Ground-mounted photovoltaic power plants - Design guidelines and recommendations
0 National Foreword

This draft Tanzania Standard has been prepared by the TBS Renewable Energy Technical Committee, under the supervision of the Electrotechnical Divisional Standards Committee (EDC)

This draft Tanzania Standard is an adoption of the International Standard IEC 62738:2018 *Ground-mounted photovoltaic power plants - Design guidelines and recommendations* which has been prepared by the International Electrotechnical Commission.

1 Terminology and conventions

Some terminologies and certain conventions are not identical with those used in Tanzania standards; attention is drawn especially to the following:

1) The comma has been used as a decimal marker for metric dimensions. In Tanzania Standards, it is current practice to use “full point” on the baseline as the decimal marker.

2) Where the words “International Standard(s)” appear, referring to this standard they should read “Tanzania Standard(s)“.
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FOREWORD

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- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62738, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.
The text of this technical specification is based on the following documents:

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Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC website under “http://webstore.iec.ch” in the data related to the specific publication. At this date, the publication will be

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.
INTRODUCTION

This document sets out general guidelines and recommendations for the design and installation of utility scale ground-mounted photovoltaic (PV) power plants. The focus is largely on design aspects that differ from those of conventional residential and commercial PV systems. Power plants are a significant and growing component of the PV market, yet design methodologies range considerably, partly due to the fact that systems are not accessible to the public or non-qualified personnel. Overall guidelines are still needed to ensure safe, reliable, and productive systems.
1 Scope

This document sets out general guidelines and recommendations for the design and installation of ground-mounted photovoltaic (PV) power plants. A PV power plant is defined within this document as a grid-connected, ground-mounted system comprising multiple PV arrays and interconnected directly to a utility’s medium voltage or high voltage grid. Additional criteria is that PV power plants are restricted from access by non-qualified persons and are continuously monitored for safety and protection, either by on-site personnel or by active remote monitoring. Technical areas addressed are those that largely distinguish PV power plants from smaller, more conventional installations, including ground mounted array configurations, cable routing methods, cable selection, overcurrent protection strategies, equipotential bonding over large geographical areas, and equipment considerations.

Safety and design requirements are referenced to the applicable requirements of IEC 62548 to address distinct differences relative to the design requirements for residential, commercial and other non-power plant applications. In general, existing standards are referenced wherever possible for uniformity. Emphasis is placed on systems employing d.c. string based systems using large scale central inverters or 3-phase string inverters, but relevant sections are also applicable to systems employing a.c. modules or d.c./d.c. converters. Medium voltage transformers, switchgear, collection systems, substations, utility interconnection, auxiliary loads, energy storage systems, and communication services are addressed, but discussion is mostly limited to recommended references to other standards and requirements.

Rooftop-mounted systems, building integrated PV (BIPV) and building applied PV (BAPV) are not included in the scope of this document. The principles of restricted-access power plants are not compatible with systems on buildings, which are used for purposes other than power generation.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60076-1, Power transformers – Part 1: General

IEC 60076-2, Power transformers – Part 2: Temperature rise for liquid-immersed transformers

IEC 60076-3, Power transformers – Part 3: Insulation levels, dielectric tests and external clearances in air

IEC 60076-4, Power transformers – Part 4: Guide to the lightning impulse and switching impulse testing – Power transformers and reactors

IEC 60076-5, Power transformers – Part 5: Ability to withstand short-circuit

IEC 60076-7, Power transformers – Part 7: Loading guide for mineral-oil-immersed power transformers
IEC 60085, *Electrical insulation – Thermal evaluation and designation*

IEC 60137, *Insulated bushings for alternating voltages above 1000 V*

IEC 60183, *Guidance for the selection of high-voltage A.C. cable systems*

IEC 60228, *Conductors of insulated cables*

IEC 60255-21-3, *Electrical relays – Part 21: Vibration, shock, bump and seismic tests on measuring relays and protection equipment – Section 3: Seismic tests*

IEC 60296, *Fluids for electrotechnical applications – Unused mineral insulating oils for transformers and switchgear*

IEC 60364-5-52, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60364-5-54, *Low-voltage electrical installations – Part 5-54: Selection and erection of electrical equipment – Earthing arrangements and protective conductors*

IEC 60502-1, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 1: Cables for rated voltages of 1 kV ((Um = 1,2 kV) and 3 kV (Um = 3,6 kV)*

IEC 60502-2, *Power cables with extruded insulation and their accessories for rated voltages from 1 kV (Um = 1,2 kV) up to 30 kV (Um = 36 kV) – Part 2: Cables for rated voltages from 6 kV (Um = 7,2 kV) up to 30 kV (Um = 36 kV)*

IEC 60853 (all parts), *Calculation of the cyclic and emergency current rating of cables*


IEC TR 60890, *A method of temperature-rise verification of low-voltage switchgear and controlgear assemblies by calculation*


IEC 61000-4-2, *Electromagnetic compatibility (EMC) – Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test*

IEC 61215-2, *Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 2: Test procedures*

IEC 61238-1 (all parts), *Compression and mechanical connectors for power cables*

IEC 61427-2, *Secondary cells and batteries for renewable energy storage – General requirements and methods of test – Part 2: On-grid applications*

IEC 61439-1, *Low-voltage switchgear and controlgear assemblies – Part 1: General rule*
IEC 61439-2, Low-voltage switchgear and controlgear assemblies – Part 2: Power switchgear and controlgear assemblies

IEC 61643-32, Low-voltage surge protective devices – Part 32: Surge protective devices connected to the d.c. side of photovoltaic installations – Selection and application principles

IEC 61724-1, Photovoltaic system performance – Part 1: Monitoring

IEC TS 61724-2, Photovoltaic system performance – Part 2: Capacity evaluation method

IEC TS 61724-3, Photovoltaic system performance – Part 3: Energy evaluation method

IEC 61850 (all parts), Communication networks and systems for power utility automation

IEC 61936-1, Power installations exceeding 1 kV a.c. – Part 1: Common rules

IEC 62109-1, Safety of power converters for use in photovoltaic power systems – Part 1: General requirements

IEC 62109-2, Safety of power converters for use in photovoltaic power systems – Part 2: Particular requirements for inverters

IEC 62271-1, High-voltage switchgear and controlgear – Part 1: Common specifications for alternating current switchgear and controlgear

IEC 62271-100, High-voltage switchgear and controlgear – Part 100: Alternating current circuit-breakers

IEC 62271-102, High-voltage switchgear and controlgear – Part 102: Alternating current disconnectors and earthing switches

IEC 62271-103, High-voltage switchgear and controlgear – Part 103: Switches for rated voltages above 1 kV up to and including 52 kV

IEC 62271-200, High-voltage switchgear and controlgear – Part 200: AC metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 52 kV

IEC TS 62271-210, High-voltage switchgear and controlgear – Part 210: Seismic qualification for metal enclosed and solid-insulation enclosed switchgear and controlgear assemblies for rated voltages above 1 kV and up to and including 52 kV

IEC TR 62271-300, High-voltage switchgear and controlgear – Part 300: Seismic qualification of alternating current circuit-breakers

IEC 62305-2, Protection against lightning – Part 2: Risk management

IEC 62446-1, Photovoltaic (PV) systems – Requirements for testing, documentation and maintenance – Part 1: Grid connected systems – Documentation, commissioning tests and inspection
3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62548 as well as the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at http://www.iso.org/obp

3.1 PV power plant

grid-connected, ground-mounted PV system comprising multiple PV arrays and interconnected directly to a utility’s medium voltage or high voltage grid

Note 1 to entry: Additional criteria are that PV power plants are restricted from access by non-qualified personnel and are continuously monitored for safety and protection, either by on-site personnel or by active remote monitoring.

3.2 electrically skilled person

person with relevant education and experience to enable him or her to perceive risks and to avoid hazards which electricity can create

3.3 electrically instructed person

person adequately advised or supervised by electrically skilled persons to enable him or her to perceive risks and to avoid hazards which electricity can create

3.4 ordinary person
person who is neither a skilled person nor an instructed person

3.5

string wiring harness
cable assembly that aggregates the output of multiple PV string conductors along a single main conductor

Note 1 to entry: The harness may or may not include fusing on the individual string conductors. The wiring harness typically does not include a disconnect device in line.

4 Compliance with IEC 62548

The design, erection and verification of PV power plants as defined in this document should generally comply with the requirements of IEC 62548 and its references to the IEC 60364 series.