

# 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](mailto:info@iec.ch)  
[www.iec.ch](http://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](http://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 It also gives information on projects, replaced and withdrawn publications.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](http://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](http://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](mailto:sales@iec.ch).

**IEC Products & Services Portal - [products.iec.ch](http://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](http://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.

## 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 <sub>1</sub> l – REN systems operating with no storage (only when solar, wind or water energy sources are available)– REN production .....	60
F.2	Type T <sub>2</sub> l – Individual electrification systems – REN generation with energy storage .....	62
F.3	Type T <sub>3</sub> l – Individual electrification systems – (REN and diesel) production without energy storage .....	66
F.4	Type T <sub>4</sub> l – Individual electrification systems – (RE and diesel) production with energy storage .....	68
F.5	Type T <sub>5</sub> l – Individual electrification systems – Genset only without storage .....	71
F.6	Type T <sub>6</sub> l – Individual electrification systems – Genset only with storage .....	72
F.7	Type T <sub>1</sub> M – Microgrid – REN only without storage .....	72
F.8	Type T <sub>2</sub> M – Microgrid – REN Micropower plant supplying a distribution system .....	72
F.9	Type T <sub>3</sub> M – Microgrid – Multi sources micropower plant (RE and diesel) without energy storage, supplying a distribution system .....	76
F.10	Type T <sub>4</sub> M – Microgrid – Multi sources micropower plant (RE and diesel) with energy storage supplying a microgrid .....	76
F.11	Type T <sub>5</sub> M – Microgrid – Diesel micropower plant supplying a distribution system .....	81
F.12	Type T <sub>6</sub> 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 <sub>1</sub> l-a (left) and T <sub>1</sub> l-b (right) systems .....		61
Figure F.2 – Type T <sub>1</sub> l-c (left) and T <sub>1</sub> l-d (right) systems .....		62
Figure F.3 – Type T <sub>2</sub> l system DC coupled system .....		64
Figure F.4 – Type T <sub>2</sub> l system AC coupled system .....		65
Figure F.5 – Type T <sub>3</sub> l system .....		67
Figure F.6 – Type T <sub>3</sub> l-b system .....		68
Figure F.7 – Type T <sub>4</sub> l system DC coupled .....		70
Figure F.8 – Type T <sub>4</sub> l system AC coupled .....		71

Figure F.9 – General architecture of a micropower plant supplying a distribution system .....	73
Figure F.10 – Type T <sub>2</sub> M system DC Coupled.....	74
Figure F.11 – Type T <sub>2</sub> M system AC coupled.....	75
Figure F.12 – Type T <sub>4</sub> M-a system DC coupled.....	79
Figure F.13 – Type T <sub>4</sub> 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 T <sub>1</sub> I .....	60
Table F.2 – List of cases, type T <sub>3</sub> I .....	66
Table F.3 – List of cases, type T <sub>3</sub> M .....	76
Table F.4 – List of cases, type T <sub>4</sub> M .....	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](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://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](http://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 (CO<sub>2</sub> 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](http://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](http://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.