

# TECHNICAL SPECIFICATION

---

**Recommendations for renewable energy and hybrid systems for rural  
electrification –  
Part 2: From requirements to a range of electrification systems**





## THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2015 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 Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
Fax: +41 22 919 03 00  
[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 corrigenda or an amendment might have been published.

#### IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### IEC publications search - [www.iec.ch/searchpub](http://www.iec.ch/searchpub)

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 It also gives information on projects, replaced and withdrawn publications.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 also once a month by email.

#### Electropedia - [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)

More than 60 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

#### 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: [csc@iec.ch](mailto:csc@iec.ch).



# TECHNICAL SPECIFICATION

---

**Recommendations for renewable energy and hybrid systems for rural  
electrification –  
Part 2: From requirements to a range of electrification systems**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

---

ICS 27.160

ISBN 978-2-8322-3064-0

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

## CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references .....	8
3 Terms and definitions .....	8
4 Methodology for non-technical preliminary studies.....	10
4.1 Place and role of preliminary studies in a decentralized rural electrification project .....	10
4.2 Specifications of the preliminary study .....	10
4.2.1 General .....	10
4.2.2 Data for a better understanding of the project environment.....	11
4.2.3 Necessary data for the techno-economic study .....	12
4.2.4 Necessary data for the financial analysis .....	14
4.2.5 Necessary data for the organizational study .....	15
4.3 The stages of a socio-economic study .....	16
5 Classification of electrification systems.....	16
5.1 Introduction to a range of systems .....	16
5.2 Users requirements.....	16
5.3 Typology of qualitative requirements.....	16
5.3.1 Type of desired use .....	16
5.3.2 Availability .....	16
5.3.3 Quality of the supply .....	17
5.4 Typology of quantitative requirements.....	17
5.5 Classification for electricity services provided .....	18
5.6 Assisted selection of production subsystem .....	18
5.7 Typology of decentralized electrification systems.....	19
5.7.1 General .....	19
5.7.2 Selection process .....	19
5.7.3 From user needs to electrification system – Summary for a range of electrification systems .....	20
6 Electrification systems architecture.....	21
6.1 General.....	21
6.2 General presentation of isolated electrification systems .....	22
6.2.1 General .....	22
6.2.2 Production subsystem.....	22
6.2.3 Distribution subsystem.....	22
6.2.4 User or application subsystem or demand subsystem .....	22
6.3 Combining subsystems .....	23
6.4 Functional diagrams.....	25
6.5 Related references.....	25
6.6 Limits between production, distribution and demand/application subsystems .....	26
6.7 Summary of the different electrification system types .....	26
Annex A (informative) Stages of a socio-economic study .....	27
A.1 General.....	27
A.2 Preparation phase.....	27

A.3	Drawing up of the questionnaires – choice of surveyors and choice of sample .....	28
A.4	Conducting the survey – Analysis of the results .....	28
A.5	Extrapolation of the results .....	28
Annex B (informative)	Analysis of the type of receivers installed versus types of use and demonstrating seasonable variability (where applicable) .....	29
B.1	Domestic use .....	29
B.1.1	General .....	29
B.1.2	Utilisation – Example 1 .....	30
B.1.3	Utilisation – Example 2 .....	31
B.2	Analysis of the type of receivers versus usage types .....	32
B.2.1	General .....	32
B.2.2	Health and care centre .....	32
B.2.3	Worship places .....	32
B.2.4	Community centre .....	32
B.2.5	School .....	33
B.2.6	Administrative premises .....	33
B.2.7	Communication system .....	33
B.2.8	Public lighting .....	33
B.2.9	Pumping .....	33
B.2.10	Battery charging station .....	34
Annex C (informative)	Supply quality indicators for isolated electrification systems .....	35
Annex D (informative)	Assisted selection of production subsystem .....	36
D.1	Characteristics of possible production subsystems .....	36
D.2	Assisted selection of a decentralized production system suited to the requirement .....	36
Annex E (informative)	Functional diagrams .....	38
E.1	Glossary of symbols .....	38
E.2	Architectures of systems .....	39
E.2.1	Type T <sub>1</sub> I: REN Systems operating with no storage (in sync with solar, wind or water energy sources) – REN production .....	39
E.2.2	Type T <sub>2</sub> I: Individual electrification systems – REN production with energy storage .....	43
E.2.3	Type T <sub>3</sub> I: Individual electrification systems: (REN + diesel) production without energy storage .....	46
E.2.4	Type T <sub>4</sub> I: Individual electrification systems: (RE + diesel) production with energy storage .....	49
E.2.5	Type T <sub>5</sub> I: Individual electrification systems: genset only without storage .....	51
E.2.6	Type T <sub>6</sub> I: Individual electrification systems: genset only with storage .....	52
E.2.7	Type T <sub>1</sub> C: Collective electrification systems: REN only without storage .....	53
E.2.8	Type T <sub>2</sub> C: Collective electrification systems: REN Micropower plant supplying a microgrid .....	53
E.2.9	Type T <sub>3</sub> C: Collective electrification systems: Multi sources micropower plant (RE + diesel) without energy storage, supplying a microgrid .....	56
E.2.10	Type T <sub>4</sub> C: Collective electrification systems: Multi sources micropower plant (RE + diesel) with energy storage supplying a microgrid .....	59
E.2.11	Type T <sub>5</sub> C: Collective electrification systems: Diesel micropower plant supplying a microgrid .....	62
E.2.12	Type T <sub>6</sub> C: Collective electrification systems: Diesel micropower plant with energy storage supplying a microgrid .....	64

Figure 1 – Example of the content of a non-technical preliminary study .....	11
Figure 2 – Systems architecture and dispatchable energy.....	20
Figure 3 – General configuration of an electrification system .....	24
Figure A.1 – Flowchart of the stages of a socio economic study.....	27
Figure D.1 – Better adequacy of production subsystems solutions with supply availability and daily duration of service .....	37
Figure E.1 – Type T <sub>1</sub> l-a system .....	40
Figure E.2 – Type T <sub>1</sub> l-b system .....	41
Figure E.3 – Type T <sub>1</sub> l-c system .....	42
Figure E.4 – Type T <sub>1</sub> l-d system .....	43
Figure E.5 – Type T <sub>2</sub> l system .....	45
Figure E.6 – Type T <sub>3</sub> l-a system .....	47
Figure E.7 – Type T <sub>3</sub> l-b system .....	48
Figure E.8 – Type T <sub>4</sub> l system .....	50
Figure E.9 – Type T <sub>5</sub> l system .....	51
Figure E.10 – Type T <sub>6</sub> l system .....	52
Figure E.11 – General architecture of a micropower plant supplying a microgrid .....	54
Figure E.12 – Type T <sub>2</sub> C system.....	55
Figure E.13 – Type T <sub>3</sub> C-a system.....	57
Figure E.14 – Type T <sub>3</sub> C-b system.....	58
Figure E.15 – Type T <sub>4</sub> C-a system.....	60
Figure E.16 – Type T <sub>4</sub> C-b system.....	61
Figure E.17 – Type T <sub>5</sub> C system.....	63
Figure E.18 – Type T <sub>6</sub> C system.....	65
Table 1 – Application types and types of uses.....	16
Table 2 – Expected quality of the supply .....	17
Table 3 – Synthesis of quantitative requirements/category – Examples of type of user and use.....	18
Table 4 – Typology of decentralized electrification systems .....	19
Table 5 – Preliminary range of relevant (as a minimum) decentralized electrification systems .....	21
Table 6 – Recapitulation of characteristics of different types of isolated electrification systems .....	26
Table C.1 – Combined categorization .....	35
Table C.2 – Service specification (example) .....	35
Table D.1 – Principles and characteristics of production subsystems .....	36
Table E.1 – Glossary of symbols.....	38
Table E.2 – List of cases, type T <sub>1</sub> l.....	39
Table E.3 – List of cases, type T <sub>3</sub> l.....	46
Table E.4 – List of cases, type T <sub>3</sub> C .....	56
Table E.5 – List of cases, type T <sub>4</sub> C .....	59

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**RECOMMENDATIONS FOR RENEWABLE ENERGY  
AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –****Part 2: From requirements to a range of electrification systems**

## 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) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- 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 62257-2, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This second edition cancels and replaces the first edition issued in 2004. It constitutes a technical revision.

The main technical changes with regard to the previous edition are as follows:

- redefine the maximum AC voltage from 500 V to 1 000 V, the maximum DC voltage from 750 V to 1 500 V;
- removal of the limitation of 100 kVA system size. Hence the removal of the word “small” in the title and related references in this technical specification.

This technical specification is to be used in conjunction with the other documents of the IEC 62257 series.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
82/947/DTS	82/998A/RVC

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

A list of all parts in the IEC 62257 series, published under the general title *Recommendations for renewable energy and hybrid systems for rural electrification*, 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 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

The IEC 62257 series intends to provide to different players involved in rural electrification projects (such as project implementers, project contractors, project supervisors, installers, etc.) documents for the setting up of renewable energy and hybrid systems with AC voltage below 1 000 V and DC voltage below 1 500 V.

These documents are recommendations:

- a) to choose the right system for the right place;
- b) to design the system;
- c) to operate and maintain the system.

These documents are focused only on rural electrification concentrating on but not specific to developing countries. They should not be considered as all inclusive to rural electrification. The documents try to promote the use of renewable energies in rural electrification; they do not deal with clean mechanisms development at this time (CO<sub>2</sub> emission, carbon credit, etc.). Further developments in this field could be introduced in future steps.

This consistent set of documents is best considered as a whole with different parts corresponding to items for safety, sustainability of systems aiming at the lowest life cycle cost as possible. One of the main objectives is to provide the minimum sufficient requirements, relevant to the field of application that is: renewable energy and hybrid off-grid systems.

The purpose of this part of the IEC 62257 series is to propose a range of renewable energy based electrification systems able to meet the requirements of customers identified in the field of decentralized rural electrification projects.

This technical specification was developed in cooperation with other IEC technical committees and subcommittees dealing with renewable energies and related matters, namely technical committee 21 ("Secondary cells and batteries"), subcommittee 21A ("Secondary cells and batteries containing alkaline or other non-acid electrolytes"), technical committee 64 ("Electrical installations and protection against electric shock"), technical committee 88 ("Wind turbines"), and others.