

## **Technical Requirements and recommendations for the implementation of ground-mounted and rooftop PV systems for own consumption up to 150 kW**

The technical requirements and recommendations for the implementation of ground-mounted and rooftop PV-systems up to 150 kW will be checked based on the checklist provided below by the loan officer of the PFI and by the subcontractor of “Fichtner GmbH & Co KG” Renewable Resources and Energy Efficiency Fund of Armenia (R2E2). The results of the technical assessment will be summarized in the last column of the attached checklist as well as in a summary report, which should include:

- Short Project Description (location, installed capacity, financial volume, pictures of project area, name of ESCO company, and module producer )
- Analysis of checklist
- Summary of the site visit
- Conclusion and Recommendations

The completed checklist and report will be provided to “Fichtner GmbH & Co KG” in Armenian and English languages for approval. Based on the conclusion provided, a decision on the financing of the PV system will be made. A negative assessment/conclusion could lead to a rejection of the project. Such cases will be discussed between GAF PMU and “Fichtner GmbH & Co KG” before deciding on the financing of the project.

The technical assessment will be performed according to the requirements as follows.

### **Requirements**

#### **General**

- The capacity of the solar PV plant should not exceed the consumption needs of the customer
- EHS during construction and operation, in particular, safe working conditions with electrical systems according to national norms and standards. This includes specific safety provisions like rubber mats, electric shock chart, first aid box, fire extinguishers, sand buckets, waste management for hazardous waste, transformers, and batteries. All personnel deployed are provided with basic training in first aid and firefighting.
- Complaint mechanism during construction
- Grid connection and evacuation of electricity is assured

- Overbuilt (ratio of total module power to total inverter power in each sub-system) should not be higher than 1.2;
- Justification of structural design for foundations and module mounting structures, especially considering wind loads and snow loads according to local standards, shall be provided, *if necessary* (at the request of a Fund specialist)
- Justification of comprehensive and complete grounding, *if necessary* (at the request of a Fund specialist)
- Adequate corrosion protection for all installed systems
- All combiner boxes are adequately closed with all cable glands sealed
- Good labeling of module rows, combiner-boxes, and cables
- Commissioning tests must be passed on system- and component level (factory acceptance tests, site acceptance tests)
- Engineering, procurement, and construction of system by a company that is certified in accordance to ISO 9001, ISO 14001, and OHSAS 18001 or a national license to operate as an ESCO.
- Only use of UV-resistant cables and cable-ducts and sufficient protection for cables from vermin for all outdoor installation of wires, adequate fixing of cables, observation of permissible bending radius of all cables, adequate sealing of cable ducts.
- Operation and maintenance (O&M) contract includes an O&M plan including work instructions or adequate staff, quality manual and qualification requirements of staff, and stating warranties to achieve specific key performance indicators such as availability, regular cleaning of air-filters, the limit on reaction times, etc. O&M planning shall be based on IEC 62446. If regular module cleaning is conducted, the impact and required frequency of module cleaning are to be evaluated at least once a year.

## Modules

- Solar modules with a linear performance guarantee of at least 25 years. Standard crystalline or thin-film modules shall be installed. Modules shall be certified for snow loads of 5400 Pascal.
- The PV modules shall have valid certifications issued by a reputable testing institution according to IEC/EN standards as follows:
  - Design qualification and the type approval following the IEC/EN 61215 requirements
  - Testing for Potential Induced Degradation (PID) by the draft standard IEC TS 62804-1.
  - Electrical safety IEC 61730 tests and certification
- The PV modules shall have a minimum efficiency at Standard Test Conditions of **20.5%**

- The degradation warranty of the modules shall be less than 20% in 25 years and less than 10% in the first 10 years. All modules shall have only positive power tolerances (-0% / +5%)
- All PV modules shall be of the same type and from a single manufacturer.

### **Inverters**

- Standard inverters shall be installed. Inverter types shall comply with the relevant IEC standards (e.g. IEC 62109-1/2) and national regulations. Especially the local standards and requirements of the grid operator for grid connection (e.g., grid code) must be met.
- The central inverters must have a minimum Euro efficiency of 95%. All inverters shall be of the same type and from a single manufacturer.

### **PV DC cable certificate**

IEC Standard for DC cables for PV systems is recommended. DC cables should comply with the EN50618/TUV 2pfg 1169/09/07 or IEC62930 and the national regulations.

### **Mounting structures**

Mounting structures shall be made of aluminum, stainless, or galvanized steel, with a product warranty of at least 25 years in the relevant climatic conditions (RA Construction Standard II-7.01-2011). The Mounting structures used shall be products well established on the market, designed for the use in PV solar installations with a proven track record. Module layout and mounting structure design shall consider higher wind loads in the roof edges and corners and consider appropriate clearance. In any case, PV modules can not be installed overhanging to roof ridge or verges.

When installing modules in parallel on the roof, walk ways for proper access for module maintenance and cleaning as specified in the operation and maintenance plan shall be considered.

Mounting structures should comply with international and local standards.

### **Installation and commissioning**

- For a safe electrical installation of the system, IEC 60364 shall be met; for the DC installation, especially IEC 60364 –7- 712.

- For commissioning and testing, IEC 62446 applies. The corresponding commissioning and safety tests shall be documented and stored according to the standard.

### **Interim and final monitoring**

At the request of **GAF**, the **Fund** will carry out one interim and one final monitoring visit to inspect the progress and quality of construction works (one final monitoring visit of PV systems smaller than 100 kWp). The outcomes will be submitted to “Fichtner GmbH & Co KG” in the scope of a short-form report.

Investor shall comply and follow through with all conditions stipulated in the TA Report and Monitoring Reports issued by the Fund on the terms as defined as follows:

- max. 6 weeks to fix defects that involve only the investor / developer / EPC Contractor
- max. 12 weeks to fix defects that involve third party (grid operator or any other public authority)
- no Final Monitoring when defects identified during intermediate monitoring are not yet fixed

Failure to comply with the above may result in a loan-call-back procedure by GAF.

Investor can apply to extend the 12-week deadline, providing a written justification including the detailed reasons for the delay, validity of which will be assessed and decided by the Fund and GAF ultimately.

### **Warranties**

- Minimum 5 years of warranty for all components, the complete installation including quality for replacements or repair.
- Minimum five years of warranty for inverters.
- For PV modules, a product warranty at least for 10 years and a linear performance warranty guaranteeing a minimum output of 80% after 25 years.

### **Recommendations**

- Monitoring system including irradiance measurement on module plane, ambient and module temperature measurement, string-monitoring in case inverters with a nominal power of over 60 kVA are used.

## Checklist of received documents

Name of PV plant \_\_\_\_\_

N	Name of document	Received	Comments	Checked	Comments/remarks
1	Land coordinates	<input type="checkbox"/>		<input type="checkbox"/>	
2	Land privatization certificate for ground-based projects or rental agreement with permission to install the project of the land-owner / Permission for rooftop installation	<input type="checkbox"/>		<input type="checkbox"/>	
3	1. Energy yield forecast / or equivalent commercial simulation software. 2. Monthly load profile of own consumption based on existing data on demand (e.g., electricity bills) and / or plausible assumptions for new buildings / enterprises.	<input type="checkbox"/>		<input type="checkbox"/>	
4	Project description of the layout, civil structures, electrical and mechanical equipment	<input type="checkbox"/>		<input type="checkbox"/>	
5	Justification of structural design for foundations / rooftop installation and respective module mounting structures for the wind and snow resistance in the corresponding area / roof. Design justification may be required at the request of a specialist of the Fund.	<input type="checkbox"/>		<input type="checkbox"/>	
6	Electrical single line diagram for DC single line, protections, switches, circuit breakers, cable specifications	<input type="checkbox"/>		<input type="checkbox"/>	
7	Technical details of the connection with the network, electrical single line diagram for AC single line, protections,	<input type="checkbox"/>		<input type="checkbox"/>	

N	Name of document	Received	Comments	Checked	Comments/remarks
	switches, circuit breakers, cable specifications				
8	Technical specifications for PV modules (including PV module certificates)	<input type="checkbox"/>		<input type="checkbox"/>	
9	Technical specifications for Inverters (including Inverter certificates):	<input type="checkbox"/>		<input type="checkbox"/>	
10	PV DC cable certificates	<input type="checkbox"/>		<input type="checkbox"/>	
11	Official document from the distribution network operator or authority granting the connection to the network	<input type="checkbox"/>		<input type="checkbox"/>	
12	Cost Estimation	<input type="checkbox"/>		<input type="checkbox"/>	
13	Implementation schedule	<input type="checkbox"/>		<input type="checkbox"/>	
14	Photos concerning the site and other structures	<input type="checkbox"/>		<input type="checkbox"/>	
15	Conclusion on the technical condition and durability of the roof	<input type="checkbox"/>		<input type="checkbox"/>	

\*Solarius PV (acca), Archelios PRO, PV\*SOL premium, Solar Pro, System Advisor Model (SAM), Helioscope.