

## **Employer's Requirements**

### **PV Generation System**

**Project:** Engineering, Procurement and Construction of Hybrid PV-Diesel-Battery Energy Storage System

**Location:** Pulau Tiga, Maluku, Indonesia

## 1 Intended purpose

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The purpose of the PV Generation System is to convert sunlight into DC electricity and feed this to the PV inverters and/or MPPT charge controller(s).

### 1.1 Topology and specifications

- The system shall comprise a ground mounted PV array, consisting of arrays of solar PV modules fixed on galvanized steel mounting frames. The arrays shall fit within the confines of the fenced grounds of the existing defunct solar power plant. PV inverters shall be installed within the array or on/in the powerhouse building.
- The size of the PV array shall be determined by the Bidder in accordance with APPENDIX L. The recommended size of the array is 70 kWp
- New layout should be proposed by Bidders in accordance to land available, see Appendix K. with current site layout and measurements.
- The new PV array should be located in the same location as the defunct PV modules currently on-site
- The reuse/remediation of existing infrastructure is encouraged, e.g. existing pathways to the extent possible and without compromising quality.



*Figure 1: Existing defunct PV modules in P. Tiga site*

## 2 Specific Equipment Requirements

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### 2.1 PV Modules

- The PV modules provided under this tender are to be of identical make and model, from a Tier 1 manufacturer with demonstrated experience in manufacturing high-quality PV modules, and with previous deployment in commercial or utility-scale systems.
- PV modules must be warranted to produce at least 90% of their nominal output (at STC) after 10 years from first energization at site, 80% of their nominal output after 25 years, and have a defects warranty period of at least 10 years. A warranty statement must be provided including descriptions of manufacturer remedial actions and claim instructions.
- The PV module temperature de-rating coefficient (at  $P_{MAX}$ ) is to be less than 0.4%/°C.
- UV-resistant, locking connectors (e.g., MC4 or equivalent) certified to EN 50521 are to be fitted to module leads. Non-locking connectors are not to be used.
- Modules are to be demonstrated as suitable for tropical marine environments through provision of test certificates, certifying compliance to IEC 61701:2011.
- Each module must be fitted with a manufacturer's sticker on the back, providing the following information:
  - Manufacturer's name
  - Module model number
  - Module serial number
  - $V_{OC}$ ,  $I_{SC}$ ,  $V_{MP}$ ,  $I_{MP}$  &  $P_{MP}$  at STC
  - Date of manufacture
  - Country of manufacture
- Poly- or Mono-crystalline silicon cells are acceptable (Not thin film or amorphous silicon) with a minimum efficiency of 20%.
- Power tolerance shall be a positive power tolerance (+0 to +3Wp or better)
- The PV module frame shall be made from marine grade anodised aluminum, stainless steel with appropriate seals to prevent water ingress and damage the laminate, or use of frameless (i.e., double glass) and bifacial modules are also acceptable.
- The front glass of the PV module shall be tempered glass with a minimum thickness of 3.2mm or 2.5mm for double glass modules.
- The PV module shall comply with IEC 61215, IEC 61730, IEC 61701 ED2 and IEC 62716. PV modules must be tested at the ESTI (European Solar Test Installation) or an equivalently qualified institution (such as TÜV Rhineland and ASU-PTL) using CEC Specifications No. 503 or certified according to IEC 61215.
- Bypass diodes are required on each module.
- The terminals must be clearly marked with + and – for the corresponding connections polarity.
- Test certificates must be supplied with the PV modules.
- The PV modules shall be under the manufacturer's active production and shall not be superseded stock.

## 2.2 PV Module Installation & Mounting

- All PV arrays are to be fixed-axis and ground-mounted.
- PV modules must be clamped onto rails (i.e., not bolted or screwed).
- All PV modules must be oriented in the same direction and under the same inclination, facing due North at a minimum angle of 10°.
- The maximum open-circuit voltage of each string is not to exceed 1,000V<sub>DC</sub> at STC. The Bidder shall supply an engineering certificate endorsing the foundation design. The mounting structure must be designed and certified to resist wind gusts of up to 32 m/s (115 km/h).
- PV structure supplied must include Structural engineers certification to ascertain compliance to Wind loading ie AS1170, ASCE7=10.
- While choosing materials and their finishes, due regard shall be given to the humid, saline, tropical conditions under which equipment is to operate. Material specifications, including grade or class shall be shown on drawings submitted for approval.
- Spacing between rows shall be sufficient to ensure self-shading loss of ≤ 2.5% p.a. Tenderers are to provide evidence of each design complying with this requirement (e.g. though a PVSyst report or similar).
- PV arrays should be installed avoiding shades from fence, powerhouse, lightning arrester, lampposts, trees, or any other shading objects in the vicinity.
- The lower edge of the PV modules shall be installed at no less than 500mm above ground level.
- Owing to the corrosive environment, the array mounting structure must be made of marine grade 316 steel or marine grade anodized (20+ micron) aluminum or 80µm Hot Dipped Galvanized Steel. HDG coating certificate to be provided as evidence.
- Fasteners are to be made of marine grade 316 stainless steel and 304 stainless steel and coated in a water-resistant rust inhibitor. Bolts are to be made of 316 stainless steel and nuts of 304 stainless steel, to prevent binding. Galvanized steel fasteners are not acceptable. The mounting structure should arrive to site pre-cut, and not be cut in the field. This is so that any corrosion-resistant treatments are not compromised by cutting.
- Fits and tolerances shall be given in accordance with ISO Standards. Fits shall be selected for the smooth functioning of the components for 25-year service life.
- Bidders must not mix types or grades of materials.
- Earthing of the PV arrays shall be designed in accordance with Peraturan Umum Instalasi Listrik (PUIL 2011). The Bidder shall design the PV System with lightning and surge protection in accordance with Peraturan Umum Instalasi Listrik (PUIL 2011).
- Cable management equipment, supports, trays, ladder and conduit etc. including trenching, ducting and catenary wires are to be used wherever necessary, to protect cables from accidental and environmental damage and deterioration during the expected lifetime of the hybrid power plant – see Attachment A - General Electrical.

## 2.3 PV AC-Inverters

- The proposed system should have the following topologies:
  - AC-coupled only:
    - Dedicated and separate PV and BESS inverters tied on the AC bus
- Hybrid AC- and DC-coupled where PV panels and batteries are to be tied on the DC side of inverters are acceptable, but will not be detailed in this tender. Bidders must describe and justify the benefits of installing a hybrid AC- and DC-coupled system.
- For redundancy reasons, a minimum of two PV inverters (dedicated or hybrid) are required to be incorporated in the system.
- The PV inverters must be of the exact same make, model and size.
- PV inverters must be sized appropriately for the maximum module peak power rating under all weather conditions of the site.
- The Bidder must ensure that the DC operating voltage window and current limits of the PV inverters are not exceeded under all environmental conditions at the site.
- The PV inverters shall be able to respond to grid frequency shifting to curtail the power fed from the PV panels to the local grid. PV inverter are to be controlled directly by the BESS and frequency. This will happen when the BESS cannot absorb all the excess power and the grid frequency will automatically be raised by the battery inverters to signal that power curtailing is required.
- The PV inverters shall be located adjacent to the PV panels or in the powerhouse and must have a protection rating of at least IP 65 (according to IEC 60529).
- The PV inverters must not be placed in direct sunlight and the Bidder will be required to construct shading structures if shading cannot be provided by other means.
- The power conversion efficiency of the PV inverters shall exceed 97% while operated above 20% of PV array rated power.
- Open protocol standards such as Modbus are required for seamless integration to third party systems. Closed or proprietary protocols are not acceptable unless approved by the Employer.
- The minimum standard warranty must be 5 years on all major Power Conditioning Equipment including the PV inverters.

### 3 Scope of Works

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Bidders shall complete the following Scope of Work:

- Supply and install all PV Modules and Framing in accordance with the specific equipment requirements.
- Supply and install all PV inverters in accordance with the specific equipment requirements.
- Supply and install all cabling and switchgear required, rated at the appropriate sizes.
- Specify cable length and diameter carefully to optimise system efficiency.
- Supply and install all interfaces and connections to the existing network.
- Supply and install all system lightning and surge protection as required.
- Supply and install all system earthing and equipotential bonding as required.
- Supply and install all terminations between PV panels and PV inverters in accordance to manufacturer specifications. No installation practices or terminations shall be used that may void manufacturer warranties
- Supply and install all cable management equipment, supports, trays, ladder and conduit etc. including trenching, ducting and catenary wires.
- Provision of data and communications cabling for interfacing between the various power conditioning units as well as with the BESS and system controller.
- Supply and install a separate, external manual isolation switch to provide isolation of the inverters from the LV network.
- Provision of data and communications cabling for interfacing between the various power conditioning units as well as with the BESS and system controller.
- Training and capacity building for local staff for operation and maintenance.

The PV array frame must be ground-mounted and should comply with the following requirements:

- PV array support shall be made from Hot dip Galvanized steel. Bidder shall provide steel structure preferably from reputable/proven manufacturer such as Schletter, Preformed line products (PLP), S-rack, Chiko.
- Foundation shall in place concrete in accordance ACI 304 with steel bar diameter 10mm. Foundation shall have surface area 35 x35 cm and height 60 cm with minimum depth 40 cm. Pull test piles post/structure shall be undertaken and issued with certifications by Structural/civil Engineers
- The minimum height between the lowest position of modules and earth surface shall be 500 mm.
- Tilt angle of PV Module shall 7-10 degrees facing North.

It will be the Bidder's responsibility to design the layout of the PV arrays within the given site perimeter with the following specific deliverables:

- Engineering drawings showing array layout (plan view), inverter locations, combiner box locations, cable runs (incl. underground).



- SLDs showing array string wiring and fusing (if required), inverter wiring, combiner box wiring schematics, equipotential bonding system, DC isolators rating, AC circuit-breakers rating, and
- Engineering drawings showing full details of mounting structure, including foundation design, and component materials specifications.