Annex 3

Minimum technical requirements for 150 to 500 kW ground-mounted and rooftop photovoltaic (PV) solar power plants (PV-500 projects)

Minimum technical requirements

The technical requirements and recommendations for the installation of PV systems with a capacity of 150 to 500 kW on land and on the roof shall be verified based on the following: ***Checklist of Submitted Documents (hereinafter referred to as the List)***, which shall be completed by the specialist of the Partner Financial Institution and the Renewable Energy and Energy Efficiency Fund of Armenia (R2E2), a subcontractor of Fichtner GmbH & Co KG. The results of the technical assessment shall be summarized in the last column of the Checklist, as well as in a summary report, which shall include the following:

- Brief description of the project (location, installed capacity, financing amount, pictures of the project area, name of the ESCO company and module manufacturer)
- Checklist analysis
- Site visit summary
- Conclusion and recommendations

The technical evaluation must be carried out in accordance with the requirements below.

General requirements:

- The capacity of the solar PV plant shall not exceed the consumption needs of the beneficiary.
- Ensuring grid connection and electricity transmission.
- The ratio of the total power of the modules to the total power of the inverters in each subsystem shall not exceed the factor of 1.2.
- Structural design justification for foundations and module mounting structures, especially considering wind and snow loads in accordance with site standards.
- Comprehensive and complete grounding.
- Adequate corrosion protection of all installed systems.
- Closing all junction boxes, insulating cable connections.
- Proper labeling of modular rows, junction boxes, and cables.
- Operational tests shall be performed at the system and component level (factory acceptance tests, site acceptance tests)

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- The engineering, procurement and construction of the system shall be carried out by a certified company (ISO 9001, ISO 14001 and OHSAS 18001 or the presence of a national license to operate).
- Use only cables and cable ducts that are resistant to ultraviolet radiation, as well as sufficient protection of all cables installed outdoors from pests, adequate reinforcement of cables, ensuring the permissible bending radius of all the cables, and closing of cable ducts.
- Connection to the grid shall be carried out in accordance with relevant IEC standards, especially if the PV plant is connected to a medium voltage grid, the voltage level of which varies from 1 to 52 kVP.
- An Operation and Maintenance (O&M) contract, which shall require an operation and maintenance plan, work regulations for professional staff, a quality manual, personnel qualification requirements and define guarantees designed to meet key performance indicators such as: availability, regular preventive maintenance and response time constraints. O&M planning shall be based on IEC 62446. In case the modules are cleaned regularly, its impact and the required frequency of module cleaning shall be assessed at least once a year.

Modules

- Solar modules shall have a minimum 25-year linear performance warranty. Standard crystalline or thin-film modules shall be installed. Modules shall be certified for snow pressure of 5400 Pa.
- PV modules must have validated certificates, which must be issued by a reputable testing organization according to IEC/EN standards.
    - Design qualification and type approval in accordance with the requirements of IEC/EN 61215.
    - Potential Induced Degradation (PID) test in accordance with IEC TS 62804-1 standard.ան:
    - Availability of testing and certification for compliance with the IEC 61730 electrical safety standard
- PV modules must have a minimum efficiency of 22% under standard testing conditions.
- Module degradation guarantee should be below 20% over 25 years and below 10% over the first 10 years. All the modules shall have only positive tolerance (0%/+5%).
- All PV modules must be of the same type and from the same manufacturer.

Inverters

- Standard inverters shll be installed. Inverter types shall comply with IEC standards (e.g. IEC 62109-1/2) Safety standards for power converters used in PV systems) and national regulations. Particularly, local standards and requirements of the grid operator for grid connection (e.g. grid code) shall be followed.
- Inverters shall have a minimum Euro efficiency of 96% (central inverters) and 97% (linear inverters).

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- All the inverters shall be of the same type and from the same manufacturer.
- Inverters shall have a warranty period of at least five years.

Certificate of Conformity for PV DC Cable

DC cables used in solar PV plants shall have verified certifications that comply with IEC standards (e.g. EN50618/TUV 2pfg 1169/09/07 or IEC62930) and national regulations.

Solar PV station mounting structures

- The supporting structures should be made of anodized aluminum alloys, for example AlMgSi (IADS 6061, 6063, 6082) or AlMg (IADS 5052, 5083, 5754), stainless or hot-dip galvanized steel or steel with an equivalent corrosion protection system (such as Magnelis®), and with a minimum 25-year warranty in appropriate climatic conditions (RA Construction Standard II-7.01-2011). The mounting structures used shall be products recognized in the market, designed for PV solar plants and with a good reputation.
- The design of the module placement and mounting structure shall take into account the wind load on the roof slopes and corners and ensure an appropriate height (distance). In any case, PV modules shall not be located hanging from the roof slope and peak.
- When installing modules on the roof in parallel, consider access routes for maintenance and cleaning of the modules, in accordance with the operation and maintenance plan.
- Load-bearing structures shall comply with international and local standards.

Connection to the electrical network

For the safe connection of PV plants to the grid, appropriate standards shall be maintained, depending on the connection point. These include:

- IEC 62271 Standards for high-voltage switchgear and controlgear,
- IEC 60298 High-voltage switchgear and controlgear in metal enclosures,
- IEC 60076 Medium voltage transformers,
- IEC 60726 Dry-type transformers,
- IEC 60183 Guide to the selection of high-voltage cables, IEC 60502 Power cables with extruded insulation and their components for voltages from 1 kV to 30 kV.

Particularly, the following requirements must be met:

Requirements for the equipment (manufacturer's responsibility)

- **Isolation and protection**

- The equipment must provide effective insulation between components at different electrical potentials.

- **Grounding and connection**
  - Equipment shall be properly grounded to ensure low fault resistance.
- **Protection against overheating and overload**
  - Components shall have thermal and overload protection mechanisms to avoid overheating and potential fire hazards.

- **Ingress/intrusion protection**
  - Equipment installed outdoors or in harsh environments shall have an appropriate IP (ingress protection) rating to prevent moisture, dust, and other types of contamination.

Installation Requirements (Installer's Responsibility)

- **Proper fastening and installation**
  - Equipment must be securely mounted and installed to avoid physical damage and ensure serviceability;
  - There must be sufficient space around the equipment for safe operation and access.
- **electrical connections**
  - All the connections, including tires, cables, terminals, and housings, must be properly secured to ensure low resistance and avoid overheating.
- **Grounding and zeroing**
  - Adequate grounding and zeroing structures shall be established in accordance with national electrical codes and standards.
  - To avoid potential differences in the system, it is necessary to make equalizing connections.
  - Soil resistance shall be measured and maintained within acceptable limits.

- **Isolation and closure**
  - All wires, terminals, and electrically conductive parts must be properly insulated to avoid accidental contact.
  - Uninsulated (exposed) electrical parts must be covered or enclosed to prevent unintended access.
  - Devices installed outdoors must have weatherproof enclosures to protect them from environmental influences.
- **Clear markings and labels**
  - Equipment must be clearly and permanently marked with electric shock hazard and warning signs and safety instructions.
  - Labels shall be placed in locations accessible to maintenance and operating personnel.
- **Testing and commissioning**
  - All the devices and connections must be thoroughly checked before the operation to ensure proper functionality and safety.
  - Insulation resistance, continuity and earth resistance tests must be conducted and documented.

Installation and launch

- For safe installation of the system, compliance with the requirements of IEC 60364 must be maintained. For DC installations, the requirement of IEC 60364-7-712 shall particularly be taken into account.
- The requirements of IEC 62446 apply to commissioning and testing. The results of commissioning and safety testing must be documented and maintained according to the standards.

Guarantees

- There must be a minimum 5-year warranty for all components, as well as the entire system, including replacement and repair.
- Minimum 5-year warranty for inverters.
- A minimum 10-year warranty for PV modules, as well as a linear productivity (performance) warranty guaranteeing a minimum of 80% productivity in 25 years.

Environmental safety and health requirements

- An environmental and social impact assessment must be provided by the landowner (client). It must demonstrate compliance with the following criteria:
  - The functional purpose of the land cannot be residential, agricultural, or conservation.
  - The investor has ownership rights to the land.
  - There are no objects of unique archaeological, historical and/or cultural value/heritage on the land.
  - The land is not covered by a significant amount of trees and/or vegetation. Removal of trees will require acceptable compensation measures (e.g. planting new trees).
- If an EIA does not exist because the project does not require one, the following information must be provided:
  - Land use status at present time, as well as prior to project implementation,
  - The investor's certificate of ownership of the land/property,
  - Awareness of stakeholders about the project (informing the closest neighbors and relevant authorities).
- Maintaining environmental, health and safety during construction and operation, and ensuring safe working conditions in accordance with national norms and standards when working with electrical systems. Particularly, the availability of safety equipment, rubber gloves, an electric shock chart, a first aid kit, fire extinguishers, sand buckets, a transformer, battery and hazardous waste management system. All the staff should be trained in first aid and firefighting.
- Availability of a complaint mechanism by other parties during the construction.

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FASTBANK

Checklist of submitted documents

Name of the PV plant (borrower)._____

N	Document name	Received	Comments	Verified	Comments / Notes
1	Location coordinates	□		□	
2	Land ownership certificate or lease agreement with permission from the land owner to implement the project *or* Rooftop installation permit (from the roof/building owner)	□		□	
3	1. Energy production forecasting / simulation with PVsyst or equivalent commercial software. 2. Volume of own consumption by month, based on the existing demand data (electricity bills) and/or reasonable assumptions for the new structures/enterprises	□		□	
4	Project description with floor plan, engineering infrastructure, electrical and mechanical equipment	□		□	
5	Justification of the structural design of the appropriate structures for the installation of the foundations / roof and the fastening (mounting) of the modules to withstand wind and snow loads in the relevant area / roof. Justification of the design may be required at the request of the Foundation Specialist.	□		□	
6	Electrical single line diagram for direct current (DC single line diagram), protection, switches, cable specifications	□		□	
7	Technical data for the connection to the network, (AC single line diagram), protection, circuit breakers, cable specifications	□		□	
8	Technical specifications of PV modules, including: PV module conformity certificates	□		□	

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9	Technical specifications of inverters, including certificates of conformity of inverters	☐		☐	
10	PV DC cable conformity certificate	☐		☐	
11	Official document provided by the distribution network operator or the entity granting permission to connect to the network	☐		☐	
12	Cost estimate	☐		☐	
13	Implementation schedule	☐		☐	
14	Photos of the site and other structures	☐		☐	
15	Operation and Maintenance (O&M) concept/budget	☐		☐	
16	Information about the site security: cameras, fencing, etc.	☐		☐	
17	Information on operational monitoring	☐		☐	
18	Conclusion on the technical condition and load-bearing capacity of the roof	☐		☐	