreover, the cost of any and all rework and/or restoration of damaged properties due to the Contractor's poor workmanship or negligence shall be borne by the Contractor.

## 5. Deliverables

The Contractor shall ensure that the following deliverables must be provided to PNOC with physical copies as the official submission and electronic copies as advance submissions. Any later correction and changes found necessary by PNOC, and all resulting additional costs and/or delays shall be of the Contractor's account. PNOC reserves the right to reproduce any drawings or documents received from the Contractor as may be necessary.

The Contractor shall provide all the necessary deliverables before the start of the Testing and Commissioning, except for the deliverables that need to be submitted at

earlier date for review and approval of PNOC (e.g., detailed project plan and timeline, site and energy yield assessment reports, detailed project designs and engineering plans, and procurement records and equipment warranties).

5.1. Documentation

- Detailed project plan and timeline
- Site and energy yield assessment reports
- Detailed project designs and engineering plans
- Procurement records
  - ✓ Bill of materials
  - ✓ Shop/fabrication drawings
- Installation and commissioning reports
- Wiring and termination diagrams
- As-Built Drawings (Power & Control Circuits) and Electronic Programs/Ladder Logic Diagrams
- Equipment and O&M manuals
- List of necessary spare parts, tools, and consumables
- Warranty certificates of the solar panels and Balance of System (BOS) and all other applicable system components and tools

5.2. Performance Guarantees

- Assurance of system performance metrics
- Warranty and maintenance agreements

5.3. Operation and Maintenance (O&M)

- Detailed one-year O&M plan
- Regular maintenance schedule and procedures
- Immediate response and repair protocols
- Performance monitoring and reporting
- List of necessary spare parts, tools, and consumables

**6. Commencement Date and Period of Implementation**

The commencement date of the Project shall be upon receipt of Notice to Proceed (NTP). There will be two (2) main activities for this entire engagement: the EPCC and O&M support. The duration of the EPCC and O&M support shall be **ninety (90) maximum days from the receipt date of the Notice to Proceed** and **365 days from the official start of operation of the 25 kWp rooftop solar PV system**, respectively.

**7. Payment Terms**

Milestone payments will be adopted where the payment shall be released upon reaching the specific project milestone, to ensure that these conform to the requirements set for the purpose.

The payments are subject to the usual government accounting and auditing requirements. Hence, the Contractor is expected to be familiar with the Government Accounting and Auditing Manual (GAAM).

<b>Project Milestone*</b>	<b>Percentage of Payment</b>
Completion of installation and testing & commissioning	90%
Handover and completion of training for building operators	10%

*\*Retention Money: 10% for every progress billing.*

**8. Evaluation Criteria**



Bids exceeding the identified Approved Budget for the Contract (ABC) will automatically be disqualified. The selection of the Contractor will be based on:

8.1. Experience and track record in similar projects

- Bidders must have completed solar PV contracts with a minimum total aggregate installed capacity of **500 kWp**, where at least two (2) contracts must be fully operational for the last two (2) years, from the date of bid submission.
- Must have a Philippine Contractors Accreditation Board (PCAB) License (Category C & D, Specialty – Electrical Works)
- Must be compliant with the ISO 9001:2015 standard on Quality Management System (QMS).

8.2. Technical expertise and key personnel

The Contractor shall employ and certify to their competency the minimum key personnel dedicated for the project.

<b>PERSONNEL</b>	<b>QTY</b>	<b>QUALIFICATIONS</b>	<b>EXPERIENCE</b>
Project Manager	1	Shall be Licensed Electrical Engineer	<ul style="list-style-type: none"> <li>• Has completed at least three (3) solar PV projects, one (1) of which with at least 50% of the project capacity (kWp)</li> <li>• Minimum of three (3) years' experience in Solar Project Management</li> </ul>
Electrical Design Engineer	1	Shall be Licensed Electrical Engineer	<ul style="list-style-type: none"> <li>• Has completed at least three (3) solar PV projects, one (1) of which with at least 50% of the project capacity (kWp)</li> <li>• Minimum of three (3) years' experience in design of Solar Project</li> </ul>
Structural Design Engineer	1	Shall be Licensed Civil Engineer	<ul style="list-style-type: none"> <li>• Has completed at least three (3) solar PV projects, one (1) of which with at least 50% of the project capacity (kWp); Minimum of three (3) years' experience in structural integrity assessment</li> </ul>
Project Site Engineer	1	Shall be Licensed Electrical Engineer	<ul style="list-style-type: none"> <li>• Has completed at least three (3) years of experience in project supervision of solar PV projects, one (1) of which with at least 50% of the project capacity (kWp);</li> </ul>
Safety Officer	1	With bachelor's degree and either BOSH or COSH certification	<ul style="list-style-type: none"> <li>• Minimum of three (3) years of experience in Construction.</li> </ul>
QA/QC Engineer	1	Shall be Licensed Electrical Engineer	<ul style="list-style-type: none"> <li>• Minimum of three (3) years of experience in Construction of Solar PV Projects.</li> </ul>

Testing and Commissioning Engineer	1	Shall be Licensed Electrical Engineer	<ul style="list-style-type: none"> <li>• Has completed at least three</li> <li>• (3) years' experience in testing and commissioning of solar PV projects, one (1) of which with at least 50% of the project capacity (kWp); Must have adequate knowledge in inverter programming configuration and programmable logic controllers.</li> </ul>
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The Contractor may nominate the personnel in dual positions, except for the Project Manager, for as long as they are qualified and capable of doing multiple tasks and with the assurance that it can deliver the work on time without compromising the quality.

*In case bidder has existing contract for PV Rooftop System with PNOC, bidder must propose different set of key personnel.*

#### 8.2.1. Roles of the Key Personnel

- Project Manager - Shall be the single point of contact with PNOC for all matters pertaining to the Project. The Project Manager shall always be available during weekly meetings and in cases where his/her presence is needed.
- Electrical Design Engineer - Shall be responsible for the engineering design of the PV system. The Design Team shall always be available during meetings pertaining to the design and specifications.
- Structural Design Engineer – Shall be responsible for the validation of the structural integrity of the building(s).
- Project Site Engineer - Shall be in-charge of the overall supervision of the project execution. The Project Engineer shall always be available at the site during the EPCC. During the three-year O&M period, he/she shall conduct all required O&M activities for the Project.
- Safety Officer – Shall ensure the safety and health of all personnel involved in the construction by monitoring and assessing possible hazards in the area.
- QA/QC Engineer – Shall ensure that all delivered materials and works performed are within standards and specifications.
- Testing and Commissioning Engineer – Shall lead the proper testing and commissioning of the PV system.

## 9. **Project Schedule**

As part of bid submission, the Contractor shall provide the project schedule, which should include key milestones such as:

- 9.1. Completion of site and energy yield assessments.
- 9.2. Procurement and delivery of equipment.
- 9.3. Completion of installation and commissioning.
- 9.4. Handover and training for building operators.
- 9.5. One-year O&M period.

The Contractor shall use applicable software or computer programs in presenting the project schedule.

## 10. Preliminary Design Drawings

The preliminary design shall be provided for the rooftop solar PV system to give an overview of the project to be developed, as part of the bid submission of the Contractor. This must be adequate and sufficient to understand the concept and orientation of the PV system being proposed. Design drawings shall be submitted in A3 size, including, but not limited to the following:

Sheet	Content
Cover Page	Project Title
G / 1	List of Drawings, Legend and General Notes
G / 2	Project Location Map, Site Development Plan, Project Site Conditions and Technical Features
E / 1	Tapping Point
E / 2	Single Line/Riser Diagram
E / 3	DC and AC Load Schedule Calculation
E / 4	Control and Monitoring System Topology
E / 5	Solar PV Array Stringing Plan
E / 6	DC, AC and Communication Cable Routing Details
E / 7	Proposed Grounding System Location and Wiring
E / 8	CT and Metering Installation
E / 9	Lightning Arrester and Grounding
S / 1	Solar PV Array Mounting & Framing Details
S / 2	Inverters Station and Tapping Point Station Details
S / 3	Access Ladders/railings for maintenance
S / 4	Concrete roof deck foundation and calculation (as needed)

## 11. Compliance with Industry Standards and Codes

Without limiting the Contractor's obligations, all engineering and construction/installation works performed, all equipment furnished, and all tests carried out under this Engagement shall be undertaken in accordance with the latest industry standards and regulation, including, but not limited to the following:

- Grid Code or Distribution Code
- Distribution Services and Open Access Rules (DSOAR)
- Philippine Electrical Code (PEC)
- National Building Code of the Philippines (NBCP)
- National Fire Protection Association Standards (NFPA)
- National Structural Code of the Philippines (NSCP)
- Revised Fire Code of the Philippines of 2008
- International Electrotechnical Commission (IEC) Standards
- Underwriter's Laboratories Inc. (UL) and/or Factory Manual (FM) or equivalent Standards

## 12. Weekly Construction Meetings and Progress Reports

The Contractor shall conduct weekly construction meetings to be held either on site or online and provide progress reports. Progress reports must be submitted to PNOC

also at a weekly basis, which shall include Program of Work, Materials Delivery Status and Accomplishment and Target Report. For urgent matters, PNOC may advise emergency meetings.

- Program of Work – Shall include PERT/CPM, S-Curve, Bar Chart, Manpower, and Equipment Utilization Schedule. The Contractor shall utilize applicable software or computer programs in presenting the Program of Work.
- Materials Delivery Status – Shall reflect the status of all materials being procured including the descriptions, quantity, name of suppliers, purchased order number, ETA site, etc.
- Accomplishment and Target Report – Shall be presented in MS PowerPoint or equivalent. It should include the percentage of weekly accomplishments, safety reports and targets. In case of delays or slippage, the Contractor shall provide a detailed “catch-up” plan.

### **13. Workmanship**

Workmanship shall follow the ISO 9001:2015 standard on Quality Management System (QMS).

The Contractor shall accept full responsibility for its work in the design, specifications, procurement, fabrication, manufacture, construction, erection, installation, calibration and testing, quality control, documentation, testing and commissioning and performance testing.

The Contractor shall be responsible for the safety and security of its personnel within the project site(s) and provide proper personal protective equipment (PPE).

The Contractor shall also be responsible for all compliance with the Distribution Utility (DU) and Energy Regulatory Commission (ERC) requirements to attain smooth synchronization and commercial operation.

The Contractor shall be deemed solely liable for all its suppliers and subcontractors and shall compensate PNOC against all third-party claims or infringement of patent, trademark, or industrial design rights arising from use of the supplied equipment or any part thereof.

### **14. Certificate of Acceptance**

Certificate of Acceptance for accomplished works shall be issued to the Contractor by PNOC to certify its successful execution and performance.

- A Certificate of Partial Project Completion shall be issued after the 90% completion of the scope of work; and
- A Certificate of Final Acceptance shall be issued by PNOC after the completion of the defects and liability period and the submission of warranty certificates and security.

### **15. Project Turnover**

The project shall be turned over to PNOC upon completion of the scope of work. The Contractor shall issue an endorsement letter for proper turnover.

## 16. Warranty Certificates

The Contractor shall turnover the warranty certificates for the following structures and equipment to PNOC prior to issuance of Certificate of Final Acceptance:

- A twenty-five (25)-year linear power warranty from the Manufacturer on the solar PV modules with at least eighty percent (80%) power output guaranteed at twenty-five (25) years. The solar PV module manufacturer shall confirm that the warranty applies on an "as installed basis," i.e., it will confirm the modules were installed according to its requirements and specifications for installation.
- A fifteen (15)-year warranty on the permanent structures which include mounting and racking systems used in the rooftop solar PV system.
- A ten (10)-year warranty from the Manufacturer on the solar PV modules. The PV module-manufacturer shall confirm that the warranty applies on an "as installed basis," i.e., it will confirm the PV modules were installed according to its requirements and specifications for installation.
- A five (5)-year warranty from the Manufacturer on the inverters. The inverter manufacturer shall confirm that the warranty applies on an "as installed basis," i.e., it will confirm the inverters were installed according to its requirements and specifications for installation.
- A one (1)-year warranty for safety and protection devices, cables, instrumentation, and control/ communication devices including software, IP cameras and Web portal and all other accessories used in the solar PV system.

## 17. Defects and Liability Period

Defects and liability period shall include servicing of defective goods and services under the warranty obligations and conditions stipulated in the Contract.

Repairs, troubleshooting, and other after-sales support to commence within seven (7) calendar days upon receipt of notification from PNOC.

Replacement for locally available components shall not exceed fifteen (15) calendar days upon receipt of notification from PNOC.

Replacement for imported components shall not exceed sixty (60) calendar days upon receipt of notification from PNOC.

## 18. Spare Parts, Tools, and Consumables

The Contractor shall supply the necessary spare parts, tools, and consumables for the installation, testing and commissioning, as well as the operation and maintenance of the project. These items will be turned over to PNOC upon completion of testing and commissioning.

Particulars	Qty	Unit
Electrical Pliers 6"	1	unit
Electrical Pliers 8"	1	unit
Long nose pliers 6"	1	unit
Long nose pliers 8"	1	unit
Side cutter pliers 6"	1	unit
Side cutter pliers 8"	1	unit

Allen wrench (black iron), metric	1	set
Crimping tools (RJ45)	1	unit
Screwdriver (flat, 8")	1	unit
Screwdriver (cross, 8")	1	unit
Adjustable wrench	1	unit
Combination wrench (applicable sizes)	1	set
Toolbox 20" (big)	1	unit
Clamp meter (1,000volts; with Rogowski coil)	1	unit
Vice grip 8"	1	unit
Torque wrench 3/8" square drive with complete set of sockets (Solar PV for Distribution Panel)	1	set
Portable washer with pump, 7.5Mpa pressure, 5 liter/minute	1	unit
16 Ton Quick Hydraulic Crimper Cable Plier Tool Kit, 16-300mm/11 Die	1	unit
Dry Chemical Fire Extinguisher (10 pounds)	1	unit
RJ 45 connector (100pcs per pack)	1	pack
Electrical tape (0.16mm x 19mm x 8meters; black)	5	roll
Cable tie (UV resistant; 12"; 100pcs per pack)	1	pack
Rubber tape (18mm x 8meters; black)	1	length
Others (please specify, if needed)		

## 19. Allied Services

### 19.1. Markings and Labeling

The Contractor shall provide markings and labelling on all electrical equipment (including wires) in accordance with applicable codes and standards or as otherwise agreed upon with the building owner. Markings shall be clearly visible, located visibly on the equipment, constructed and installed to remain eligible for the whole of the design's life of 25 years. The marking and labeling shall be compliant with the following codes:

- PEC article 6.90 and article 1.10
- UL 696

### 19.2. Safety Signages and Fire Extinguishers

The Contractor shall provide safety signages as per standards including warnings for high voltage, cable burial, etc.

The Contractor shall likewise provide a fire extinguisher to be mounted near each of the identified solar array stations, inverter station and tapping point station as per design drawings.

### 19.3. Power Supply

The Contractor shall provide power supply, complete with protection devices (e.g., circuit breakers, AVR, etc.) for equipment that will require power such as POE hub, inverter controller, router, etc. The Contractor shall identify the location of the tapping source and request permission to the building owner.

### 19.4. Water Source

The Contractor shall coordinate with the building owner for the location of the water source to be used during maintenance (e.g., PV module cleaning).

#### 19.5. Canopy

In case an inverter station or any equipment is placed outdoors, a canopy shall be provided as per Manufacturer's standards and recommendation.

#### 19.6. Access Platforms, Stairs and Safety Handrails

The Contractor shall provide access such as sufficient portable access ladder along the PV facility for safety and protection during construction and PNOC's operations and maintenance.

The Contractor shall provide anchors at strategic locations for safety harnesses.

#### 19.7. Relocation or Modification of Existing Structures

The PV system shall be designed with no requirement for relocation or modification of the existing structures. In extreme cases when relocation or modification of existing structures is necessary, the Contractor shall submit modification or relocation plan to ensure that the structures shall be maintained, restored or upgraded.

### **20. Available Data and Schedule of Site Inspection**

Potential bidders can access the relevant site data (e.g., electric consumption information, plans, and drawings) via the following link:

- <https://bit.ly/Carmona-Water-District>

The site inspection is scheduled for November 22 and 27, from 9:00 AM to 12:00 PM (can be subject to change). Bidders must inform PNOC representatives in advance using the contact details provided below:

- **Louie Aaron L. Razon:** +639564761790
- **Richard Miguel D. Allauigan Jr.:** +639178460403
- **Patrick Jose IV V. Andaya:** +639369318841

### **21. Technical Specifications and Standards**

#### 21.1. Design Calculations

The design of the PV system shall be for a minimum service life of twenty-five (25) years. Design shall consider service conditions that will affect the performance of the solar PV system such as irradiation, UV radiation, temperature variations, rainfall intensity, humidity, pollution etc. Design shall be able to protect and harness the equipment from natural calamities such as earthquake, tropical typhoons, cyclones and wind gustiness prevailing in the Philippines.

##### 21.1.1. *Electrical Design*

Maximum DC voltage per string shall not exceed 1500 Volts at a temperature of 15 degrees Celsius.

Minimum DC voltage per string shall be more than the "minimum input voltage" of the inverter at a temperature of 50 degrees Celsius.

Minimum DC voltage per string after 20 years shall be more than the "minimum input voltage" of the inverter at a temperature of 50 degrees Celsius.

Maximum DC power per array (combination of strings) shall be less than the maximum allowable generator power of inverter.

Maximum voltage drop between equipment to equipment shall not exceed 1% on DC system and 5% on AC system.

#### *21.1.2. Structural Design*

Seismic loading shall be selected to ensure the Performance Criteria set out below are achieved:

- All system's components which are critical to the generation of electricity shall remain undamaged and operational following a moderate earthquake;
- In case of a massive earthquake, the damage to structures and equipment shall be limited to that which can be repaired sufficiently quickly for the generation of electricity to resume safely within thirty (30) days, unless otherwise the main building has collapsed; and
- Potential costs of repair or replacement and the duration of inability to generate electricity after a large seismic event shall be minimized.

The wind resistant design required for the facility shall be at minimum of 270 kph. In case the basis for wind resistant design in the latest National Structural Code of the Philippines (NSCP) is higher, then NSCP shall govern.

### 21.2. Minimum PV System Components Specifications

#### *21.2.1. Solar PV Modules*

The modules must follow the IEC 61215 standards (i.e., Crystalline Silicon Terrestrial Photovoltaic modules; Design Qualification and Type). These shall be made of monocrystalline material solar cells, tested in extreme weather conditions, and equipped with safety protection mechanisms. These shall also have a minimum efficiency of 17% at Standard Testing Conditions (STC). The solar PV panels supplied must include a performance warranty guaranteeing no more than 2% efficiency degradation in the first year and no more than 0.5% annual degradation thereafter. At the end of 25 years, the panels must still produce at least 85% of their original rated power output. The solar PV modules supplied must be manufactured by a Tier 1 manufacturer as defined



by industry-recognized standards such as Bloomberg New Energy Finance (BNEF) or equivalent.

#### *21.2.2. PV Mounting System*

The PV mounting system shall be suited to the environment and atmospheric conditions (e.g., corrosion, salt). Structures shall be fixed, metallic and have appropriate design and adequate strength which can withstand the load of the modules, cyclonic and high wind velocities as applicable to the site condition. The material shall be robust and non-corrosive, made from anodized structural grade aluminum 6005 T5 and/or stainless-steel components or equivalent. Use of different metals shall be avoided where practically possible to prevent galvanic corrosion. The structure shall prevent water accumulation. The mounting system must be compliant to AS/NZS1170.2:2011 AMDT 2-2012 standard or equivalent.

#### *21.2.3. Inverter*

The inverter to be used shall be string type, weatherproof and equipped with a safety protection mechanism. The inverter shall be compatible with the existing electrical system. The inverter and its appurtenances shall be state-of-the-art with energy management and communication system and maximum power point trackers (MPPT) for optimum performance. The inverter shall have efficiency of not less than 98.5%, with a 10-year guaranteed service life. It also must have the following minimum communication specifications: WLAN/Ethernet, Wi-Fi, and 4G/3G/2G.

The mounting shall be robust and non-corrosive, made from hot-dipped galvanized structural steel or equivalent. The foundation shall be fixed and secured. The inverter shall have adequate spacing, free from obstructions and well ventilated.

#### *21.2.4. Inverter Controller*

The inverter controller shall be the central communication unit for system monitoring, recording data and controlling. It shall be capable of interconnection of other measuring devices such as solarimeter, weather-meter, etc.

#### *21.2.5. DC Combiner*

In cases where design requires the need for a DC combiner, the DC combiner shall be made of glass-fiber reinforced polyester material or approved equivalent. Enclosure protection shall be sealed, dust proof, vermin, waterproof and sturdy – compliant to IP65/NEMA 3R or equivalent. Mounting may be wall-mounted type or stand-alone support. The dimensions and thickness are as per manufacturer's standard. It shall be rated 1500Vdc minimum.

The DC combiner shall have appropriate cable entry points, with cable glands, fitted for input and output cables and a lockable door.

The DC combiner shall be equipped with auxiliaries such as circuit breakers, surge protection devices and grounding terminals, mounted on DIN rail or

equivalent and with adequate spacing for easy termination and testing. Auxiliaries shall conform to IEC standards or equivalent.

All circuit breakers and fuses shall be compliant with IEC 60947 Part I-III, IS 60947 Part I-III and EN 50521 or equivalent. The voltage rating shall be a minimum of 1000VDC. The ampere trip/ampere frame, number of poles and other mechanical parameters shall be as per Design standards.

#### *21.2.6. AC Combiner*

Enclosure protection shall be sealed, dust proof, vermin, waterproof and sturdy – compliant to IP65/NEMA 3R or equivalent. Mounting may be wall-mounted type or stand-alone support. The dimensions and thickness are as per manufacturer's standard. It shall be rated 0.6/1kV minimum.

The AC collector shall have appropriate cable entry points, with cable glands, fitted for input and output cables and lockable doors.

The AC collector shall be equipped with auxiliaries such as circuit breakers (mounted on busbar with adequate spacer) and neutral and grounding terminal mounted on DIN rail or equivalent and with adequate spacing for easy termination and testing. Auxiliaries shall conform to IEC standards or equivalent.

All circuit breakers shall be compliant with IEC 60947 Part I-III, IS 60947 Part I-III and EN 50521 or equivalent. The minimum voltage rating shall be equivalent to inverter output voltage. The ampere trip/ampere frame, number of poles and other mechanical parameters shall be as per Design standards.

#### *21.2.7. Transformer*

In cases where design requires the need for a transformer, the transformer configuration shall be based on the system configuration or topology between the inverter i.e., TN-S, TN-C, TN-C-S, TT and IT and grounding configuration and voltage.

Depending on the location, the transformer shall either be outdoor type or indoor type in compliance with NEMA or IP standards. The compartment shall be metal-enclosed and non-corrosive. The transformer shall be dry-type, self-cooled and floor mounted. The foundation shall be equipped with an anti-vibration pad or equivalent. The transformer shall be UL/IEC listed or equivalent.

#### *21.2.8. Transient Voltage Surge Suppressor with Isolation Switch*

The TVSS shall be capable of bi-directional filtering of harmonics and surges that may be created from the PV system and from the grid.

The surge protection devices shall be compatible with the existing electrical system. The ampere-interrupting capacity (AIC) rating of the devices shall be equal to or greater than the available fault current to which they might be subjected.

Enclosure protection shall be sealed, dust proof, vermin, waterproof and sturdy – compliant to IP65/NEMA 3R or equivalent. It shall be rated 0.6/1kV minimum.

#### *21.2.9. PV Generation (Revenue) Meter Including CT/PT and Terminals*

The PV generation (revenue) meter shall be digital multi-function power meters complete with CTs and potential fuses. The meter shall conform to the following minimum requirements:

- IEC or ANSI revenue metering standards (i.e., Class 0.3 accuracy); and
- Capable of providing outputs and terminal strips for remote monitoring and data acquisition using RS485 or equivalent.

The meter shall be boxed in a standard enclosure with a viewing window made of fiberglass or equivalent.

#### *21.2.10. ECB Main Disconnect Switch*

The enclosed circuit breaker shall act as the main fault current protection device and disconnect switch to isolate the solar PV system from the existing electrical system. Enclosure protection shall be sealed, dust proof, vermin, waterproof and sturdy – compliant to IP65/NEMA 3R or equivalent. The dimensions and thickness as per manufacturer's standard. It shall be rated 0.6/1kV minimum.

The circuit breaker shall be compliant with IEC 60947 Part I-III, IS 60947 Part I-III and EN 50521 or equivalent. The minimum voltage rating shall be equivalent to system voltage. The ampere trip/ampere frame, number of poles and other mechanical parameters shall be as per Design standards.

#### *21.2.11. Cables*

PV cables shall be copper type. It shall be UV-rated, sunlight-resistant, waterproof protection and manufactured under UL standard. It shall be designed and manufactured in accordance with:

- IEC 60811: Insulation and Fire Protection
- IEC 60227 and IEC 60502: Design
- IEC 60228: Conductors
- UL 1581 (Xeno-Test), ISO 4892-2 (Method A) or HD 506/A1-2.4.20: DC solar cables

All power cables shall be of XLPE insulated with PVC sheathed, 0.6/1kV single or multicore, stranded copper conductor. The conductor shall be made from electrical purity copper for power cables and annealed high conductivity copper for control cables. Conductors shall be stranded for copper power cables and solid for copper control cables.

All cables shall be designed to withstand the mechanical, electrical, and thermal stresses under the steady state and transient/ fault conditions. All cables shall be suitable for high ambient temperature, high humidity and tropical climatic conditions. All cables shall be color coded as per IEC 60364 and should be provided with tag/markings.

All cable ties should be UV protected and can withstand high heat stress without damaging the cables. Cable ties shall conform to EN 50146 and IEC 62275 standards.

Cables to be supplied are categorized as follows:

<b>Particular</b>	<b>Description</b>	<b>Requirement</b>
PV String Cables	Cables from PV strings to DC Enclosures	Must be 2 x 6mm <sup>2</sup>
DC Enclosure Cables	Cables from DC Enclosures to Inverters	As per PEC Standards
Inverter Cables	Cables from Inverters to AC Collector	As per PEC Standards
AC Collector Cables	Cables from AC Collector to Transformer	As per PEC Standards
Transformer Cables	Cables from Transformer to ECB for Disconnect Switch	As per PEC Standards
Tapping Point Cables	Cables from ECB for Disconnect Switch to tapping point	As per PEC Standards
Grounding Cables	Cables for grounding	As per PEC Standards
Neutral Cables	Cables for Neutral	As per PEC Standards
Communication Cables	Cables for Controls and Monitoring	UTP, Ethernet, CAT5/CAT6
Power Supply Cables	Cables for 220-240V power supply	As per PEC Standards

*21.2.12. Raceways (Cable Trays, Conduits, PVC Pipes and Fittings, Accessories)*

Cable trays and fittings shall be hot-dipped galvanized with a minimum of 2mm thickness in accordance with IEC standards or equivalent. Conduit shall be rigid steel in accordance with IEC standards or equivalent.

PVC systems that are to be buried underground shall conform to IEC 61386 Part 24 standards or equivalent.

Raceways shall be color coded as per standards or as per existing color coding of the building.

*21.2.13. Lightning Arrester and Grounding System*

In cases where design requires the need for a lightning arrester and grounding system, the lightning protection shall be made of conventional lightning protection or the Early Streamers Emission (ESE) type. It shall be equipped with a lightning strike counter. The protection radius shall cover the whole solar PV facility.

The grounding system shall have a maximum resistivity of 5 ohms. The size and diameter of bare copper and grounding rod shall be as per standard.

The safety protection devices shall provide optimum filtering in relation to the specification of inverter and PV panels. The surge protection device shall be compact and shall comply in accordance with the UL 1449 3rd edition testing, ANSI/IEEE C62 and ANSI/IEEE Std. 1100-1999

The surge protection devices shall be compatible with the existing electrical system. The ampere-interrupting capacity (AIC) rating of the devices shall be

equal to or greater than the available fault current to which they might be subjected.

The grounding wires shall be placed in a standard UV-rated PVC or equivalent.

*21.2.14. PV Monitoring and Data Acquisition System (Internet Connection)*

The PV monitoring and data acquisition system shall be capable of both remote and onsite access and monitoring via a subscription-free online platform. The system shall be able to provide the following minimum data:

- energy generation (kWh);
- power (kW);
- power factor;
- voltage;
- current;
- irradiance;
- weather; and
- temperature

The system shall be capable of detecting failures and fault conditions.

Data transmission shall be real-time and shall be equipped with safety and high-security protocol. The data shall be displayed in graphical trends and in figures. Historical data shall be available for a minimum of one (1) year.

*21.2.15. CCTV/IP Surveillance Camera*

The CCTV/IP surveillance camera shall be capable of onsite monitoring, continuous recording, and remote access and monitoring via a subscription-free online platform. Viewing shall be real-time and can operate 24/7. Video recording shall be capable for a minimum of one (1) month. The camera shall be robust, weatherproof and with high-resolution.

Type	Fixed Bullet
Video Camera	2 units
Resolution	1080HD
Enclosure	Weatherproof, outdoor IP65 or equivalent, minimum
Hard Disk Drive	2TB SATA 6.0Gb/s Cache 64MB Surveillance Type
NVR	Minimum 8 Channel IP Camera, Resolution minimum of 1920x1080
POE Hub/Switch	8 ports
CPE/Router/Modem	1 × USB 2.0 Port for Connecting 4G/3G Modem as WAN Backup; 4 × Gigabit WAN/LAN Ports; Non-WIFI router

*21.2.16. Communication and Control Cables, Radio Transmission or Fiber Optics or Equivalent*

If long distance controls are needed, a radio transmission or fiber optics or any equivalent communication protocol may be used. In the case of wireless communication, it shall be equipped with reliable communication equipment such that it will not create unacceptable delays and interference that would compromise the operability of the whole system.