Section 6 Employer Requirements
Attachment C – Renewable Energy Solar PV Array Requirements

1. Definitions

Unless explicitly stated in this document, or the Contract, definitions are as per the Standards.

2. Standards

All equipment shall be installed, and all work shall be carried out in accordance with statutory requirements. Where explicit local regulations are not applicable, all equipment and works supplied shall conform to the latest editions of the relevant international standards.

Key standards applicable to the solar PV array are:

- AS/NZS 3000:2018 – Wiring Rules
- AS/NZS 3008.1.1:2017 –Selection of Cables
- AS/NZS 5033:2021 – Installation & Safety Requirements for Photovoltaic (PV) Arrays
- AS/NZS 4777.1:2016 – Grid-connection of Energy Systems via Inverters: Installation Requirements
- AS/NZS 4777.2:2020 + Amd 1 – Grid-connection of Energy Systems via Inverters: Inverter Requirements
- AS/NZS 1170:2021 – Structural Design Actions
- AS 2159:2009 - Piling
- AS 60529:2004 – Degrees of Protection Provided by Enclosures (IP Code)
- AS/NZS 3947 (series) – Low Voltage Switchgear & Control gear
- AS/NZS 61439 – Low Voltage Switchgear & Control gear Assemblies
- AS/NZS 1768:2021 – Lightning Protection
- AS 3600:2018 – Concrete Structures

In case the equipment or materials offered from a country where the relevant standards to which the equipment or materials offer better performance or safeguards for Solomon Power than the relevant standard required here, these are acceptable. The Contractor must substantiate any such claims by submitting an independent assessment, by an appropriately qualified person, that identifies differences in the standards and demonstrates the benefit for Solomon Power.

All referenced standards must be complied with unless exception is granted by Solomon Power. If a Functional Requirement exceeds a standard listed, then that Functional Requirement shall be adhered to.

Standard(s) referred to shall mean the current Edition / Revision together with Amendments issued.

3. System Design

3.1 Topology

The solar PV array shall comprise a ground mounted or rooftop solar PV array with multiple solar PV string inverters all marshalling to a single AC connection point.

The exact number of solar PV modules, solar PV inverters and string configuration is left to the tenderer to determine to meet the Specifications and Functional Guarantees.

3.2 Functionality

The solar PV array is designed to form an integral part of the overall power system. In addition to the physical topology outlined in Section 3.1, the solar PV array shall incorporate all digital and analogue IO as well as high-level communication interfaces for:

- Metering and monitoring the performance and operation of the system.
- Controlling all generation components and the transmission of power/energy from the system to the electrical distribution system.
- Visual presentation of system status and operation information to local system operators.
- Logging of system operation, event and status data, and all associated communication systems, including internet connection for transmission and cloud portal for online data storage and remote access.

Solar PV Generators (SPVGs) shall utilise a central *Data logger/Controller* that can be programmed with all of the main operational alarm, event, and corresponding action parameters, which directs all sub-controls accordingly.

The central *Data logger/Controller* shall incorporate a data logging system that is internet connected for the feed of live data via a cloud portal to remote operators, technicians, and system managers. The internet portal shall support remote access from any internet connected computer via a web browser or smartphone devices via an Android or iOS application.

The solar PV array shall incorporate a series of alarms for communicating critical system status information to local and remote operators, as well as a series of status specific control actions, including real and reactive power control for grid management and generation curtailment as required. The solar PV array shall have the capability of actively ramping/curtailing the real power output in response to a control signal from the BESS.

The solar PV array central *Data logger/Controller*, shall incorporate the following control and monitoring functionality, which will direct the system’s automated alarms and event logging:

- Time and Date including time clock function (automatically adjusts Alarm set points or triggers control actions based on time/date)
- Plant Status by inverter (including string level monitoring)
- Plant Faults by inverter (including string level monitoring)

- Available real power
- Available reactive power
- Active power control through control input
- Reactive power control through control input
- Automatic reactive power control via voltage droop

The solar PV array central *Data logger/Controller* shall incorporate a centrally located meteorological station per site to log the following parameters as a minimum:

- Ambient Temperature
- PV Module Temperature
- Wind Speed
- Global and Tilted Solar Irradiance

3.3 General Design Requirements

3.3.1 Reliability

In line with the design specifications for the SPVGs outlined herein, the solution, including all main and sub-components should be able to operate with a high level of reliability within the tropical, humid, saline, and coastal environments with minimal maintenance.

The design of the SPVGs should focus on ensuring reliability through the following principles:

- Control and monitoring sub-systems and components requiring on-site external computer based programming for anything other than firmware upgrades should be limited where-ever possible.
- All system interfaces (text based screens, component labelling, informational process charts, decals, etc.) should be in English. Any programmable options for changing displays to another language should be permanently disabled.
- Incorporation of components which can be readily changed out with common spares by trained local operators without the need for significant re-programming or complex electrical procedures.

The PV array framing system (including fasteners and BOS components) will be generally installed in areas relatively close to the ocean with high salt spray (and thus potential for corrosion), high wind speeds, and flooding. As a result, the PV array framing/mounting system shall be designed in such a way as to be able to withstand these environmental impacts. The contractor will be required to demonstrate that the array framing/mounting system design is able to meet these requirements.

3.3.2 Maintainability

The solar PV array should be designed for safe and easy maintenance by local operators. This should be achieved through adherence to the following principles:

- Major equipment of the solar PV array should have plug-and-play capability, allowing for the replacement of faulty components without complex electrical or reprogramming procedures being required.

- As much as possible, the requirement for on-site high-level technical expertise should be limited, with maintenance processes designed for completion by local staff with appropriate training.
- Full sets of operation and maintenance manuals to be provided on-site in physical and digital format, with spare copies provided to the Employer. These are to be in English. These should include:
    - High level description of the solar PV array topology, hierarchy of programming structures, and a State Diagram showing the data that contains the program state and what triggers changes in this state.
    - List and description of all programming variables, including the As-Commissioned values.
    - Descriptions of all major components, including their role in the solar PV array.
    - Complete set of system schematics and electrical drawings.
    - Full set of datasheets for all major components.
    - System balance of materials listing.
    - Programming instructions for all major components (where relevant) and copies of the most recent firmware versions.
- The solar PV array should have the capacity to identify all potential fault events and communicate these to local operators in an accessible and easy to interpret/understand format, with relevant troubleshooting and fault rectification processes clearly laid out in system operation and maintenance manuals.
- Complete and comprehensive labelling of all electrical components, wiring, and connections to be provided in English for ready reference to system schematics and electrical drawings.

3.3.3 Accessibility for Local Operators

The solar PV array, including all sub-systems and components, should present relevant information concerning system status, operation mode and fault events in a format that is well labelled, in English, and is clear and easy to read and interpret by local operators. The use of non-text based indicator lights or simple graphic HMIs with supporting explanatory images or digital graphics is strongly recommended.

3.3.4 Materials

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. Material specifications shall include corrosion resistant materials and/or coatings to ensure the design life is achieved. Structural materials shall be concrete, stainless steel, or hot-dip galvanised steel with a galvanising thickness designed for site conditions.

3.3.5 Fits and Tolerances

Fits and tolerances shall be given in accordance with ISO Standards. Fits shall be selected for the smooth functioning of the components for a 25-year service life.

3.3.6 Solar PV Array Performance

Solar PV inverter settings and operation shall be shown to be in accordance with the solar PV module manufacturer's specifications and warranty terms specific to site conditions at each island.

3.4 Specific Equipment Requirements

3.4.1 PV Modules

Modules provided shall either be bifacial or monofacial. For each PV system under this tender, the PV modules shall be of identical make and model from a manufacturer with demonstrated experience in manufacturing high-quality PV modules and with previous deployment in commercial or utility-scale systems. Approval from the owner is required before orders are placed.

The solar PV modules shall have been manufactured in accordance with:

I. ISO 9001 - Quality Management Systems; and

II. ISO 14001 - Environmental Management Systems

The Module temperature derating coefficient (of PMAX) is to be less than 0.4%/°C. UV-resistant, locking connectors (e.g. MC-4 or equivalent) certified to EN 50521 are to be fitted to module leads. Non-locking connectors (e.g. MC-3 or equivalent) are not to be used.

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;
- VOC, ISC, VMP, IMP & PMP at STC;
- Dimensions;
- Max. system voltage;
- Max. series fuse rating;
- Date of manufacture;
- Country of manufacture.

3.4.2 PV Module Certification

Modules are to be demonstrated as suitable for tropical marine environments through the provision of test certificates, certifying compliance to:

- IEC 61701:2011, Salt mist corrosion testing of photovoltaic (PV) modules (to level 6 of 6).
- Clean Energy Council requirements
- IEC 60068-2-68:1994 – Environmental testing (Test L: Dust and Sand)
- IEC 61701:2011 – Salt mist corrosion testing of photovoltaic (PV) modules.

- IEC 61215-1 and 2:2016, Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements and Part 2: Test procedures
- IEC 61730-1 and 2:2016, Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction and Part 2: Requirements for testing
- IEC 62759 Photovoltaic (PV) modules - Transportation testing - Part 1: Transportation and shipping of module package units or ISTA 3E;
- IEC TS 62782:2016 - Photovoltaic (PV) modules – Cyclic (dynamic) mechanical load testing
- IEC TS 62804-1:2015 Test methods for the detection of Potential Induced Degradation.
- IEC 62892:2019 - Extended thermal cycling of PV Modules
- TÜV Rheinland 2 PfG 2665/06.18 Additional Testing Requirements of Bifacial Photovoltaic (PV) Modules (if bifacial technology).

Evidence of certification is to be provided. Evidence is to be submitted that the modules are manufactured using the same factory, production line, and bill of materials as used for the certification.

All modules shall be tested to:

- IEC 61215:
    a) Visual inspection
    b) Electroluminescence (EL) testing
    c) Maximum power determination

Evidence of testing is to be provided.

3.4.3 PV Module Installation

All PV arrays are to be fixed-axis and have a north-facing orientation.

The maximum open-circuit voltage of each string is not to exceed 1,000 VDC at STC.

The mounting structure must be designed to resist wind load in accordance with AS/NZS 1170.2:2021. The contractor shall supply an engineering certificate confirming the mounting structure is certified to this standard. If the contractor proposes to use ‘mid or end clamps’ as part of the PV module mounting structure, then these shall be type tested and demonstrated to meet the wind speed requirement.

The spacing between rows shall be sufficient to ensure a self-shading loss of ≤ 2.5% p.a.

Fasteners are to be made of marine grade 316 stainless steel and 304 stainless steel, and coated in a water-resistant rust inhibitor (e.g. lanolin). 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 use of any dissimilar metals causing potential galvanic corrosion is not allowed. Where dissimilar metals are required, appropriate isolation precautions should be taken to prevent galvanic corrosion.

The mounting structure should arrive at site pre-cut, and not be cut in the field. This is so that any corrosion-resistant treatments are not compromised by cutting.

The Contractor shall be responsible for reviewing the site's topography and ensuring all appropriate earth preparations (cut and fill) required so all PV modules are mounted on the same plane.

Modules shall be tilted at 10° relative to the horizontal to ensure suitable self-cleaning properties. These are outlined below:

Site	**Module tilt**
Subproject 1 - Guadalcanal - Honiara	10°
Subproject 4 - Malaita – Auki	10°
Subproject 5 – Solar School Systems	Flush with roof tilt angles or a minimum 10°

3.4.3.1 Piles

A geotechnical study is not provided to tenderers for foundation design. The contractor shall be responsible for geotechnical investigations and supply an engineering certificate endorsing the foundation and structural design. In particular, this shall consider the embedment depth of the piles and their suitability for the design life, design loads, and tolerance to movement of the modules and module mounting hardware. The pile design shall be in accordance with AS 2159.

Pile design verification testing shall be undertaken on site for the lesser of ten (10) or 0.1% of the installed quantity of piles, and providing coverage for each type of pile likely to be installed. Pile design verification shall test piles to failure (breach of any design condition).

The Contractor must implement procedures for special cases, including:

- Piling in test pit locations, fill areas, or other situations where piling speed exceeds reasonable expectation

- Where piling refusal occurs prior to reaching the required embedment depth

- Transition in geotechnical conditions over the length of a sub-array that may increase differential movement.

Piling solutions may include, but are not limited to traditional bored piers, driven / helical piles and concrete ballast (gravity) based systems. Alternative solutions (Surefoot footings, for example) may also be specified by the contractor.

The contractor shall supply an engineering certificate endorsing any foundation/pier design.

3.4.4 PV Inverters

Different inverters may be provided for the PV systems in the schools only. The same model shall be proposed for all other systems. The minimum technical specifications for inverters are as follows:

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- The inverter plant is to consist of multiple string inverters, coordinated through a power plant controller or equivalent.
- Inverters are to be tested and certified according to
  - IEC 61000-6-2 (EMC)
  - IEC 61683
  - IEC 62109-1
  - IEC 62109-2
  - IEC 62216

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- PV inverters are to be rated to IP65 (min).
- PV inverter peak efficiency shall be greater than 98%
- PV inverters shall be capable of curtailing their active power output based on frequency response to mitigate against generation over-supply, and in response to external command signals (issued by the Employer, or BESS energy management system).

- PV inverters shall include:
  - Harmonic distortion < 3%,
  - LVRT and HVRT
  - No power reduction at temperatures below 35ºC for indoor inverters and 40ºC for outdoor inverters should be mentioned.

The inverter shall have been manufactured in accordance with:

I. ISO 9001 - Quality Management Systems; and

II. ISO 14001 - Environmental Management Systems

3.4.5 PV Inverter Installation

PV inverters are to be positioned under the PV array such that they are shaded and protected from environmental conditions. If mounting the inverters under the array is not practical, alternative locations may be proposed that meet this shading requirement (brief or partial periods early morning/late afternoon may be accepted). Mounting heights (including applicable cabling/switchgear) shall facilitate operation and maintenance activities and be clear of any anticipated flooding levels.

Sufficient space around each inverter is to be left for air circulation and heat dissipation. The manufacturer's guidelines are to be observed. Inverters are to be installed such that cables cannot be unplugged without appropriate tools.

The inverter mounting is to be corrosion resistant to the same degree as the array mounting structure.

3.4.6 Layout

The solar PV plant layout must include the following features:

- All weather access to the array is required.
- An external access track must be provided around the perimeter of the array and within the site fence, ideally for a vehicle.

- Internal access tracks must be provided to each inverter / PCU, suitable for all servicing, including the replacement of the inverter / PCU.
- The spacing between tables shall be sufficient (minimum walkway width of 1.0m) to allow pedestrian access to all modules (maximum of 2P tables).
- Provision shall be made for all drainage and stormwater management, and prevention of erosion around piles.

For the school rooftops:

1. Access to the roof is required.
2. Access to each PV module for servicing shall be considered
3. Spacers between adjacent modules shall be considered.
4. Modules shall not be installed outside of the roof.
5. Provision shall be made for the roof drainage to unimpeded.

5.1.1 DC & AC Cabling

AC and DC cabling is to be sized and spaced in accordance with AS/NZS 3000 wiring standards, AS/NZS 5033 installation and safety requirements for photovoltaic (PV) arrays, Solomon Power regulations and all applicable international standards. Further, cable sizing shall ensure a maximum voltage rise between inverters and the point of supply is minimised in line with the applicable standards and not exceeding 2%. Cable sizing between the furthest PV module to any inverter shall be limited to a maximum voltage drop of 3%. Calculations demonstrating compliance with this requirement are to be provided by the contractor.

Within the same enclosure, any AC and DC cables shall be sufficiently segregated in accordance with AS/NZS 5033 and AS/NZS 3000 or equivalent IEC standard..

DC cabling shall be sized in accordance with AS/NZS 5033 and AS 3008 or equivalent IEC standard, with appropriate de-ratings applied for circuit grouping quantities. Outdoor AC cabling is to be routed underground in heavy-duty conduit. Direct-buried cabling is not acceptable. Trenching bedding material shall be clean and free of large particulate materials (>50 mm. OD). Design details shall be strictly followed during construction in regard to selected materials, cable spacing and documented with adequate construction records.

All cabling that would otherwise be exposed to direct sunlight must be routed through UV-stabilized conduit. Direct exposure of cabling to sunlight is not acceptable (except between modules), even if the cable sheathing is marked as UV-stabilized. All cable ties and fixings and trays shall be rated to withstand the tropical marine environment and both direct and reflected UV radiation for the design life of the project. Plastic cable ties are not acceptable.

PV cabling at the array must be installed such that inductive loops are minimized, to minimize voltage surges caused by inter-cloud lightning.

5.1.2 Switchgear

DC isolators and/or combiner boxes are to be provided adjacent to both the array as well as inverters, and in accordance with AS/NZS 5033 or equivalent IEC standard. Inverter-integrated isolators may be considered. DC isolators and Combiner boxes shall be suitable for the high moisture/humidity environment, with breather valves fitted as needed.

String fusing is to be provided where the modules' maximum series fuse rating is exceeded by the maximum current of all parallel strings minus one.

Surge protection is to be provided on both DC & AC circuits.

If PV inverters are located more than (3) three metres from the switchboard, AC isolators shall be installed and shall be located directly adjacent to the inverter.

AC isolators are to be appropriately labelled and rated to carry a continuous current that is higher than the maximum current rating of the inverter(s). The ambient temperature influence of circuit breaker ratings and settings shall be considered.

Any outdoor enclosures or junction boxes are to be rated to at least IP65.

Any outdoor enclosures must be sheltered from direct sun and rain by the array or an awning. Any outdoor enclosures must be UV-resistant, as they will still be subject to reflected UV radiation.

All outdoor enclosure cable entries are to be done from the bottom of the enclosure, to prevent water ingress. Unused cable entries are to be closed to prevent water and insect penetration.

5.1.3 Signage & Labelling

Permanent labelling shall identify all major components including circuit breakers, isolators, string fuses, surge arrestors, DC/AC cables and inverters, in accordance with AS/NZS 3000, AS/NZS 4777, and AS/NZS 5033.

A laminated colour-coded drawing that identifies each PV string and a laminated single-line diagram of the PV system are to be mounted in the powerhouse.

5.1.4 Weather Station

A weather station is to be installed at the PV arrays in each site (excluding the solar school systems). This station is to collect the following information:

- Solar irradiance in the plane of the PV array
- Solar irradiance on a horizontal plane to measure global horizontal irradiance (GHI) and avoid any shading or reflection from other equipment
- PV module temperature (two modules)
- Ambient temperature
- Wind speed and direction

The weather station is to communicate to the on-site data logger, where data is to be logged at a minimum of 1-minute resolution. Monitoring shall be consistent with IEC 61724-1:2017 – Photovoltaic system performance – monitoring.

6. Documentation

6.1 Construction Drawings

Documentation is to be submitted for the design, quality assurance and final construction of the balance of plant works.

Where noted, documents are to be provided in the local language as well as English, and on a per-installation basis.

Typical deliverables are listed below. These are specific to the Solar PV plant.

	Deliverable	**Typical revisions (IFU=issued for use; IFC=issued for construction)**	**Local languag e version**	**Per-installatio n**
1	**DESIGN**	**Within One (1) month after EFFECTIVE DATE**		
a	Basis of design report, including attachments, detailed functional specifications for the Solar PV Plant	80%		Yes
b	AC and DC electrical single line diagrams	30% / 80%		Yes
2	**DESIGN**	**Within four (4) months after the EFFECTIVE DATE**		
a	Design drawing package to include, at a minimum:			Yes
b	Basis of design report, including attachments, detailed functional specifications for the Solar PV Plant	IFU		Yes
c	Site layout	30% / 80% / IFC		Yes
d	Sub-surface works layout	80% / IFC		Yes
e	Earthworks	30% / 80% / IFC		Yes
f	Drainage and stormwater management	30% / 80% / IFC		Yes
g	Detailed drawings of the Solar PV Plant	30% / 80% / IFC		Yes
h	Inverter and transformer General Arrangement	80% / IFC		Yes
i	Detailed layout drawings of switchboards and panels and electrical fit-out	80% / IFC		Yes

	Deliverable	Typical revisions (IFU=issued for use; IFC=issued for construction)	Local languag e version	Per-installatio n
j	AC and DC electrical single line diagrams	IFC		Yes
k	Electrical schematics of all systems	80% / IFC		Yes
l	Solar PV Plant structural designs (piles and footings)	30% / 80% / IFC		Yes
m	Protection details	80% / IFC		Yes
n	Earthing drawings	30% / 80% / IFC		Yes
o	Cable tray section drawings	30% / 80% / IFC		Yes
p	Details of interconnection	80% / IFC		Yes
q	Details of auxiliary power distribution	30% / 80% / IFC		Yes
r	Communications network drawing	30% / 80% / IFC		Yes
s	Electrical, Mechanical and Civil Specifications documents, including detailed installation and materials compliance requirements	80% / IFC		
t	Protection single line diagram	30% / 80% / IFC		Yes
u	Equipment schedules for the following, at a minimum	80% / IFC		Yes
v	Cable schedule, including terminations	80% / IFC		Yes
w	EMC Report	80% / IFC		Yes
x	Protection equipment and ratings schedule	80% / IFC		Yes
3	**Studies:**			
a	Arc Flash	80%		
b	Insulation Coordination	80%		
c	Protection and Coordination	80%		
d	Earthing study	30% / 80%		
e	Cable sizing calculations	30% / 80% / IFC		
f	Short circuit study	80%		
g	Safety in Design	30% / 80% / IFC		

7. Spare Parts and Tools

All the spare parts supplied shall be of the same material/workmanship and interchangeable with the corresponding parts of the executed work, protected against corrosion and marked Approved with identification labels.

All tools supplied shall be of a high quality and fit for purpose and include:

- All tools and instruments specifically listed in the scope of works
- All accessories required for maintenance of the system
- Any customary and special tools, as well as auxiliary devices, i.e. lifting devices, ropes, etc., necessary for assembly and disassembly of all parts.
- Special tools designed and supplied for the project can be used by the Contractor during erection and handed over to the Employer in good working condition without any wear and tear.