Appendix One, Implementation Conditions and Technical Instructions, Installation of photovoltaic systems:

General description of services and technical specifications

Clause "z" Note "9" of the Law 1393

Employer:

University of Medical Sciences

(Shahid Mohammad Montazeri Hospital, Najafabad)

Supervisory Body:

Technical management of the university

2019

Overview of service work

Design, supply and providing the equipment, construction, installation and commissioning of photovoltaic system of the type connected to the hospital network is a maximum power of "system" for twenty (20) kW. In this project, the employer is Shahid Mohammad Montazeri Hospital and the technical management of the university is as the supervisory body.

1) Preliminary measures

Preliminary visit to the site to make the necessary estimates, determine the proposed and initial location, check the condition of the site in terms of the sun environment and suitable space for installation, protection and safety of the building for construction, are among the initial measures taken in this regard.

2) Design operations:

In this part, operations related to designing a 20 kW system, preparing technical specifications and executive plans, selecting equipment such as solar panels, inverter (inverters), designing structures and supporting bases based on selecting the necessary cables, accessories and panels as well as the necessary equipment to connect to the network, will be provided by the winner of the tender.

3) Description of procurement operations:

Purchasing of equipment including panels, inverters, retaining structures with concrete foundations (if necessary), cables and related pipes and other accessories, switchboards, fuses and switches, preparation of hospital connection switchboards and necessary cabling as well as providing the ground system with accessories.

4) Description of installation operations:

Includes Final visit to the designated location, inspection and determination of the final location to install the system, installation and commissioning operations, installation of structures and concrete foundations (if necessary), installation of solar panels, wiring, cabling panels with Necessary ducts, pipes and related panels, inverter installation, installation of necessary panels with equipment to connect to the hospital network, implementation of the required ground system, commissioning of the entire system including commissioning of DC and AC departments.

The winner of the tender must submit their detailed plan to the supervisory body within one week from the exchange of the memorandum.

Note: The final form and status will be payable after the work completion and the approval of the employer, the supervisory body and the regional distribution company on the correct execution and injection of electrical energy into the hospital network.

Technical specifications of the equipment

In this section, general technical specifications considered to select the equipment, are presented separately for components and equipment.

A) General technical specifications to select a photovoltaic panel

an important point regarding the selection of photovoltaic modules to use in this project is as follow:

1) Photovoltaic panel used crystal technology

- Manufacturing technology of poly or mono crystal type

- The cumulative power of photovoltaic panels, in STC standard conditions, should be equal to the system power of about twenty (20) kW.

- The panel efficiency should be at least 14%.

- Filled Factor of modules should be more than 70%.

- The power of the selected panel should be from 200 to 350 watts made inside.

- Static load capacity should be equal to 4 Newtons per square meter.

- Operating temperature should be from -40 to 80 degrees Celsius.

- Modules must be equipped with bypass diodes and blocking diodes.

-The glass on the panel should be made of solar grade.

-The back panel made of composite film should be UV resistant, waterproof and weather resistant.

- Necessary equipment and arrangements for installation should be installed in the protective wall of the selected panels.

- Tolerating environmental and climatic conditions, humidity and frost (compatible with the environmental conditions of the installation site).

- Having valid manufacturing and quality standard certificates according to the National Standard No. 11882 (IEC61215) and National Number 11274-1(61730, IEC).

-Having other international standard certificates L, TUV, VDE, and IEC has a special advantage in selecting modules.

-The panel lifespan and the performance efficiency as well as the panel performance curve should be in accordance with the declared lifespan (preference is given to the panels whose efficiency is 90% over ten years and more than 85% over fifteen years).

-The junction box on the back of the panel should be waterproof. Technical specifications should be in accordance with EN 50548 or DIN V VDE 0126-5.

-electrical connectors should be of MC4 type.

-The panels' number and power should be selected in a way that after serial and parallel processing, the voltage and current of each string be compatible with the input voltage and current characteristics of the selected inverter.

- The catalog and technical specifications of the proposed panel should include the following:

-Physical specifications of the panel include:

- Panel weight
- Panel dimensions
- Protective material for back and front panel walls
- Panel frame
- Static load capacity according to IEC standard
- Panel diagram and panel frame tool location

-Electrical specifications of each panel include:

- Open-circuit voltage
- Maximum voltage at maximum Nominal power
- Short-circuit current
- Maximum current at Nominal power
- Nominal power and performance range in standard conditions
- Interval changes of output power of the panel
- Cell and module efficiency
- Module current voltage curve at different radiation intensities
- Cell thermal coefficient
- Maximum panel voltage (to be closed in series)
- Maximum panel current (to be connected in parallel)
- Technical specifications of the junction box behind the panel (J. B)
- Static panel coefficient of resistance, corrosion resistance, ambient humidity resistance

Note: Obviously, the selected panel in the project will be chosen by comparing the technical specifications submitted by the bidders. Modules with a working class of type A will be given priority.

2) Photovoltaic panel with thin -film technology

-Non-crystalline or thin-layer fabrication technology

- The cumulative power of photovoltaic panels, in STC standard conditions, should be equal to the system power of about twenty (20) kW.

- Panel efficiency should be (at least 9%).

-The power of the selected panel should be at least 50 watts.

-Static load capacity should be equal to 2400 Pascals per square meter.

-Operating temperature should be from -40 to 80 degrees Celsius.

-Necessary equipment should be installed in its protective wall (frame). (In the absence of a protective wall, the bidder must announce the specifications of the appropriate retaining structure in order to install the panel and protect it)

-Moisture and frost tolerance (compatible with the environmental conditions of the installation site)

-Filled Factor of modules should be more than 70%.

-The power of the selected panel should be at least 150 watts (this is due to the ease of installing the system)

-Static load capacity should be equal to 4 Newtons per square meter.

-Modules must be equipped with a bypass diode and a blocking diode.

-The glass on the panel should be made of solar grade.

-Electrical connectors should be of MC4 type.

-Having valid manufacturing and quality standard certificates according to IEC 61646 (IEC61646) and national number 11274-1 (61730IEC).

- Having other international standard certificates L, TUV, VDE, and IEC has a special advantage in selecting modules.

- The lifetime of the performance efficiency and the panel performance curve should be announced.

-The catalog and technical specifications of the proposed panel should include the following.

-The panels' number and power should be selected in a way that after serial and parallel processing, the voltage and current of each string be compatible with the input voltage and current characteristics of the selected inverter.

-Tolerating humid conditions, humidity and frost (compatible with the environmental conditions of the installation site).

-Physical specifications of the panel includes:

-Panel weight and dimensions

-Protective material for back and front panel walls

-Panel frame

-Static load capacity according to standard

-Panel diagram, tools location and panel frame

-Electrical specifications of each panel include:

- Maximum voltage at maximum Nominal power
- Short-circuit current
- Maximum current at Nominal power
- Nominal power and performance range in standard conditions
- Interval changes of output power of the panel
- Cell and module efficiency
- Module current voltage curve at different radiation intensities
- Cell thermal coefficient

-Module current voltage curve at different temperatures

- Maximum panel voltage (to be closed in series)
- Maximum panel current (to be connected in parallel)
- Technical specifications of the junction box behind the panel (J. B)
- Static panel coefficient of resistance, corrosion resistance, ambient humidity resistance

-Warranty period and conditions, replacement guarantee and warranty should be announced by the bidder.

Note: Obviously, the selected panel in the project will be chosen by comparing the technical specifications submitted by the bidders. Modules with a working class of type A will be given priority.

B) General technical specifications of the supporting structure

Placing and bracing of the panel structures at the installation site should be such that the structures do not change location and displacement during the power plant lifespan. The material of the structures should be selected in such a way that it is strong and durable according to the weather conditions of the region, does not suffer from corrosion, rust, twisting and bending, and it is the responsibility of the contractor.

The equipment specifications and fittings used in the supporting structure are as follows.

-All sections, metal fittings, studs and corners are made of hot-dip galvanized iron with ST37 grade or aluminum.

-All steel sections must be heated after galvanizing according to ASTM123 or ISIRI2478 standard.

-All fittings (bolts and nuts) must be galvanized or chromed according to A153 and A325.

-Each of the mentioned structures must be completely secured in a separate package by galvanized belts.

-All fittings (bolts and nuts) with two flat washers and a galvanized spring washer and sufficient spare should be packed and delivered in separate sets.

-If the panels selected in this project, do not have a protective wall (frame), it is necessary to select the appropriate structure and provide the necessary arrangements in the supporting structure to install the panels.

-The minimum height of the structure and the lower edge of the panels from the ground should be considered in the design so that the mud caused by rain does not settle on the panels and it is possible to clean and wash the ground surface.

-The installation angle of the panels on the structure is calculated and installed by the contractor.

-The method of stabilization and restraint of the structure should be such that it is resistant to wind up to 120 km per hour and the weather conditions of the region and snowfall.

-Documents related to the corrosion resistance of the structure must be provided to the employer.

-It is mandatory to provide a diagram and a calculation and technical specifications of the supporting structure book.

C) General technical specifications of the inverter connected to the network

-The technical specifications of the selected inverter are as follows.

-Selected inverter or inverters should be as single-phase or three-phase of the hospital network type.

-Equipped with MPPT system, inverter electrical efficiency should be at least 94%.

-Nominal output voltage in accordance with single-phase or three-phase network

-Input voltage and waveform Injection output voltage, in accordance with the national grid

-50 Hz output frequency (according to the national power grid)

-The inverter should be equipped with a display that displays the specifications and current - status and energy injected into the network.

-Having a minimum frequency tolerance

-The operating temperature range should be appropriate to the climatic and regional conditions of the installation site.

-The degree of device IP protection (if the inverter is installed outdoors and without a roof) must be at least 54.

-Equipped with protection system against telecommunication equipment noise.

-Equipped with Islanding protection system.

-THD% output should be less than 4%.

-Equipped with short-circuit protection system.

-Equipped with ground fault protection system.

-Automatic operation in different conditions (load detection, Standby mode, overload, overvoltage, reconnection).

-Equipped with high temperature or overload prevention system.

-Ability to register, transfer and send system functional information at least through the computer port.

-Displaying the operation status of the device (network connection, power outage, cloudy and no radiation, device failure).

-Having the standard manufacturing certificates and valid quality of the National Standard Medication Chart No. 11859 (IEC 61727) and the international standards IEEEI754, 1741, UL 61000, IEC62109-1, 2, are required and special privileges are considered for other certificates of the relevant standards.

-Providing a replacement warranty certificate for up to 5 years and after-sales service for at least 10 years.

-If the inverter has a DC cut-off switch, it will have more points.

-Dimensions, weight, diagram of inputs and outputs and how to connect, input current range, input voltage range, output frequency range, operating temperature range of the device, power consumption in Standby mode of the proposed device must be provided in the catalog of the proposed device.

-It is mandatory to provide a complete catalog of the offered equipment to the employer and the supervisory body as well as providing valid certificates of the proposed equipment specifications and standards.

- The list of offered main parts and spare parts along with related documents should be presented.

D) General technical specifications of wiring and fittings.

Wiring, ground system and fittings must be in accordance with the method by the supervisory body and the regional electricity distribution company. The size of communication cables should be designed and calculated according to the voltage and current passing. Wiring losses in low voltage and direct current should be maximum 1% to 2% and in alternating current section should be maximum 1%.

-Cables should have an insulation voltage of 0.6 to 1 kW and for wires 450 to 750 volts.

-The connection of photovoltaic modules to the inverter should be done through single-stranded cables.

-Communication cables used to connect photovoltaic modules outdoors, should use standard and suitable outdoor cables with UV Resistant, resistant to climate change and fire.

-Using appropriate color scheme for cables to separate the polarity and phases.

-Using a suitable riser and duct to pass cables and wires in accordance with the standard.

-Using suitable and standard junction boxes and terminals to connect cables and wires to each other.

-It is mandatory not to use adhesive tape for capping.

-Using a suitable DC disconnect switch to connect the photovoltaic modules to the inverter.

-The photovoltaic system at the junction box location, separator and equipment that may be electrified and uncoated while repairing should be labeled with the following warning:

((Warning: risk of electric shock. The conductors of this photovoltaic system may be electrified.))

It is mandatory to provide technical documents, calculations and documentation in this section.

E) Ground system

Grounding is very important in various aspects of safety and protection. In order to protect people and devices, it is necessary to use the earthing system and ground the equipment in accordance with the standard methods approved by the supervisory body. According to the standard, it should be designed in such a way that it does not cause overvoltage beyond the nominal value of the equipment connected to the electricity network and also should not disturb the coordination of ground fault protection in the electricity network.

-To arrangement the photovoltaic panels, if the maximum system voltage is more than 50 volts, one of the current-carrying wires (often negative conductor) must be grounded on the DC side. Also on the AC side the neutral wire must be grounded.

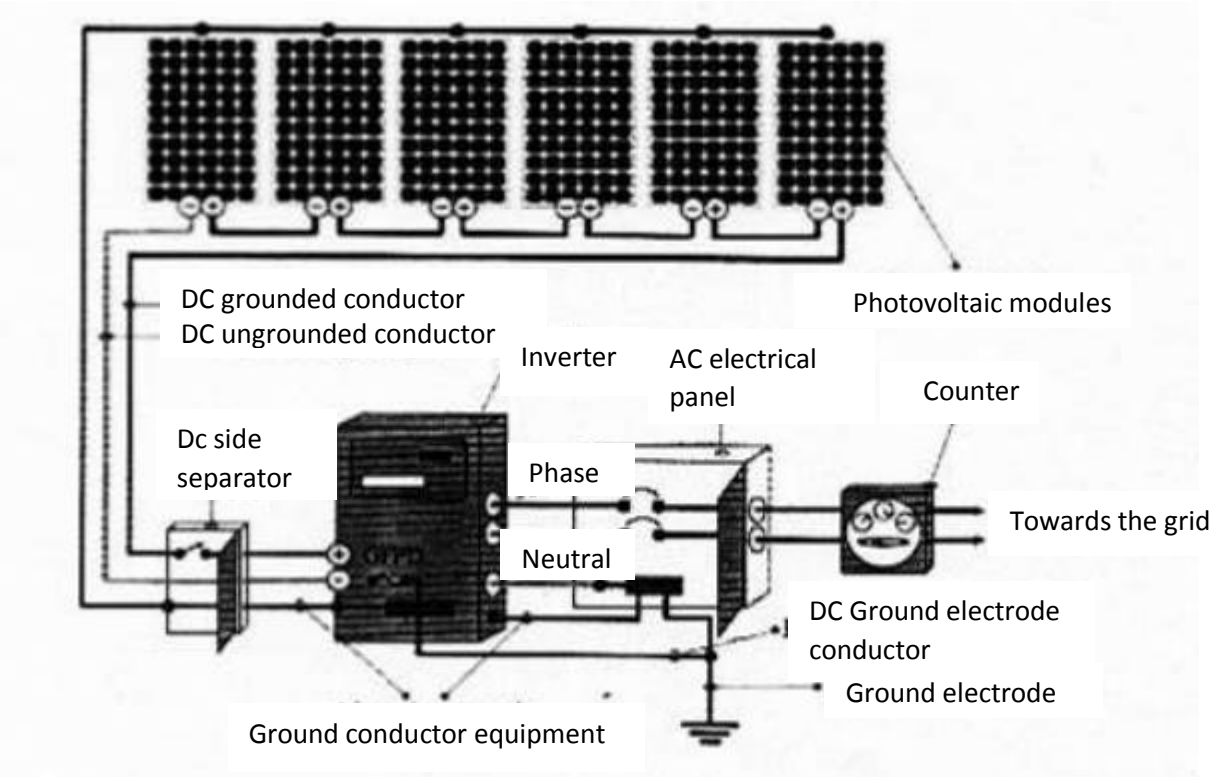
-The resistance of the ground system should be less than 2 ohms and should be obtained from the competent companies with the approval of the supervisory body.

-All unprotected metal surfaces that can be electrified, must be grounded through conductors or mechanical connections being responsible for grounding the equipment.

-The ground conductor on the panels and on the output circuit must have a minimum current-carrying capacity of 1.25 times the short-circuit current of the panels.

-Designing a suitable and standard ground system in each location, must be calculated by the winner of the tender and implemented after approving by the supervisory body.

The following figure shows an example of a grounded system:



Lightning arrester

If lightning strikes, the building is usually equipped with a lightning arrester. In this case, the supporting structure and modules are connected to it. In the absence of lightning arresters and the possibility of lightning strikes, the lightning arrester system must be implemented.

Designing this section, is the tender winner's responsibility and will be executed right after being approved by the supervisory body.

F) General specifications of the panels

An AC switchboard with a suitable degree of protection is required for outdoor installation, along with a standard on / off switch and a two-way meter. The panel designed by the contractor, in terms of layout and type of panel, must be approved by the supervisory body before ordering. The specifications of the required electrical panels are as follows:

-All low-pressure switches of the panels are from reputable Schneider or ABB or Siemens brands.

-The boards should be of outdoor type.

-Can be installed on the wall.

-The panel body should be made of steel sheet, with a suitable kiln color (making the panel body from composite material is also acceptable).

-The panels' body should be made in such a way that any changes are possible without the need for welding and re-painting (anticipation of suitable holes and displacements with bolts and nuts).

-DC switchboard with suitable on and off switches in photovoltaic modules place.

Painting the boards

If metal panels are used, they must be resistant to corrosion, rust and moisture conditions of the installation site. All parts of the panel body should be painted according to the employer's request and the following steps.

-Painting the panels in the form of electrostatic furnace to the thickness of at least 80 microns according to the following steps.

-Degreasing (in a special tub)

-Deoxidation (in a special tub)

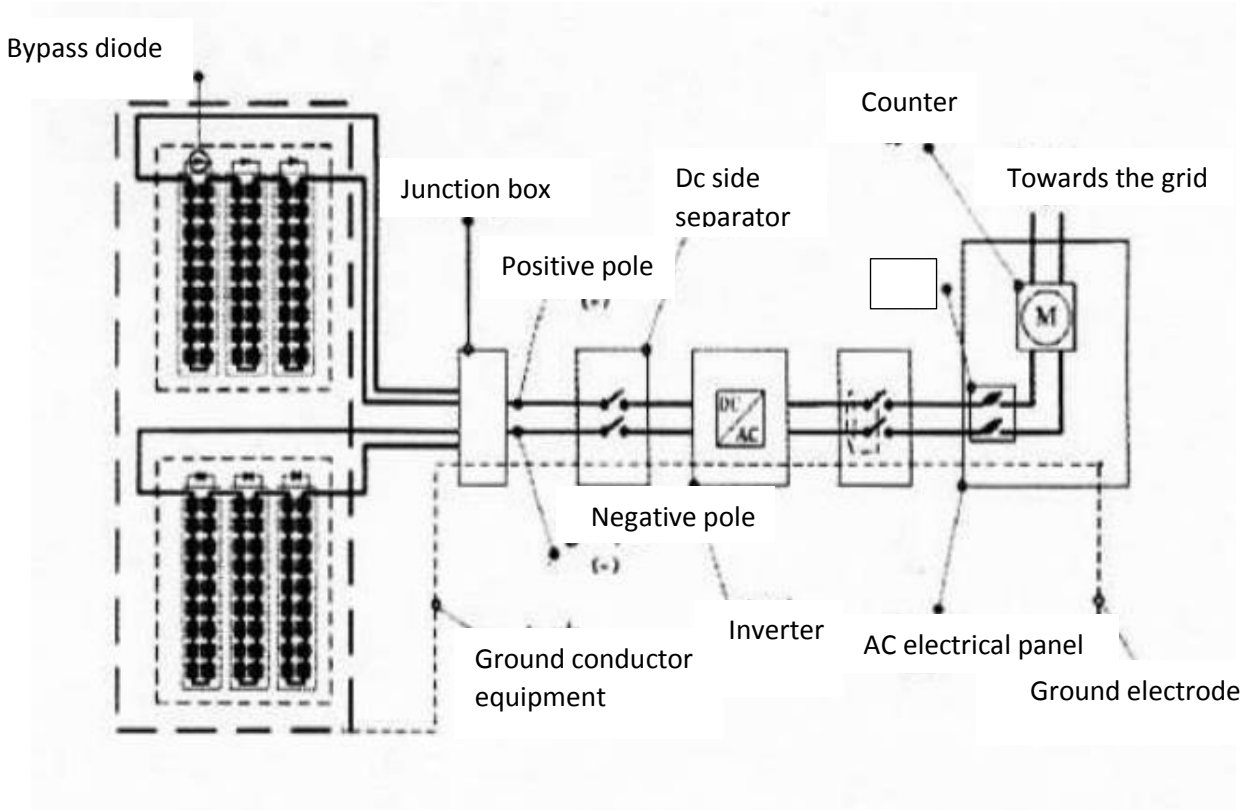
-Phosphate (in a special tub)

-Two primer coats and a final paint coat where each coat is fully baked in the oven.

G) Hospital grid connection

It is mandatory to observe all the items and requirements of grid connection and distributed products. It is possible to connect to the grid after the approval of the supervisory body and the regional electricity distribution company.

The following figure shows a schematic of a grid-connected system (hospital**). It is worth mentioning that in this project, the sale of electricity to the regional distribution company is not considered and the entire production capacity is consumed inside the hospital.**



According to the diagram, safe ground system, design and installation of other relevant equipment must be done after the approval of the supervisory body. After sealing the photovoltaic modules, electrical energy is injected into the inverter via a communication cable and then into the hospital's electrical grid. Observance of safety requirements regarding the selection of box equipment and panels, on and off switches, fuses, communication cables and other parts is mandatory.

H) Protection and safety

The system should include island protection, short-circuit, abnormal grid conditions such as over / decreasing voltage or frequency outside the standard range, allowable harmonic interval of the grid and other protections related to the hospital grid and all switches and

Protective fuses, including direct-current, alternatively, must be designed and observed in accordance with national and international standards and the Scattered Production Guidelines listed in the Standards section. The following table summarizes the required specifications.

Distortion limits	Odd harmonics
Less than 0.4%	3rd to 9th
Less than 0.2%	11th to 15th
Less than 1.5%	17th to 21st
Less than 0.6%	23rd to 33rd

Distortion limits	Even Harmonics
Less than 0.1%	2nd to 8th
Less than 0.5%	10th to 32nd

Maximum disconnection time *	Voltage (at the point of connecting to the grid)
0/1s	V<0/5×Vnominal
2/0s	50%≤V≤85%
Continuous operation	85%≤V≤110%
2/0s	110%≤V≤135%
0/05s	135%≤V
* Disconnection time refers to the time between the occurrence of abnormal conditions and the stop of the inverter from injecting energy into the grid. The PV system control circuits must remain practically connected to the grid to allow it to feel the electrical conditions for use with the "reconnection" feature.	

According to National Standard 11859, in case of frequency changes, the inverter must be disconnected from the grid. These amounts are presented in the table below.

Normal operating conditions	Between 1 ± Hz
0.2 seconds	Out of range 1% Hz

The system must have island protection. In case of a distribution grid outage, the

Photovoltaic system must inject energy into the hospital grid by the hospital emergency power supply.

The photovoltaic system should not inject more than 1% of the nominal output current into the DC current distribution grid. The system must have EMC and EMI standards certification in terms of electromagnetic interference.

When the inverter is operating at 100% of nominal power and is at peak output voltage, if it is disconnected from the grid, it is necessary to discharge the load within 10 seconds.

I) Technical documents and documentation that can be provided to the employer

It is mandatory to provide all technical documents of design, drawings and nominal power of the system (kW DC or kV-AC), model, number and manufacturer of photovoltaic modules and inverters, and operating instructions to the employer and supervisory body as follows.

Detailed system design

The content of the detailed report of the system includes the following sections.

-General diagram and the system diagram and physical coordinates, wiring diagram, supporting structures and specifications of structures and constituent materials, calculation and design booklet: direct and alternating current section calculations and cable size selection, diagram of installed structures and panels, Photovoltaic arrays, information book and complete catalog of all scheduled equipment, ground system, maintenance and operation repair book.

The wiring diagram should include the following information for the photovoltaic field.

-String cable specifications, size and type

-Specifications of overcurrent protection device (where installed) - allowable Type and rate of voltage / current.

-Type of blocking diode (if any).

Electrical details of the array

-Array Main Cable Specifications - Size and Type.

-Array junction box locations (where applicable).

-Type of DC separator, location and allowable amount (voltage / current)

-Array Overcurrent Protection Devices (Used) - Type, Location and allowable amount (Voltage / Current)

-The wiring diagram should include the following information to ground and protect the overvoltage.

-Details of total ground / connection conductors - size and connection points. Including cable connection details of the l array frame potential where it is installed.

-Details of each device installed for impact protection (on both AC and DC) including location, type and allowable amount.

-The wiring diagram should include the following information for the AC system.

-Location, type and allowable amount of AC separator.

-Location, type and allowable amount of AC overcurrent protection device.

-Location, type and allowable amount of waste flow device (where installed).

Datasheet

At least, datasheet must be provided for the following system components.

-Module datasheet for all types of modules used in the system - in accordance with the requirements of IEC61730-1.

-Inverter datasheet for all types of inverters used in the system.

NOTE: preparing datasheet is also recommended for other important components of the system.

Mechanical design information

A data sheet must be provided for the supporting structures and the array.

Operation and maintenance information

Operation and maintenance information should be provided and, at least, should include the following sections:

-Procedures to confirm the correct operation of the system.

-Emergency shutdown / separation procedures.

-Maintenance and cleaning recommendations (if any).

-Considerations of any future construction work related to the photovoltaic array (such as roofing work).

-Warranty documentation for photovoltaic modules and inverters - including warranty start date as well as the warranty period.

Test results and setup data

Copies of panels test and commissioning data, DC section, inverter, AC section, and grid connection must be provided.

J) Equipment warranty and guarantee

-Panel replacement warranty for 5 years

-The efficiency of panels over a period of more than ten years is 90% and fifteen years is more than 85%.

-Inverters warranty for five years and after-sales service for ten years

-Monitoring and measuring equipment warranty for two years and after-sales service for ten years

-Warranty and after-sales service of supporting structures for ten years

-Documents related to the warranty of equipment and tools must be provided to the employer