

TECHNICAL SPECIFICATION

**Renewable energy off-grid systems -
Part 200: System selection and design**



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2026 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search -

webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD	6
INTRODUCTION	8
1 Scope	9
2 Normative references	10
3 Terms and definitions	10
4 Functional requirements of off-grid electrification systems for isolated sites	12
4.1 General	12
4.2 Overall requirements to be satisfied	12
4.2.1 Main factors to be considered	12
4.2.2 Requirements and characteristics to be considered	12
4.3 Introduction to electrification systems	16
4.4 Functional description of a micropower plant	17
4.4.1 General	17
4.4.2 Detailed functions to be achieved by a micropower plant	17
4.4.3 Detailed performances criteria to be achieved by a micropower plant	18
4.5 Functional description of a distribution system	18
4.5.1 Detailed functions to be achieved by a distribution system	18
4.5.2 Detailed performances criteria to be achieved by a distribution system	19
4.6 Functional description of a user electrical installation	21
4.7 Constraints to be complied with by micropower plant, distribution system and user electrical installation	21
5 Types of micropower plants	22
5.1 General	22
5.2 Typology of micropower plants	24
6 Resource assessment	25
7 Energy use assessment	25
7.1 Type of desired use	26
7.2 Availability	27
7.3 Quality of the supply	27
7.4 Power and energy requirements	27
7.5 Energy reduction strategies	28
7.6 Design of micropower plant and energy management	28
7.6.1 General	28
7.6.2 Energy management for microgrid	28
7.6.3 Energy management for individual electrification systems	29
8 Expected results from the system sizing process	30
8.1 Overview	30
8.2 Participants in the sizing process	30
8.3 Elements for comparing various design proposals	31
8.4 Frameworks for design proposal	31
8.4.1 General	31
8.4.2 General commitments to supply	32
8.4.3 Technical specifications for the system design	32
8.4.4 Specifications for a photovoltaic array	33
8.4.5 Specifications for wind turbines	34
8.4.6 Specification for genset	36

8.4.7	Specifications for micro hydro turbines	37
8.4.8	Specifications for biomass generators	38
8.4.9	Specification for battery system	39
8.4.10	Specifications of inverters (battery)	40
8.4.11	Inverters (solar for AC coupled systems)	41
8.4.12	Solar battery charge controllers	42
8.4.13	Specifications for system controllers	43
8.4.14	Specifications of cables, switchgear and protection equipment	44
8.4.15	Energy outputs	45
8.4.16	Presentation of the costs	46
8.4.17	Design warranty	46
8.4.18	Steps to reduce the impact of climatic hazards on the system	46
8.4.19	Environmental designs	46
8.5	System sizing process	47
9	Monitoring of off-grid electrification systems	47
9.1	Overview	47
9.2	Individual component data to be measured and recorded	48
9.2.1	PV arrays	48
9.2.2	Wind turbines	48
9.2.3	Micro hydro turbine	48
9.2.4	Generator sets	49
9.2.5	Biomass generator	49
9.2.6	Battery systems	49
9.2.7	Battery inverters	49
9.2.8	Solar inverters	50
9.2.9	Solar controllers	50
9.3	Micropower plant	50
Annex A (informative)	Example for detailed performance criteria and levels for a micropower plant	51
Annex B (informative)	Example for detailed performance criteria and levels for a distribution subsystem	53
Annex C (informative)	User load questionnaire	54
C.1	General use	54
C.2	Specific users	55
Annex D (informative)	Supply quality indicators for isolated electrification systems	56
D.1	General	56
D.2	Power quality	56
D.3	Availability	56
Annex E (informative)	Classification of systems with reference to the Energy Sector Management Assistant Program (ESMAP) World Bank tier structure	57
E.1	General	57
E.2	Relationship of ESMAP tiers to the relevant documents in the IEC TS 62257 series	57
E.2.1	General	57
E.2.2	Tier 1 – Portable lighting	58
E.2.3	Tier 2 – Small household	58
E.2.4	Tier 3 – Household	58

E.2.5	Tier 4 – Commercial	58
E.2.6	Tier 5 – Commercial enterprise	59
E.2.7	Tier 6 – Small communal or large commercial	59
E.2.8	Tier 7 – Large communal or industrial	59
Annex F (informative)	Architecture of systems	60
F.1	Type T ₁ I – REN systems operating with no storage (only when solar, wind or water energy sources are available) – REN production	60
F.2	Type T ₂ I – Individual electrification systems – REN generation with energy storage	62
F.3	Type T ₃ I – Individual electrification systems – (REN and diesel) production without energy storage	66
F.4	Type T ₄ I – Individual electrification systems – (RE and diesel) production with energy storage	68
F.5	Type T ₅ I – Individual electrification systems – Genset only without storage	71
F.6	Type T ₆ I – Individual electrification systems – Genset only with storage	72
F.7	Type T ₁ M – Microgrid – REN only without storage	72
F.8	Type T ₂ M – Microgrid – REN Micropower plant supplying a distribution system	72
F.9	Type T ₃ M – Microgrid – Multi sources micropower plant (RE and diesel) without energy storage, supplying a distribution system	76
F.10	Type T ₄ M – Microgrid – Multi sources micropower plant (RE and diesel) with energy storage supplying a microgrid	76
F.11	Type T ₅ M – Microgrid – Diesel micropower plant supplying a distribution system	81
F.12	Type T ₆ M – Microgrid – Diesel micropower plant with energy storage supplying a distribution system	81
F.13	Microgrid – Distributed RE micropower plant	81
Bibliography		82
Figure 1	– Factors involved in the design of a system	12
Figure 2	– Functional diagram of a distribution system with one micropower plant	20
Figure 3	– Functional diagram of a distribution system with one central micropower plant and distributed RE micropower plant	21
Figure 4	– Example of AC micropower plants	23
Figure 5	– Example of DC micropower plants	24
Figure E.1	– ESMAP tiers for use cases	57
Figure F.1	– Type T ₁ I-a (left) and T ₁ I-b (right) systems	61
Figure F.2	– Type T ₁ I-c (left) and T ₁ I-d (right) systems	62
Figure F.3	– Type T ₂ I system DC coupled system	64
Figure F.4	– Type T ₂ I system AC coupled system	65
Figure F.5	– Type T ₃ I system	67
Figure F.6	– Type T ₃ I-b system	68
Figure F.7	– Type T ₄ I system DC coupled	70
Figure F.8	– Type T ₄ I system AC coupled	71

Figure F.9 – General architecture of a micropower plant supplying a distribution system	73
Figure F.10 – Type T ₂ M system DC Coupled.....	74
Figure F.11 – Type T ₂ M system AC coupled.....	75
Figure F.12 – Type T ₄ M-a system DC coupled.....	79
Figure F.13 – Type T ₄ M-a system AC coupled.....	80
Table 1 – Technical factors – Requirements or characteristics to be considered for an isolated microgrid created via a project.....	13
Table 2 – Technical factors – requirements or characteristics to be considered for individual electrification systems created for a system user or owner	13
Table 3 – Economic factors – requirements and characteristics to be considered for a microgrid supplied via a project.....	14
Table 4 – Economic factors – requirements and characteristics to be considered individual electrification systems supplied to a system user or owner.....	14
Table 5 – Site characteristics.....	14
Table 6 – Regulations and requirements to be considered	16
Table 7 – Typology of isolated electrification systems	24
Table 8 – Application types and types of uses.....	26
Table 9 – Expected quality of the supply	27
Table 10 – Participants in the sizing process for a project.....	31
Table 11 – Participants in the sizing process for a system provided by IES.....	31
Table 12 – Perspectives to be considered for electrifications systems provided through a project	32
Table 13 – Photovoltaic array specifications	33
Table 14 – Specifications for photovoltaic array supporting structure	34
Table 15 – Specifications for the wind turbine.....	35
Table 16 – Specifications for wind turbine structure	36
Table 17 – Specifications for the genset	37
Table 18 – Specifications for micro hydro turbines	38
Table 19 – Specifications for biomass generators	39
Table 20 – Specifications for battery systems	40
Table 21 – Specifications for inverter (battery).....	41
Table 22 – Specifications for solar inverter	42
Table 23 – Specifications for solar controller.....	43
Table 24 – Specifications for system controllers	43
Table 25 – Specifications of cables, switchgear and protection equipment.....	44
Table 26 – Energy output from renewable energies	45
Table 27 – Energy output from fossil energies	45
Table 28 – Energy output from storage	45
Table A.1 – Detailed performance criteria and levels for a production subsystem.....	51
Table A.2 – Typical example of Table A.1	52
Table B.1 – Detailed performance criteria and levels for a distribution subsystem.....	53
Table B.2 – Typical example of functional specifications	53

Table C.1 – General user load questionnaire 54

Table C.2 – Specific user load questionnaire 55

Table D.1 – Availability and power quality indicators 56

Table F.1 – List of cases, type T₁I 60

Table F.2 – List of cases, type T₃I 66

Table F.3 – List of cases, type T₃M 76

Table F.4 – List of cases, type T₄M 77

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Renewable energy off-grid systems -
Part 200: System selection and design**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TS 62257-200 has been prepared by IEC technical committee 82. Solar photovoltaic energy systems. It is a Technical Specification.

This first edition cancels and replaces the second edition of IEC 62257-4 published in 2015. It constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) The previous edition focussed on isolated electrification systems provided through projects only. This version includes isolated electrification systems that could be supplied directly to a user by a system supplier.
- b) Information that was previously included in IEC TS 62257-2 that was directly relevant to system design has been moved to be included in this version.

- c) The operation of numerous micropower plants typologies has changed due to changes in features and functions of inverters. The typologies of the various powerplants have been updated to reflect these changes.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
82/2505/DTS	82/2573/RVDTS

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Specification is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 62257 series, published under the general title *Renewable energy off-grid systems*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

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

- reconfirmed,
- withdrawn, or
- revised.

INTRODUCTION

The IEC 62257 series provides technical standardization to different stakeholders (including but not limited to project developers, financing agencies, testing agencies, installers, etc.) involved in electrification projects for access to electricity for those not solely connected to the regional grid, through the setting up of off-grid renewable energy and hybrid systems (including micro-grids) with a voltage less than or equal to 1 000 V for AC (alternating current) or a voltage less than or equal to 1 500 V for DC (direct current).

Access to electricity is one of the predominant policy actions designed to increase the well-being of populations, together with access to clean water, improved healthcare, education, personal advancement and economic development. Increasing access to electricity through utilization of renewable off-grid electricity also directly or indirectly supports various United Nations Sustainability Development Goals (<https://sdgs.un.org/goals>), depending on the application.

Several strategies can be adopted to implement electrification and improve access to electricity in rural and urban settings, including the ability for connection to a national or regional electricity grid. The IEC 62257 series applies to cases where the utility grid is too far away, the individual demand centres are too small to make grid access economical, off-grid solutions provide an economical option, and where autonomous power systems can be used to supply these services.

These technical specifications are used to:

- a) choose the right solution for the right place with the optimal technology,
- b) design, purchase and install the product(s) or system to optimal compliancy,
- c) operate and maintain the system.

The IEC 62257 technical specifications focus on enabling access to electricity by concentrating on, but not being specific to, developing countries. This series is not to be considered as all-inclusive for access to electricity. That means that the technical specifications could be used for rural electrification, also for electrification of remote sites in developed countries, or any requirement for electricity access that cannot be met by attaching solely to the national utility grid. They promote the use of renewable energies, but at this time they do not deal with clean-energy mechanisms development (CO₂ emissions, carbon credit, etc.). The series does allow for other types of energy, such as diesel generators, to be included as part of a hybrid renewable energy off-grid system.

This consistent set of documents can be considered as a whole, with different parts focusing on specific aspects of renewable energy off-grid systems. However, several parts are intended to be read as stand-alone documents depending on their intended application. IEC TS 62257-100 provides an overview of the various topics covered by this series. Additionally, the content and scopes of individual documents, available at the website webstore.iec.ch, provide potential users with the intended application for each document. For further information on planned documents to be published under the new IEC 62257 numbering scheme, IEC TC 82 committee members can refer to the annex in the JWG1 Program of Work circulated after each JWG1 meeting, or to the Planned Work Programme on the www.iec.ch TC 82 website.

One of the main objectives of this series is to provide the minimum sufficient recommendations, including items for safety, sustainability of systems and at the lowest life cycle cost, relevant to the renewable energy and hybrid off-grid systems field of application.

1 Scope

This part of IEC 62257 provides a method for describing the results to be achieved by the electrification system independently of the technical solutions that could be implemented.

The purpose of this part of IEC 62257 is to provide a method to assist designers of renewable energy systems, project contractors and project developers to design the electrification system for isolated sites while matching the identified needs. This part of IEC 62257 assesses the needs of the users and the different power system architectures which can be used for meeting these needs. In relation to the needs of the different participants to the project, functional requirements to be achieved by the production and distribution subsystems are listed.

In Clause 4, the functional requirements of off-grid electrifications systems are described. These include the micropower plant, distribution system for isolated microgrids and the user's electrical installation providing power to their loads.

In Clause 5, the types of micropower plants that can be installed within an individual electrification system (IES) or isolated microgrid are described.

In Clause 6, resource assessment (solar, wind, hydro, biomass) and data sources (PVGIS, Global Solar Atlas, NASA POWER, etc.) are outlined.

In Clause 7, the requirement to undertake load energy assessment is described and includes the relationship between the available energy, the design of the system and the user's expectation.

In Clause 8, the information that has been used in the design process and should be specified in any design documentation to allow the participants to select the equipment or component able to fulfil the functional requirements are listed.

To allow and facilitate the management of the micropower plant and the maintenance of the whole electrification system, some information is collected and monitored.

In Clause 9, the required measurement parameters for each component (PV, wind, hydro, genset, battery, inverters, controllers) to support operation and maintenance are listed.

The steps to follow this part of IEC 62257 when designing an off-grid electrification system are as follows:

Step 1: Conduct a resource assessment (see Clause 6).

Step 2: Conduct a load assessment (see Clause 7).

Step 3: The designer uses the information obtained in the two assessments to determine the type and configuration of the micropower plant (see Clause 5) and to select or specify the micropower plant components (equipment) (see Clause 8).

Step 4: The designer should develop a monitoring plan that will support the ongoing operation and maintenance of the off-grid electrification system (refer to Clause 9).

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 TS 61836, *Solar photovoltaic energy systems - Terms, definitions and symbols*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TS 61836 and the following apply.

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

- IEC Electropedia: available at <https://www.electropedia.org/>
- ISO Online browsing platform: available at <https://www.iso.org/obp>

3.1

battery system

system comprising one or more cells, modules or batteries

Note 1 to entry: Depending on the type of technology, the battery system can include one or multiple battery management systems, battery management modules, auxiliary supporting or protective equipment for the system.

3.2

dispatchable power system

generating system that is capable of generating electricity as required by its interconnected electrical distribution system

Note 1 to entry: For example, a fuel-based engine-powered generator is dispatchable.

3.3

distributed RE micropower plant

micropower plant that uses a single resource and is interconnected at the users' electrical installation

3.4

distribution system

electrical facility and its components including poles, transformers, disconnects, relays, isolators and wires for the purpose of distributing electrical energy from micropower plant to customers

3.5

genset

GS

engine-generator set consisting of a fuel-driven engine coupled to an electric generator

3.6

hybrid system

multi-sources system with at least two different kind of generation technologies