1.00 General.

The PV solar power plant system (hybridisable with utility and diesel generator) is intended to supply different essential loads at the field office in Abuja, Nigeria. It will supply, among others, outdoor lighting for security reasons, server equipment, the work station, fireman’s lift, security building, plant room and diesel pump. This project is justified by the unstable power supply network because of which over 52% of the Commission’s energy needs are provided by stand-by generators. The power supply to these essential loads are backed up by a diesel generator which is overstretched particularly at the night and weekend periods. The solar power plant will replace the power supply via utility and diesel generator, and its production surplus will be injected directly into the building to help cut down on the utility bill and the cost for fuel consumption.

1.01. The system should be designed to have at least 1-day autonomy (i.e. can run for a day without charging from the panel).

1.02. The Solar system should be packaged to provide convenient installation at a remote customer site by a qualified technician. The system shall be constructed such that a user can perform routine maintenance easily, and a technician can easily perform system diagnostics or replace components.

2.0 Certification Requirements

2.1 Products to be used for this project (PV Component) must have a type-test certificate from an accredited testing and certification organization as elaborated in Annex-1. For local products, a certification from an authorized institution is acceptable. In case the AFDB authority feels, they may ask for sample test of any component from those aforesaid institutions.

2.2 The supplier provides the most appropriate system integration, components, assembly and packaging that meet all the component specifications in Annex-1: Solar System Component Specifications’ and the ‘Recommended Practices’ described below.

3.0 Recommended Practices

This section provides a minimum set of requirements that shall be followed in the design, specification and installation of the qualified solar plant. They form a set of “Recommended Practices” which when followed will ensure adequate levels of safety, performance, reliability and system lifetime.

3.1 PV Module Installation

PV module installation refers to the following:

1. If more than one module is used, identical models shall be used, and they shall be connected in parallel.
2. For the system installed permanently on a structure (in contrast with portable units), the following must be observed:

   a. The modules must ensure waterproof sealing for the solar cells. Modules must be framed in such a way as to allow secure connection to the module mounting structure.

   b. The mounting structure will hold the photovoltaic module(s). The module(s) must be mounted on a support structure made of corrosion resistant material that assures stable and secure attachment.

3. The PV array and support structure must be able to withstand wind gusts up to 160 km/hour without damage.

4. The structure must be mounted at a fixed angle and oriented to maximize the useful energy supplied to the user over the year (for AFDB Abuja, the panel should be facing south with a tilt angle of around 6 degrees with the horizon).

5. The structure will incorporate corrosion resistant hardware for all external connections.

6. The modules can be roof or ground-mounted: In case of roof-mounted modules, minimum clearance between the PV module and the roofing material must be at least 20 cm. For pole mounted modules it is recommended that the module mounting structure be supported on top of a pole of at least 5m height. The mounting structure must be anchored to the building and not to the roofing material. For ground-mounted modules, a metal, concrete or treated wood pole must be used with the modules to be placed at the top of the pole. The modules must be at least 4 meters off the ground and the pole must be anchored in concrete or tightly packed soil at least one meter deep in the ground. The pole and mounting structure must be sufficiently rigid to prevent twisting by the wind or if large birds alight on the module.

7. The panel should be mounted clear of vegetation, trees and structure so as to assure that they are free of shadow throughout daylight hours during each season of the year. Furthermore, if more than one panel is mounted on a support structure the panels should not be mounted such that one panel will not shade the other module(s).

3.2 Circuit Protection and Charge Controls

Circuit protection and charge controls include the following:

   Systems must include a mean to protect users and system components from the following:

1. Battery overcharge and excessive water loss.

2. Battery undercharge and excessive discharge.


4. Circuit protection against reverse polarity of module or battery.

5. Circuit protection against internal shorts in charge controller, inverter or other devices.

6. Circuit protection against damage by the high PV open circuit voltage when it is connected to the controller without battery.
7. Night time discharge of the battery due to reverse current through the module.

8. Systems will provide appropriate protection by a charge controller incorporating a high voltage disconnect (HVD), low voltage disconnect (LVD) and circuit protection.

3.3 System Monitoring

System monitoring includes the following:

1. A display to indicate when the battery is in the charging mode must be provided.

2. This device must, at a minimum, indicate when the battery condition is:
   3. Suitable to operate loads
   4. Energy conservation required
   5. The chosen device must come appropriately labelled such that the user does not have to refer to a manual to understand the existing battery condition.

3.4 Batteries

Recommended practices for batteries include the following:

1. Batteries should be selected to offer at least seven years of useful life.

2. The batteries can be supplied in a dry-charged condition and all chemicals and electrolyte must be supplied in accordance with battery supplier specifications. The battery and associated containers should be packaged to handle transport down rough roads.

3.5 Equipment Enclosure

Regarding equipment enclosure, recommended practices comprise the following:

1. The batteries and charge controller should be kept in properly designed protective enclosures.

2. The batteries must be housed in a vented compartment. All parts of the compartment subject to battery acid contact must be acid resistant. This compartment must be built strong enough to accommodate the weight of the battery. Access to the battery compartment by children must be prevented.

3.6 Wiring

Wiring practices include the following:

1. Stranded and flexible insulated copper wiring must be used. Sample of wires for the sub circuits are as follows:
   • From PV module to Charge Controller
   • From Charge Controller to battery
   • From Charge Controller to Socket Out-let
   • From Charge Controller to all other loads
     : 6.0 sq. mm
     : 6.0 sq. mm
     : 4.0 sq. mm
     : 2.5 sq. mm.

See BOQ’s and schematics for details.
2. All wiring must be sized to keep line voltage losses to less than 2% including each sub-circuit and to allow the circuit to operate within the rating of the wire. It is to be noted that cables used for wiring must have three years of warranty. The submitted test report from enlisted testing facilities must have insulation and resistance test results.

3. For system permanently installed on a structure, all exposed wiring (except for the module interconnects) must be in conduits or be firmly fastened to the building structure. Wiring through roofing, walls and other structures must be protected using bushings. Wiring through roofing must form a waterproof seal.

4. Field-installed wiring must be joined using terminal strips or screw connectors. Soldering or crimping in the field must be avoided if possible. Wire knots are not allowed. The rated current carrying capacity of the joint must not be less than the circuit current rating. All connections must be made in junction boxes. Fittings for lights, switches, and socket outlets may be used as junction boxes where practical.

3.7 Documentation
The component specifications should be summarized by the interested supplier in the form attached in Annex-2 - Solar Home System Specification Data Sheet along with the required test certificates. Any exceptions and variations to the specifications must be explicitly stated in a section entitled Exceptions and Variations in Annex-2. The scope and reasons for each listed exception and variation must be fully explained with supporting data.

The supplier must provide a User's Manual intended for the customers and will be included with each of the packaged systems. The manual must be in English. The User’s Manual documentation should be simple and easy to understand. Sketches or graphics should be used to make the manual easy to understand. The documentation is to include the following:

1. How the system works: battery charging by the array, functions, battery low voltage protection, and battery overcharge protection. The relationship between energy available daily and sunlight conditions should be clearly and simply explained.

2. A description of all user interactive hardware including disconnect switches and status indicators.

3. Procedures for proper system operation, including a list of load limitations and any problem loads. These procedures should include suggested operation, including load conservation during periods of inclement weather, and/or a low voltage disconnect event. The adverse effect of panel shading and the importance of preventing it must be explained.

4. Any user maintenance items.

5. Emergency shut down procedures and recommendations for extended periods of system non-use.

6. A user trouble-shooting guide.

7. A block diagram showing the main components.

5. Technicians/Technical Manual
The supplier must provide a Technician’s Installation, Operations and Maintenance Manual to be used by the service technicians. The manual must be in English. The manual will include the specific details on installation, operation and maintenance, such as:

1. A detailed technical description of the system.
3. A complete list of all system components, with associated manufacturers literature, specifications, and warranties.
5. Recommended post-installation acceptance test procedures, including all appropriate set points and test procedures. They will include:
6. Verification of the installation of the photovoltaic array with regard to position, direction, inclination and shading avoidance to maximize energy generation.
7. Test all of the loads for proper operation.
8. Make system-wide voltage drop measurements in the sub-circuits to verify that connections meet the required maximum allowable voltage drop.
9. Note all measurements in the installation log.
10. Explain to the user the system operating principles, load management requirements, impact of shading of the array and how to check and avoid it, user maintenance checks and how to conduct them.
11. A recommended annual maintenance schedule, with complete maintenance instructions.
12. A functional block diagram, electrical single-line drawing showing the placement of all hardware and ratings of all component and physical layout diagram.

6. Packaging and Delivery

1. The system supplier/PO must obtain the PV system equipment and components, assemble and wire them into integrated packaged system in accordance with the proposed design, and deliver the packaged system to the user.
2. Each system must be packaged to prevent any shipping related damage. The supplier/PO will be responsible for settling any shipping related damaged claims and will be responsible for replacing damaged systems in a timely manner.

7. Maintenance

The supplier/PO must have the manpower and technical capability to trouble shoot and maintain the systems installed.
Annex-1

The Systems Component Specifications

1. General

1.1 The supplier will provide at a minimum of six-month warranty against manufacturers’ defects on all system-integrated parts and labor excluding fuses or end-use devices such as luminaries or lamps. On all major individual components, manufacturers’ warranties will be passed through to the user for AFDB. Specifically, the PV modules should be warranted for at least twenty (20) years and must not experience more than 20 percent of rated capacity reduction in output over its lifetime. The charge controller, switches-socket and other accessories-appliances should be warranted for at least three years. The pole mount module supporting structure set with fitting and fixture should be warranted for 10 years. The battery should be warranted for at least seven (7) years. Battery end-of-life will be determined when the battery capacity down to 1.75 V/cell at 25°C drops to less than 80 percent of the initial rated capacity. All warranties become effective from the day the system is accepted by the user for AFDB. POs will prepare one invoice for all the equipment sold to the customer and make two copies of that invoice; one to share with customer and another to preserve for their own office use.

1.2 Nominal system voltage (rated voltage) shall be 48 Vdc.

1.3 The main components should be integrated in such a way as to allow replacement (in case of failure) with a similarly functioning component of a newer design or a different brand. This will allow for future component evolution or variability of future component availability.

1.4. Each of the approved models of the components like solar panel, battery, charge controller, connecting wires/cables, lamps and LEDs with their inverters/controller circuits should be tested from AFDB approved testing agencies every year (as per AFDB schedule).

All components, including spares, will undergo full bench testing at the supplier factory or the originating source factory with proper documentation supplied. All electrical settings (voltages, current, etc.) will be verified and documented with the results dated and the records maintained at the suppliers facility.

2. Operating Environment

2.1 PV module should be able to withstand under the climate conditions stated below: -

<table>
<thead>
<tr>
<th>Particular</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>Tropical, intense sunshine, heavy rain</td>
</tr>
<tr>
<td>Maximum Temperature</td>
<td>45°C</td>
</tr>
<tr>
<td>Relative Humidity</td>
<td>&gt;90%</td>
</tr>
<tr>
<td>Average annual rainfall</td>
<td>3000 mm</td>
</tr>
<tr>
<td>Maximum wind velocity</td>
<td>160 km/hour</td>
</tr>
<tr>
<td>Altitude</td>
<td>As per site</td>
</tr>
<tr>
<td>Atmospherical, Mechanical and chemical impurities</td>
<td>Moderately polluted</td>
</tr>
</tbody>
</table>

2.2 All wiring, enclosures, and fixtures that are mounted indoors must be resistant to high humidity conditions, corrosion, insect, salinity and dust intrusion.
3. Photovoltaic Module

The following are applicable standards for PV modules:

- International Electrotechnical Committee (IEC) 61215: Crystalline Silicon Terrestrial PV Modules Design Qualification and Type Approval
- IEC 61646: Thin Film Silicon Terrestrial PV Modules Design Qualification and Type Approval IEC 60904-1: Photovoltaic Devices Part 1 Measurement of PV Current-Voltage Characteristics
- IEEE 1262: Recommended Practice for Qualification of Photovoltaic Modules
- PV GAP Recommended Standards are preferred.

3.1 The photovoltaic array will consist of one or more flat-plate photovoltaic modules. Each module should comprise of no less than 20 series-connected single or poly-crystalline silicon solar cells. Flat plate thin-film modules could also be used.

3.2 The photovoltaic module should have a peak power output of at least 350 Wp.

3.3 All modules must be product tested and certified.

3.4 Each module must be factory equipped with weatherproof junction box with terminal strip that allows safe and long-lasting wiring connection to the module. Where applicable, protective diodes should be used to avoid the effect of partial shading.

1.5 Each module must be labelled indicating at a minimum: Manufacturer, Model Number, Serial Number, Peak Watt Rating, Voltage and Current at peak power, Open Circuit Voltage and Short Circuit Current of each module.

PV field design simulation must be attached for modules made of amorphous silicon or thin layer cells.

- For manufacturing tolerances, a module’s real peak power must be no less than 90% of its nominal peak power;
- Cells’ maximum power output at 60°C junction temperature must be higher than 88% of nominal power;
- Voltage at module’s maximum power point (MPP) at 60°C junction temperature must be higher than 16V;
- Modules must include IP54 watertight casing(s) housing the terminal blocks. Casings must be equipped with cable glands to facilitate cables passage. Terminals’ polarity must be clearly indicated inside the casing;
- Each module must include a by-pass protective diode and series of diodes,
- Each PV module must include a nameplate containing at least the following information:
  - Manufacturer’s name, monogram or symbol
  - Model number or reference
  - Power-peak (Wp), short-circuit current (A), open circuit voltage (V) for STC Conditions
  - Serial number
  - Country of manufacture

Modules of the same field must be in the same category and interchangeable, i.e. with the same nominal power and size.
A category of modules’ nominal power must be higher or equal to 200Wc; ratings must be indicated in standard conditions (STC) as defined in IEC 61215 and IEC 60904-3.
Modules of the same field must be in the same category and interchangeable, i.e. with the same nominal power and size.

**Warranty:**

**A. Two (2) Year Limited PV Module Warranty**

PV Modules(s) should be warranted to be free from the defects and/or failures specified below for a period not exceeding two (2) years from the date of sale to the original customer:

1) defects and/or failures due to manufacturing;
2) defects and/or failures due to materials;
3) cracking of the front glass surface due to foreign objects inside the glass; or
4) non-conformity with specifications due to faulty manufacturing and/or inspection processes.

If the PV Module(s) fails to conform to this warranty, PV module(s) should be immediately replaced.

**B. Limited Power Output Warranty**

Any power loss is due solely to defects in materials or workmanship; AFDB demands the warranty of the power output of each type of PV Modules(s) as follows:

**20 years (90% / 80%)**

AFDB demands that if, (a) within the first ten (10) years from the date of sale to the Customer, the PV Modules(s) exhibits a power output of less than ninety percent (90%) of the original minimum rated power specified at the time of sale, or (b) within twenty (20) years from the date of less than eighty percent (80%) of the original minimum rated power specified at the time of sale, manufacturer will repair, fix (by putting additional panel) or replace the PV Modules(s) at their own cost or refund the Purchase Price taking into account a yearly depreciation of five percent (5%) of the panel price. In case of the refund of the depreciated price of the panel, the panel will remain with the user and company will not take it from him/her. The period of power output warranty for these replaced modules(s) will be equal to the remaining warranty period of the originally supplied module(s). Notably, respective POs will be responsible to arrange all the warranty services from the respective suppliers.

**4. Battery Storage**

4.1 a) The battery should be 48V block, rechargeable flooded lead-acid battery (Lead-antimony grid), heavy duty plate construction, deep-cycle, tubular positive plate should include explosion-proof safety vent, carrying handle. The positive plate must be of tubular type.

4.1 b) Any other type of battery could be accepted if the manufacturer agrees to provide 7 years of warranty and complies with other issues.

4.2 The maximum permissible self-discharge rate is 8 percent of rated capacity per month at 25°C.
4.3 Cycle life of the battery (i.e., before its residual life drops below 80 percent of the rated AH capacity), at 25 degree C must exceed 2500 cycles when discharged down to an average depth of discharge (DOD) of 50 percent at the discharge rate of 10 hours.

4.4 The inter-cell connection should not be exposed.

4.5 Size of the battery in AH should not be more than 1.8 times of panel size in Watt peak i.e. for 50wp panel battery size should not be more than 75Ah.

The following shall be considered:

- 2V nominal tension per cell,
- 3000Ah /C100 nominal capacity, that is 5kWh per cell,
- 886kWh battery bank total capacity,
- stationnary batteries in positive gel tubular plates or batteries in liquid tube plates suitable for use with PV systems,
- life cycle: between 15 to 20 years in charge retention mode (floating) at 20°C for 1,600 cycles at 80%, discharge at 20 °C,
- auto discharge rate at 25°C should not exceed 5% of the nominal capacity per month,
- the battery case should be strong and solid enough to withstand transport and handling,
- for non-gel electrolyte batteries, the user should be able to easily check the electrolyte level in the batteries – there should be minimum and maximum levels markings on translucent cases
- each battery should have a data plate containing the following minimum information:
  - Voltage,
  - manufacturer’s or supplier’s product reference,
  - capacity, with mention of the characteristics expressed by current type or discharge time,
  - manufacturer’s or supplier’s name,
  - electrolyte density (for fully-charged battery at a reference temperature),
  - manufacturing date (month and year)
- stationary battery cells should, at the minimum, bear polarity markings for the positive terminal.

Markings: symbols used for marking the polarity should correspond to IEC 417

The marking will be by way of the symbol +, embossed or stamped, on the cover close to the positive terminal.

If the negative terminal is also marked, this will be with the symbol -, embossed or stamped, on the cover close to the negative terminal.

- batteries shall be delivered with a protective housing for the terminals
- dry charged batteries shall be delivered with the necessary quantity of electrolytes. The volume of electrolytes should be higher than 1.15 litres per 100 Ah of C20 nominal capacity and per cell for electrolyte batteries.

Electrolyte: electrolyte specifications shall conform to the DIN 43530 standard (for non-gel electrolyte batteries)

Electrolyte nominal density for lead batteries shall be specified according to the battery manufacturer’s applications and in relation to nominal temperature. Electrolyte density shall not exceed 1.24 kg/l at 20°C. Electrolyte volume shall exceed 1.15 litres per 100 Ah of nominal capacity per cell.

The quality of the electrolyte shall be checked against DIN 43530 for the synthesis/comboination parameters, electrolyte purity and characteristics.
Warranty:

Battery capacity will not be less than 80 percent of the rated capacity over the period for 7 years for systems above 350Wp. In case of failure of the battery before the warranty period, the battery should be replaced.

5. Charge Controller & Energy Metering

5.1 Charge controller

5.1.1. The charge controller set points must be factory preset with the set points applicable to the specified battery characteristics. Charge Controllers should be dust and termite proof.

5.1.2. The charge controller input current rating must be greater than 120% of the module's rated short circuit current.

5.1.3. Maximum current draw of the controller, when no LED’s are lit should not exceed 20 mA and 50 mA with LED.

5.1.4. The model number, serial number, rated voltages and currents, and set points should be printed on the visible side of the charge controller casing.

5.1.5. Battery, high voltage disconnects 14.3±0.2 volts (for lead acid batteries), or as specified by the manufacturer. Charge controller specifications must include the type of the battery to be used with it.

5.1.6. Reverse current leakage protection is recommended. Blocking diodes or logic-derived methods are both acceptable. If blocking diodes are used, they must exhibit a low forward voltage drop.

5.1.7. The system must be protected against damage caused by short circuit at panel terminals and load terminals when battery is connected to the charge controller, and reverse polarity of battery or panel connections. Over-current protection must be provided. Lightning induced surge protection is recommended.

5.1.8. Some means must be provided to safely disconnect the battery and the module during servicing or repair by a technician.

5.1.9. The load must be controlled by a low voltage disconnect (LVD) device. The LVD must be capable of handling at least 150 percent of the maximum expected continuous load (e.g., assuming all end use devices are simultaneously on). It should be factory preset to disconnect and reconnect voltages corresponding to the safe operation of the battery under ambient temperature conditions. For example, for a lead acid battery, a disconnect voltage of 11.6 Vdc +/- 0.1 Vdc and reconnect voltage of 12.6 Vdc +/- 0.2 Vdc is required.

5.1.10 Each charge controller should be capable of handling at least 120 percent of the rated current at PV, battery and load terminals for at least for 1 hour without being damaged. Overload of Charge Controller will be the actual current that exceeds 120% of the rated current.

5.1.11 Charge Controller should be capable of withstanding 25V at PV terminal when battery and load is disconnected.
5.1.12 The technical specification of the charge controller must mention the input voltage range (PV panel side), input current (PV panel side), battery nominal voltage, LVD and HVD, rated output current (load side).

5.1.13 The panel must have reverse polarity protection, output short circuit and over load protection.

5.1.14 Efficiency of the charge controller should be at least 90%.

**Warranty:**

Charge controller or energy meter should be replaced in case of any performance deviation from the specifications mentioned above over the period of 3 years.

5.2 Energy metering:

Energy metering will be mandatory for 2% of the systems. Each of the POs must keep a track of their installed systems and use energy meters on 2% of their system installed. DC energy meters, either to be connected separately or built within the charge controller have to be used. The energy meters should have non-volatile memory so that the data does not get erased in case of disconnection from the power source. Both input (on the panel side) and output energy (on the load side) needs to be metered. Accuracy of the energy meters should be such that inaccuracy in the readings should be less than 0.5%.

**Warranty:**

Energy meter should be replaced in case of any performance deviation from the specifications mentioned above over the period of 3 years.

6. DC to DC Converter

6.1. The rated input voltage will be determined by the proposed system (like 12V, 24V or 48V etc.) and the rated output voltage should be maintained within the range of 110V-240V.

6.2. The tolerance of the rated output voltage should be ±5% and must not be lower than 110V or higher than 240V.

6.3. The Efficiency of the Converter at rated input voltage and rated load should be 90% or higher at the ambient temperature condition.

6.4. Self-consumption of the DC-DC converter should be measured in no load condition at the rated input voltage and should not exceed 25 mA.

6.5. The DC-DC converter must be able to withstand 50% higher voltage (rated voltage) at the battery terminals.
7.0 DC-DC converter has built in charge controller:

Technical solutions allowing for the use of an inverter with the charge regulator will also be accepted. The charge regulator will serve to protect the battery bank against excessive surcharge and discharge.

The regulator shall have the following characteristics:
- voltage: depending on the output voltage of the modules (48 Volts plus)
- Current module: TBA
- Current use: TBA
- the regulator must operate under the control mode PWM (pulse wave modulation)
- disconnection and reconnection of threshold voltages of the PV generator and the use assigned to the regulator must be set according to actual environmental conditions and the battery type. The bidder shall set out in detail in the annex regulator control the thresholds proposed
- reference values for 20°C temperature and for those with electrolytes, an electrolyte density of 1.24 kg/l are as follows:
  - final charge voltage: \( V = 2.3 \text{ Volts} \)
  - end of discharge voltage: \( V = 1.9 \text{ Volts} \)
  - use reconnection voltage: \( V = 2.1 \text{ Volts} \)

The values can change slightly if the manufacturer’s data differs from the above-mentioned; the regulator shall conform to manufacturer’s instructions.

- the regulator must be equipped with a temperature compensation device for the end of charge voltage the correction factor to be applied is from -4 to -5 mV/°C per battery cell
- the regulator’s idle load consumption must not exceed 6mA regardless of the operating conditions
- regulator must withstand damage or be protected against the following accidental events
  - reverse polarity connection to the battery and module(s) on the regulator
  - short circuit on use: this protection can be provided by a fuse or similar device which the user can replace without having to open the regulator case
  - surges induced at the input modules or output use point (lightning)
  - any “no battery” operating situation, the photovoltaic module(s) being connected to the regulator,
  - the regulator must withstand without damage an input current 25% higher than the short circuit current of the PV generator, and an output current use 25% higher than the maximum rated current (all devices turned on) of the PV system for a period to be specified by the supplier,
- the regulator shall protect the module against battery discharge at night
- the regulator shall not cause interference to radio frequencies regardless of the operating conditions,
- the regulator casing shall have the following characteristics
  - the degree of protection is at least IP54
  - it includes a wall mounting system
  - the printed circuit board is mechanically secured to the regulator casing (clips or screws)
the charge regulator must be equipped with LED type or equivalent battery charge indicators, providing the user with the following minimum information:
  - system ready for use, sufficient battery charge
  - use disconnected, battery charge too low
  - indicators for the following settings will be checked:
    - input voltage of the charge regulator
    - output voltage of the charge regulator
    - input current of the charge regulator
    - output current of the charge regulator
  - the regulator shall be equipped if possible, with an indicator warning of imminent discharge
  - the regulator shall have a data plate with the following minimum information:
    - manufacturer name, insignia or symbol
    - model number or reference
    - connection plan
    - rated voltage (V)
    - nominal current at input module and output use point (A)
  - the regulator shall have a permanent marking showing the + or – polarity of every electrical connection terminal
  - the regulator terminal blocks must be inaccessible to users,
  - the system should include lightning protection

The sizing was done for modules made of monocrystalline silicon or polycrystalline cells. In the case where the modules are made of amorphous silicon or thin film cells, the simulation for the design must be attached.

**Warranty:**

Warranty for a DC to DC Converter should be 3 years.

### 8.0 PV Inverter

The inverter should be suitable for operation in a hybrid system and allow for the battery bank to be recharged through the solar field and also with the generator. It must thus be bidirectional. The inverter may come as a single-piece inverter or several inverters capable of operating in master and slave mode. Bidders shall clearly explain the operating mode of the inverters proposed and the total capacity must meet the requirements.

25 kW rated power reversible inverter,
Overload, overheating and under voltage protection
Programmable voltage thresholds
Nominal input voltage: 48 V DC or higher (or based on the modules output voltage)
Output voltage: 380-400 Volt / 50 Hz (three-phase) will be used in single-phase mode
Protection index: IP 65
Temperature sensor
Consumption: the no load consumption shall not exceed 3% of the inverter’s nominal current
- output waveform frequency should be maintained within the 50 Hz +/- 5% range
- harmonic distortion of the output voltage
- noise level: this should not exceed 65 dB within 3 meters of an inverter in operation
- input voltage range:
  o the inverter must be able to function normally within the input voltage range of 90% to 120% of rated voltage. The output voltage must be maintained under these conditions within the range of 240 V +/- 10%
  o the inverter must meet the standards for electromagnetic compatibility defined as the capacity of a device, equipment or system to function satisfactorily in its electromagnetic environment without introducing intolerable electromagnetic disturbance to anything within this environment
  o Tests will be conducted in accordance with standards:
    ▪ IEC 725
    ▪ IEC 1000,2,2
    ▪ EN 61000-3-2
    ▪ EN 61000-3-3
    ▪ EN 61000-4-11

The sizing is for modules made of monocrystalline silicon or polycrystalline cells.
In the case where the modules are made of amorphous silicon or thin film cells, the design simulation must be included.

Marking
The inverter shall have a permanent data plate with the following details:
- manufacturer’s name
- inverter type/model
- serial number
- nominal input voltage
- rated input current
- nominal output voltage
- rated output current
- polarity marks at the connection points

The inverter must have a performance data acquisition system in real time for the PV generator and transmit same via the Internet. Maintenance team should be able to need access the information on output, possible errors, etc. over the internet using their computers.
Remote management and monitoring of the system capability is required

Documentation
Inverters shall be supplied with an installation and operating manual containing:
- technical features of the charge regulator,
- temperature range ensuring nominal operation of the inverter,
- protection class of the casing,
- Safety instructions
- Installation instructions
- Operating instructions
- Maintenance instructions
- Troubleshooting instructions
- Commercial guarantee
9.0 Warranty
Warranty shall start from the date of provisional acceptance of the equipment supplied, installed and commissioned. Warranty periods covering material, manufacture or assembly and component performance defects shall be as follows:

- For photovoltaic modules, the product warranty shall be 20 years minimum and shall cover defects on the characteristics as stipulated under the qualification tests performed in accordance with IEC-61215 standard. Modules performance must be above 90% for the first 10 years and above 80% after the first 10 years of operation.
- For batteries, warranty shall be 7 years minimum with performances above 80%.
- For structures - support, accessories and cabling, warranty shall be 15 years minimum.
- For inverters and other accessories, minimum warranty shall be 10 years.

However, warranty shall be fully applicable in the event of improper installation, detected or otherwise, during the provisional acceptance and shall remain under the exclusive responsibility of the holder.

Damages resulting from acts of war, riots and vandalism and natural disasters shall not be covered by the warranty.

To delineate his responsibilities, the Bidder shall clearly indicate the possible limitations to the application of the warranties and concerning third party interventions. Any restriction other than those relating to third party intervention and those specified in this section, shall be rejected and might render the offer non-compliant.

All costs relating to the services associated with these warranties shall be included in the contract.

10.0 Technical warranty
The Bidder must ensure the PV modules’ peak power (Wp) will not degrade (compared to the nominal peak power) more than:

- 10% over the first 10 years of operation with effect from the provisional acceptance;
- 20% in 20 years of operation following provisional acceptance;

He must meet all performances listed above (Paragraph on warranty conditions).

11.0 Quality of service
The Bidder must provide information on the international standards he holds and provide supporting documents (ISO9001, ISO 14001 of equivalent).
Annex-2

Solar System Specification Sheet

**Photovoltaic Module(s)**

(a) Model number

(b) Type (a-Si, Mono/Poly Crystalline Si, etc.)

(c) Number of cells in series

(d) Open circuit voltage (Voc) V

(e) Short circuit current (Isc) A

(f) Rated peak power (Pmax) Wp at STC, (Standard Testing Conditions)

(g) Vmax V

(h) Imax I

(i) NOCT (Nominal Operating Cell Temperature) deg C

• Short Circuit Current Temp. Co efficient mA/oC

• Open Circuit Voltage Temp. Co efficient mA/oC

• Frame: The laminate should be fitted with a corrosion and torsion resistant anodised aluminium frame with extremely high mechanical stability and convenient mounting access.

• JUNCTION Box: Weatherproof, suitable cable entry inlets/outlets, external grounding screw, +ve and -ve terminal mark, UL/IEC certification.

(j) Test certification standard
(k) Test laboratory

(Please attach I-V Curve and copy of test certificates, if not supplied already.)

Support Structure
(a) Type ___________________________(roof/pole)
(b) Wind velocity withstand capacity

__________________________ km/h

(c) Material ________________________________

Battery Storage
(a) Model number ____________________________

(b) Nominal voltage

__________________________________________ V

• Battery low voltage

__________________________________________ V

• Battery Gassing Voltage

__________________________________________ V

• Max. Charging Current (Continuous)

__________________________________________ A

• Max. Discharging Current (Continuous)

__________________________________________ A

(c) Structure and material of positive plate

________________________

(i) Positive plate thickness ____________________ mm

(ii) Negative plate thickness ____________________ mm

(d) Capacity per battery at C/10 down to 1.75/cell

__________________________________________ Ah

(e) Self discharge rate

__________________________________________ (%/month)

(f) Cycle life down to 75 percent of DOD

________________________

(g) Electrolyte volume

(Charge Regulator and Load Control)

(a) Model number

(b) Rated voltage

(c) High voltage disconnect

(i) Voltage regulation set point (Vr)

(ii) Reconnect voltage (Vrr)

(d) Charging indicator?

• Battery Status

• Charging Status

• System Connection status

• Other (specify)

(e) Maximum current handling capacity

(f) Type of current leakage protection

(g) Voltage drop between module and battery terminals at controller/regulator

(h) Temperature compensation?

(i) LVD maximum current handling capacity

(j) LVD set points
(i) Disconnect voltage
___________________________________________V

(ii) Reconnect voltage
___________________________________________V

(k) Current draw with and without LEDs ______________________, mA
____________________mA

(l) Short circuit protection?
___________________________________________(Yes/No)

(m) Reverse polarity protection?
___________________________________________(Yes/No)

(n) Electronic over current protection
___________________________________________(Yes/No)

(o) Lightning surge protection?
___________________________________________(Yes/No)

(Please copy of test certificates, if not supplied already.)

System Monitoring
(a) Battery State-of-Charge indicator?
___________________________________________(Yes/No)

(b) Type of indicator
___________________________________________

(c) Indicator settings

(i) Fully charged suitable to use
___________________________________________V

(ii) Energy conservation
___________________________________________V

(iii) Other (explain)
___________________________________________

Equipment Enclosure
(a) Type of battery enclosure

• Material
___________________________________________

(b) Type of controller housing
___________________________________________

• Material
___________________________________________
Protection method against battery acid/fumes etc.

Wiring
(a) Wire material type

Wire cross-sections
(b) PV module to controller

• Voltage loss factor

• Insulation type

(c) Controller to battery

• Voltage loss factor

• Insulation type

(d) Controller to loads

• Voltage loss factor

• Insulation type

Lengths of wired supplied?

Other Components/Features
(a)

(b)

(c)

(d)

(e)
Exceptions and Variations to the Specifications Taken and Explanations

(a)

(b)

(c)

(d)

(e)