IEC TS 62257-9-6

Edition 2.0 2019-09
REDLINE VERSION

TECHNICAL SPECIFICATION

colour inside

~~Recommendations for small~~ Renewable energy and hybrid systems for rural electrification –
Part 9-6: Integrated system – Recommendations for selection of Photovoltaic Individual Electrification Systems (PV-IES)

IEC TS 62257-9-6:2019-09 RLV(en)

Documents
Document Sharing Hub

Full document details: IEC TS 62257-9-6 2019 RLV

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2019 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 Varembé
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 It also gives information on projects, replaced and withdrawn publications.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.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
67 000 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.

Documents
Document Sharing Hub

Full document details: IEC TS 62257-9-6 2019 RLV

IEC TS 62257-9-6

Edition 2.0 2019-09
REDLINE VERSION

TECHNICAL SPECIFICATION

colour inside

~~Recommendations for small~~ Renewable energy and hybrid systems for rural electrification –
Part 9-6: Integrated system – Recommendations for selection of Photovoltaic Individual Electrification Systems (PV-IES)

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.160; 27.180

ISBN 978-2-8322-7454-5

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

® Registered trademark of the International Electrotechnical Commission

Documents
Document Sharing Hub

Full document details: IEC TS 62257-9-6 2019 RLV

CONTENTS

FOREWORD 4
INTRODUCTION 2
1 Scope 8
2 Normative references 8
3 Terms, definitions and abbreviated terms 9
3.1 Terms and definitions 9
3.2 Abbreviated terms 10
4 System boundaries 10
5 System pre-selection 10
5.1 Services to be provided by the system 10
5.2 Specification of a model 10
5.2.1 General operating conditions 10
5.2.2 Design 11
5.2.3 Components requirements 11
5.2.4 Safety issues 11
5.2.5 Installation rules 11
5.2.6 Operation and maintenance rules 11
5.2.7 Documentation and marking 12
5.3 Pre-selection process 12
5.3.1 Elements of the GS to be provided to potential suppliers 12
5.3.2 Answers to be provided by potential suppliers 12
5.3.3 Pre-selection criteria 12
6 Comparative tests 13
6.1 General 13
6.2 Service requirements 13
6.3 Service quality index 13
6.4 Testing programme 16
6.4.1 General 16
6.4.2 Test 1: initial inspection and commissioning 17
6.4.3 Test 2: ability to provide the required service under daylight favourable conditions 18
6.4.4 Test 3: ability to provide the required service under daylight unfavourable conditions 21
6.4.5 Test 4: final inspection 23
6.4.6 General conclusion 23
Annex A (informative) Data record sheet for visual inspection 25
Annex B (informative) Commissioning records sheet 26
Annex C (informative) Examples of load profiles for comparative tests 28
C.1 Examples of loads 28
C.2 Examples of systems 28
C.3 Examples of load profiles 29
Annex D (informative) Instruction and data record sheet models (according to a load profile as proposed in Annex A) 30
Bibliography 37

Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

Figure 1 – Test 2, Phase A: initial charge cycles 19
Figure 2 – Test 2, Phase B: operating cycles 20
Figure 3 – Test 3, operating cycles 22

Table 1 – Climatic conditions (example) 11
Table 2 – Suggested minimum values for IP and IK 11
Table 3 – Lighting service indexes 14
Table 4 – Radio / TV service indexes 15
Table 5 – Refrigeration service indexes 15
Table 6 – Testing programme 17
Table A.1 – Data record sheet for visual inspection (example) 25
Table B.1 – Commissioning records sheet (example) 26
Table C.1 – Example of loads 28
Table C.2– Example of small PV-IES loads (~50 Wp) 28
Table C.3 – Example of medium PV-IES loads (~200 Wp) 28
Table C.4 – Example of large PV-IES loads (~500 Wp) 29
Table C.5 – Example of system load profile to perform test on PV-IES 29
Table D.1 – Overview instruction sheet for daily records (example) 30
Table D.2 – Record sheet for lighting service (example) 32
Table D.3 – Record sheet for radio service (example) 33
Table D.4 – Record sheet for TV service (example) 34
Table D.5 – Record sheet for refrigeration service (example) 35
Table D.6 – System daily quality index of service evaluation (example) 36

Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

INTERNATIONAL ELECTROTECHNICAL COMMISSION

_____

~~RECOMMENDATIONS FOR SMALL~~ RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 9-6: Integrated systems – Recommendations for selection of Photovoltaic Individual Electrification Systems (PV-IES)

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.

This redline version of the official IEC Standard allows the user to identify the changes made to the previous edition. A vertical bar appears in the margin wherever a change has been made. Additions are in green text, deletions are in strikethrough red text.

Documents
Document Sharing Hub

Full document details: IEC TS 62257-9-6 2019 RLV

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 62257-9-6, which is a technical specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

This second edition of IEC TS 62257-9-6 cancels and replaces the first edition published in 2008. It constitutes a technical revision.

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

- Removal of the term "small" from the title of the publication and from description of rural electrification systems.
- Removal of the limits on system voltage and power; these recommendations apply to systems of all sizes.

This part of IEC 62257 is to be used in conjunction with the IEC 62257 series.

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

Enquiry draft	Report on voting
82/1279/DTS	82/1533A/RVDTS

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.

A list of all parts of IEC 62257 series, under the general title: *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.

Documents
Document Sharing Hub

Full document details: IEC TS 62257-9-6 2019 RLV

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

Documents
Document Sharing Hub

Full document details: IEC TS 62257-9-6 2019 RLV

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, product suppliers, etc.) documents for ~~the~~ setting up ~~of~~ renewable energy and hybrid systems with a.c. voltage below ~~500 V, d.c. voltage below 750 V and power below 100 Kva~~ 1 000 V and d.c. voltage below 1 500 V.

These documents are recommendations:

- to choose the right system for the right place;
- to design the system;
- to ensure product quality and installation quality;
- to operate and maintain the system.

~~These documents are focused only on rural electrification concentrating on but not specific to developing countries. They must 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 developments at this time (CO_2 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 and 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: small renewable energy and hybrid off-grid systems.~~

~~This document and the others of the IEC 62257 series are only guidance and so cannot be International Standards. Additionally their subject is still under technical development and so they shall be published as Technical Specifications.~~

These documents are focused on off-grid electricity access, concentrating on, but not limited to, areas with a significant fraction of the population living without reliable electric grid access. They should not be considered as providing complete coverage of all issues related to rural electrification.

This set of documents is best considered as a whole, with different parts covering topics such as safety, system design, product quality, installation and maintenance, and the sustainability of systems aiming at the lowest life cycle cost possible. One of the main objectives is to provide minimum requirements relevant to renewable energy and hybrid off-grid power systems.

Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

~~RECOMMENDATIONS FOR SMALL~~ RENEWABLE ENERGY AND HYBRID SYSTEMS FOR RURAL ELECTRIFICATION –

Part 9-6: Integrated systems – Recommendations for selection of Photovoltaic Individual Electrification Systems (PV-IES)

1 Scope

The purpose of this part of IEC 62257 is to propose simple selection procedure and cheap, comparative tests which can be performed in laboratories of developing countries, in order to identify the most suitable model of ~~small~~ Photovoltaic Individual Electrification Systems (PV-IES) up to 500 Wp for a particular rural electrification project from a number of products submitted for test.

It is different from the scope of IEC 62124, *Photovoltaic (PV) stand alone systems – Design verification*, which provides guidance for verifying the design of stand-alone PV systems and indoor and outdoor tests in order to evaluate the performance of PV systems including PV generator, battery storage and loads such as lights, TV sets, and refrigerators.

The tests provided in this document allow assessment of the performance of PV-IES according to the requirement of the General Specification (GS) of the project (see IEC TS 62257-2) and to verify their ability to provide the required service. They ~~should be~~ are performed locally, as close as possible to the real site operating conditions.

This document is not a type approval standard. It is a technical specification to be used as guidelines and does not replace any existing IEC standard on PV systems.

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 61215 (all parts), *Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval*

~~IEC 61646, *Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval*~~

IEC 61730-1, *Photovoltaic (PV) module safety qualification – Part 1: Requirements for construction*

IEC 61730-2, *Photovoltaic (PV) module safety qualification – Part 2: Requirements for testing*

IEC TS 62257-2:~~2004~~2015, *Recommendations for ~~small~~ renewable energy and hybrid systems for rural electrification – Part 2: From requirements to a range of electrification systems*

IEC TS 62257-4, *Recommendations for ~~small~~ renewable energy and hybrid systems for rural electrification – Part 4: System selection and design*

AVA Documents Document Sharing Hub

Full document details: IEC TS 62257-9-6 2019 RLV

IEC TS 62257-5, *Recommendations for ~~small~~ renewable energy and hybrid systems for rural electrification – Part 5: Protection against electrical hazards*

IEC TS 62257-6, *Recommendations for ~~small~~ renewable energy and hybrid systems for rural electrification – Part 6: Acceptance, operation, maintenance and replacement*

IEC TS 62257-7-1, *Recommendations for small renewable energy and hybrid systems for rural electrification – Part 7-1: Generators – Photovoltaic ~~arrays~~ generators*

IEC TS 62257-8-1:~~2007~~2018, *Recommendations for ~~small~~ renewable energy and hybrid systems for rural electrification – Part 8-1: Selection of batteries and battery management systems for stand-alone electrification systems – Specific case of automotive flooded lead-acid batteries available in developing countries*

IEC TS 62257-9-3, *Recommendations for ~~small~~ renewable energy and hybrid systems for rural electrification – Part 9-3: Integrated system – User interface*

IEC TS 62257-9-4, *Recommendations for ~~small~~ renewable energy and hybrid systems for rural electrification – Part 9-4: Integrated system – User installation*

IEC TS 62257-12-1, *Recommendations for ~~small~~ renewable energy and hybrid systems for rural electrification – Part 12-1: ~~Selection of self-ballasted lamps (CFL) for rural electrification systems and recommendations for household lighting equipment~~ Selection of lamps and lighting appliances for off-grid electricity systems*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1.1
cycle
sequence of a discharge followed by a charge or a charge followed by a discharge of a battery under specified conditions

3.1.2
duration of service
number of hours when a load is powered

3.1.3
fulfilment of service
ratio of a measured provided service to a required service

3.1.4
initial charge
commissioning charge given to a new battery to bring it to the fully charged state

3.1.5
period of service
part of the day when a load is powered

Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

3.1.6
reference irradiation
value of irradiation taken in consideration for the design of the system, approved by the project implementer and specified in the GS of the project

3.1.7
service ratio
extent in which the service required by the GS is fulfilled by the system

3.2 Abbreviated terms

GS	general specification for the project
QI	quality of service index
$TWQI_T$	total weighted quality of service
$DWQI_T$	daily weighted quality of service
S_{good}	service ratio under favourable conditions
S_{bad}	service ratio under unfavourable conditions
S_d	daily service ratio

4 System boundaries

A PV-IES comprises the following elements:

- a PV generator including PV modules and support structure;
- a charge controller;
- a storage system (including battery and associated casing);
- adequate wiring, switches and protective devices (see IEC TS 62257-9-3 and IEC TS 62257-9-4);
- loads relevant for the required service (such as lamps, TV set, radio set, and refrigerators).

5 System pre-selection

5.1 Services to be provided by the system

The preliminary socio-economic studies shall provide the project developer with information on the ability of the customers who will benefit from the project to pay for the service provided. Then, the project developer shall define within the GS the range of services to be provided as described in IEC TS 62257-2 as well as the relative priority of the services to be provided (TV, lighting, etc.)

5.2 Specification of a model

5.2.1 General operating conditions

The project implementer shall define the operating conditions to which the PV-IES can be subjected. Examples of such conditions are given in Table 1.

Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

Table 1 – Climatic conditions (example)

	Nominal operating range	Storage – Transport
Temperature	–10 °C to +50 °C	–40 °C to +80 °C
Humidity at 28 °C	5 % to 95 %	
Atmospheric pressure	860 hPa to 1 060 hPa	

5.2.2 Design

For the part of the project which will be implemented through Individual Electrification Systems, the project developer shall size a range of PV IES able to provide the required service under the specified operating conditions (see IEC TS 62257-2). The project implementer could either:

- specify complete integrated systems, or
- specify the different components for PV-IES in order to realize the integration of these components through its own system design.

In addition, the project developer shall set up the requirements for the loads relevant for the service to be provided (such as lamps, TV set, radio set, and refrigerator).

5.2.3 Components requirements

The components of the PV-IES shall comply with the relevant IEC standards and/or the relevant local regulations if any.

For the selection of batteries, tests recommended in IEC TS 62257-8-1 shall apply and for the selection of lamps, tests recommended in IEC TS 62257-12-1 shall apply.

5.2.4 Safety issues

The project developer shall define the IP degree and IK code of the expected products.

Table 2 gives some values that could be considered as a minimum.

Table 2 – Suggested minimum values for IP and IK

Protection degree	Minimum suggested value
IP	34
IK	8

Safety rules shall comply with IEC TS 62257-5.

5.2.5 Installation rules

The complete installation shall comply with IEC TS 62257-7-1 and IEC TS 62257-9-4 and any local wiring codes.

5.2.6 Operation and maintenance rules

The systems shall be designed in order that operation and maintenance may be performed in accordance with the specifications given in IEC TS 62257-6.

AVA Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

5.2.7 Documentation and marking

A manual shall also be provided including PV-IES installation and operating guidelines such as:

- initial operations before first use;
- instructions to use the PV-IES properly;
- mounting the PV module;
- charging instructions;
- maintenance and troubleshooting instructions.

5.3 Pre-selection process

5.3.1 Elements of the GS to be provided to potential suppliers

The project implementer shall supply the annual locally available solar irradiation curve.

NOTE This information could be provided through available laboratory data or through local measurements performed with a reference cell that will be used afterwards for the comparative tests.

This information as well as the requirements defined in 5.1 and 5.2 shall be provided to potential suppliers in order to receive proposals for relevant products.

The project implementer could:

- provide load requirements and let the suppliers provide systems to supply the load, or
- provide a complete PV-IES system specification, in order to source complete integrated PV-IES, or
- provide components requirements in order to source separately the different components of a PV-IES and realize the integration of these components.

5.3.2 Answers to be provided by potential suppliers

The supplier of the PV-IES and/or of the components shall prove that the PV-IES and/or the components comply with the relevant IEC standards and IEC 62257 technical specifications.

A technical sheet shall be provided by the supplier in order to demonstrate the ability of its product to match the requirements defined in 5.1 and 5.2.

5.3.3 Pre-selection criteria

The performances claimed by the manufacturer shall be compared to the performances required by the GS in order to make a pre-selection of available products.

The following general criteria can be used as an initial help for product pre-selection:

- services characteristics claimed by the manufacturer (duration of service and fulfillment of service);
- conformity of the modules with the following IEC standards: IEC 61215 series, ~~IEC 61646,~~ and IEC 61730-1 and IEC 61730-2;
- conformity of the batteries, lamps, etc., with the relevant IEC standards and pre-selection process of potential products as recommended in the IEC TS 62257 series;
- battery casing characteristics.

A short list of products potentially able to match the requirements of the GS shall be set up by the project implementer.

AVA Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

6 Comparative tests

6.1 General

After the pre-selection process, samples of products of the short list shall be processed through comparative technical tests.

IMPORTANT: All the pre-selected systems shall be tested simultaneously in the same local conditions in order to ensure that they are tested under the same environmental parameters (irradiation, humidity, temperature, etc.).

Tests could be performed either in outdoor conditions, in local laboratories or in site conditions (on future customer homes for instance). The systems installation rules provided in the GS are also applicable to test installations.

6.2 Service requirements

Pre-selected models shall be examined to ensure that they will provide the required services mentioned in the GS according to the load profile used for the design of the system.

A service is defined by:

- The types of appliances/loads powered by the system (such as lamps, TV set, etc.);
- For each type of appliance:
  - the number of appliances that can be simultaneously powered;
  - the daily duration of the power supply;
  - the fulfilment of the provided service.

6.3 Service quality index

A Quality of service Index (QI) of a system is based on one of these two terms:

- d = duration index, d, is the ratio of the measured daily duration of service compared to the required daily duration of service;
- f = fulfilment index, f, is the ratio of the measured performance (illuminance for lamps, temperature for refrigerator, etc.) compared to a reference level required by the GS.

For the different considered services the QI takes into account either, d, or, f:

– for lighting: f;
– for radio: d;
– for TV: d;
– for refrigeration: f.

The systems shall be compared through a Total Weighted Quality of service Index ($TWQI_T$) calculated on the basis of observations and measurements performed during, T, days of comparative tests.

The $TWQI_T$ and service ratio (S) are calculated as follows:

a) Step 1: for each service, calculation every day of either "duration" or "fulfilment" indexes

The following Tables 3 to 5 illustrate the necessary index evaluation data and calculation rules.

Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

Table 3 – Lighting service indexes

<table>
<tr><td>Service</td><td colspan="3">Lighting</td></tr>
<tr><td rowspan="3">Requirements</td><td>Number of lamps</td><td colspan="2">N_L</td></tr>
<tr><td>Daily duration of service per lamp (h)</td><td colspan="2">D_L</td></tr>
<tr><td>Illuminance (lux)</td><td colspan="2">Q</td></tr>
<tr><td colspan="2">Duration index</td><td colspan="2">Fulfilment index</td></tr>
<tr><td colspan="2" rowspan="2">Not relevant</td><td>Measured illuminance

lux</td><td>Total measured illuminance for every hour of service

lux

see Note 1</td><td>Fulfilment index

see Note 2</td></tr>
<tr><td>For lamp 1: q_{L1}
For lamp 2: q_{L2}
…
For lamp i: q_{Li}</td><td>$\sum_{i=1}^{i=n} q_{L_i}$</td><td>$f_{\text{Lighting}} = \frac{\sum_{j=1}^{j=D_L}\sum_{i=1}^{i=n} q_{L_i}}{n \times Q}$</td></tr>
<tr><td colspan="4">NOTE 1 n = number of illuminance measurements at each hour of service; $n \le N_L$.
NOTE 2 In order to limit the number of measurements, if $N_L > 3$, n could be limited to $n = 3$.</td></tr>
</table>

In this case the formula becomes: $f_{\text{Lighting}} = \frac{\sum_{j=1}^{j=D_L}\sum_{i=1}^{i=3} q_{L_i}}{3 \times Q}$

In this example only 3 lamps out of N_L are measured every hour. Generally it is preferable to ensure that all the lamps have been equally monitored at the end of the test.

A complete example for the lighting service is given in Table D.2.

Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

Table 4 – Radio / TV service indexes

Service	**Radio (or TV)** (see Note)			
Requirements	Number of radio sets			N_R
	Daily duration of service per set (h)			D_R
Duration index				**Fulfilment index**
Total required daily duration of service h	Measured daily duration of service h	Total measured daily duration of service h	Duration index	Not relevant
$N_R \times D_R$	For set 1: d_{R1} For set N: d_{RN}	$\sum_{i=1}^{i=N_R} d_{R_i}$	$d_{Radio} = \frac{\sum_{i=1}^{i=N_R} d_{R_i}}{N_R \times D_R}$	
NOTE In the TV set case, subscript R should be changed to T.				

Table 5 – Refrigeration service indexes

Service	**Refrigeration**		
Requirements	Number of refrigerators	N_F (N_F=1 in most cases)	
	Daily duration of service (h)	Not relevant	
	Temperature (°C)	Temperature reference: T°	
Duration index	**Fulfilment index**		
Not relevant	Measured temperature: Θ °C See Note 1	Average measured temperature deviation °C	Fulfilment index
	measure 1 $\Delta\theta_1 = \Theta_1 - T$ measure 2 $\Delta\theta_2$ … measure n $\Delta\theta_n$	$\frac{\sum_{i=1}^{i=n} \Delta\theta_i}{n}$	$f = 1 - \left(\frac{\sum_{i=1}^{i=n} \Delta\theta_i}{n \times T} \right)$
NOTE n = number of temperature measurements.			

b) Step 2: for each tested system, calculation of a DWQIT

For a given service X, the Quality of service Index (QI) is:

$QI_X = d_X$

or

$QI_X = f_X$.

If the project implementer does not give the same priority to the services, he could determine some “weighting coefficients”, k, reflecting the relative importance assigned to the different services provided.

Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

The relative priority of the different services shall be determined by a socio-economic study (see 5.1).

Using these weighting coefficients, a Daily Weighted Quality Index (DWQI) shall be calculated for a system, as given in the following formula (1). For a given day, *t*, and for X types of services:

$$DWQI_t = \sum_{i=1}^{i=X} k_i \times QI_i \quad (1)$$

– For lamps: $k_{Lighting} = k_L$

– For radios: $k_{Radio} = k_R$

– For TVs: $k_{TV} = k_T$

– For refrigerators: $k_{Fridge} = k_F$

Using this hypothesis, for a system providing all the mentioned services the $DWQI$ for a day, t, is:

$$DWQI_t = (k_L \times QI_{Lighting}) + (k_R \times QI_{Radio}) + (k_T \times QI_{TV}) + (k_F \times QI_{Fridge})$$

It is the project developer's responsibility to determine the *k* coefficients according to the importance he gives to each service.

~~NOTE~~ As an example, a convenient rule to determine values for the weighting coefficient, k, may be based on the daily required duration of service (see Table D.6).

c) Step 3: for each tested system, calculation of a $TWQI_T$

On the complete duration of the test, a $TWQI_T$ shall be determined according to the following formula (2). For a test performed on, *T*, days:

$$TWQI_T = \sum_{t=0}^{t=T} DWQI_t \quad (2)$$

with $TWQI_{T,max} = T \times \sum_{i=1}^{i=X} k_i$ (case where all service quality indexes are equal to 1)

d) Step 4: for each tested system, calculation of a service ratio, S

The laboratory operator shall calculate the maximum value of the $TWQI_T$ in the conditions of the test.

Then he shall calculate for each system the service ratio by the following formula (3):

$$S = \frac{TWQI_{T,act}}{TWQI_{T,max}} \quad (3)$$

where

$TWQI_{T,act}$: results of $TWQI_T$;

and $TWQI_{T,max}$: maximum value of $TWQI_T$

This ratio expresses to what extent the system is able to provide the service required by the GS.

6.4 Testing programme

6.4.1 General

The comparative tests include a set of 4 tests as indicated in Table 6.

Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

The complete set of tests is intended to be performed within a period of 90 days during the appropriate season as identified during the project preliminary studies and according to the quality of service specified by the project developer (see IEC TS 62257-2:2015, Annex C).

The system shall be tested under two daylight conditions:

- Daylight favourable conditions: in this configuration local irradiation is at least 90 % of the reference value given in the GS.
- Daylight unfavourable conditions: in this configuration, the irradiation taken into account shall be determined by the project implementer as a percentage of the reference value given in the GS (such as for example the irradiation during the rainy season).

Table 6 – Testing programme

Test 1	**Test 2**	**Test 3**	**Test 4**
Initial inspection and commissioning	Ability to provide the required service under daylight *Favourable conditions*	Ability to recover the required service under daylight *Unfavourable conditions*	Final inspection
See 6.4.2	See 6.4.3	See 6.4.4	See 6.4.5

6.4.2 Test 1: initial inspection and commissioning

6.4.2.1 General

The purpose of the different inspection tests (Test 1 and Test 4) is to assess the evolution / degradation of the conditions of the different parts of the product during the test period, especially casings, lamps, cables and PV modules.

The initial inspection is intended to record all necessary details of each sample of each pre-selected model and identify the sample for the duration of all tests. It will also verify that the sample has been supplied with all necessary items and components required by the GS.

In Test 1, after the initial inspection, the system shall be commissioned.

As much information as possible concerning each sample to be tested should be recorded.

6.4.2.2 Sampling

Three samples of each model are required. For small projects, if the cost of the testing is too high, the sampling could be limited to two samples of each model.

A test item number shall be assigned to each sample and used in all data sheets and records to avoid confusing sample results. It is recommended that the unit should be photographed in such a way that all major accessible components are recorded.

6.4.2.3 Operation

The initial inspection shall be performed in two steps:

- unpacking step; and
- installation step.

Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

A list (non comprehensive) of items to be checked and recorded during these two periods is provided as an example in Annex A.

After the initial inspection and installation of the system, commissioning shall be performed (an example of a commissioning sheet is given in Annex B).

6.4.2.4 Results

The pass criteria is based on the following:

For each sample:

- there shall be no visual evidence of a major defect on any component; and
- the sample is complete; and
- the installed system has been commissioned satisfactorily.

The fail criteria is based on the following:

For each sample:

- there is evidence of a major defect; or
- some components are missing or incorrect; or
- the system cannot be installed properly according to the GS requirements.

It is up to the project implementer to determine whether he will accept a certain model if one or more samples have failed this initial visual inspection.

6.4.3 Test 2: ability to provide the required service under daylight favourable conditions

6.4.3.1 General

The purpose of this test is to check the ability of a PV-IES product to perform the required service under daylight sunny conditions considered as favorable.

A reference load profile shall be established for the tests according to the service required in the GS. Some examples of such load profiles are given in Annex C.

6.4.3.2 Sampling

Each model for which ~~the three~~ all samples passed Test 1 shall go through to Test 2.

6.4.3.3 Equipment

To perform Test 2 the following equipment shall be necessary:

- A power system to supply energy to all test instruments.

  ~~NOTE 1~~ If the testing is performed in a laboratory connected to a grid, no additional power system is necessary. If the testing is performed on site, a dedicated power system is necessary to supply energy to testing devices.

- A reference device (such as a reference PV module, pyrheliometer, etc.) to assess and record the daily irradiation.

  ~~NOTE 2~~ This device may also be initially used to assess the value of the irradiation to be taken in account for the design of the systems.

AVA Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

- Test instruments:
  - Programmable controllers to monitor the load profiles. If not, the loads may be switched on/off manually.
  - One (or several) illuminance measurement box(es) (see IEC TS 62257-12-1).
  - A thermometer, preferably electronic.

6.4.3.4 Operation

6.4.3.4.1 General

Test 2 shall be performed according to the following phases:

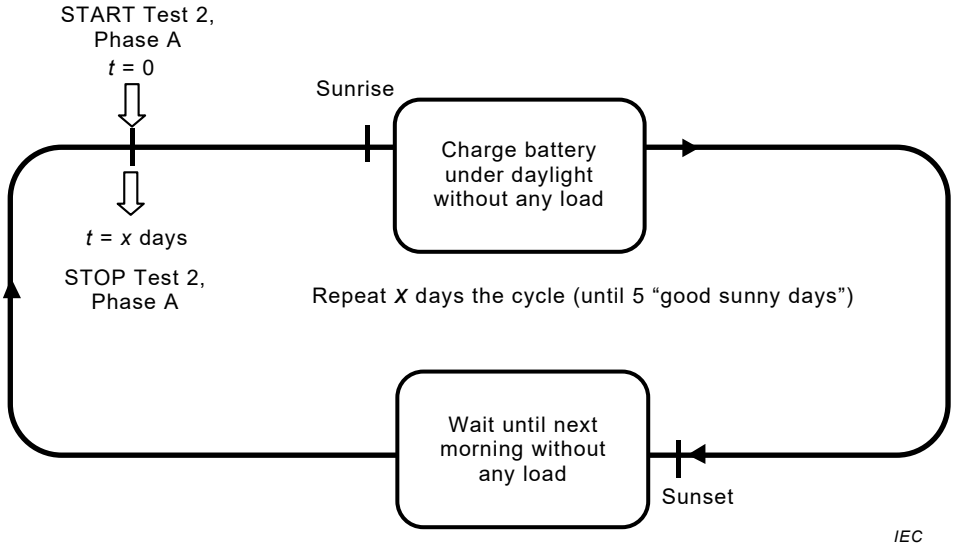
6.4.3.4.2 Phase A: initial preparation

This phase is dedicated to charge the battery before testing the ability of the system to perform the required service.

The initial charge is controlled by the charge controller of the PV-IES without any manual intervention. During the initial charge, all the loads shall be switched off.

The initial charge shall be performed for, x days ($x \geq 5$) until 5 "good sunny days" have been recorded. A "good sunny day" is defined as a day when irradiation is equal to or greater than 90 % of the reference irradiation defined in the GS (considered as favourable conditions).

The following Figure 1 illustrates the Phase A cycles:



NOTE It would be preferable to perform the initial charge in the season when the probability of having five "good sunny days" consecutively is the highest.

Figure 1 – Test 2, Phase A: initial charge cycles

6.4.3.4.3 Phase B: operating conditions

This phase is dedicated to run the system over a long period in order to check its ability to provide the required services under local operating conditions.

Phase B shall be performed immediately after Phase A.

Figure 2 illustrates the cycles to be performed.

Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

The time for start is chosen a short while before sunrise.

The charging of the battery is controlled by the charge controller provided within the system.

The loads are switched on and off according to the load profile, either manually by the laboratory operator or automatically by a programmable controller.

Between sunrise and sunset, the system is intended to be both able to charge the battery and to supply energy to loads (according to the load profile).

After sunset, the system is intended to be able to supply the loads according to the load profile which reflects as close as possible the way of life of the future customers.

The sunrise-sunset cycle shall be repeated, *y,* days ($y \geq 30$) until 30 "good sunny days" have been recorded.

~~NOTE~~ It is better to perform the test during the sunny season and to ensure that, *y*, is less than or equal to 40 days. This is intended to shorten the duration of the test and thus reduce its cost and ensure good quality records.

The laboratory operator shall observe and record the start and the end of the service according to each step of the load profile.

An example of an instruction sheet for the operator is given in Annex D. For the duration of the test, the laboratory operator will live at the same rhythm as the future customers.

As a debugging period, a preliminary cycle will be performed in order to verify that the programmable controller (if any) and all the test facilities are functional.

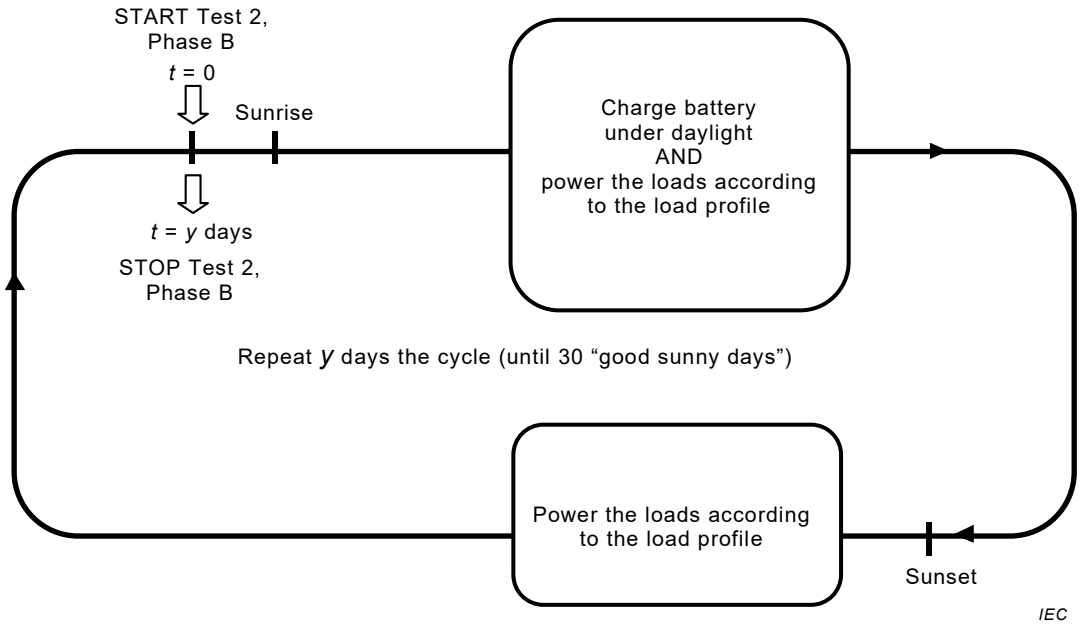


Figure 2 – Test 2, Phase B: operating cycles

All along the test, the characteristics of the service provided shall be recorded. Examples of record sheets are given in Annex D.

Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV

6.4.3.5 Results

The different tested systems shall be compared through the different quotations based on the total weighted quality of service index (see 6.3) and also on economic considerations (see IEC TS 62257-4).

a) Pass criteria

For each tested systems, the service ratio $S_{good} = \frac{\text{actual TWQI}_T}{\text{maximum TWQI}_T}$ shall be ≥ 0,70.

b) Fail criteria

If the service ratio S < 0,70 the concerned system models shall be rejected.

If none of the tested products match the pass criteria the project implementer has two options:

- Change the GS requirements (if acceptable) and select the tested products which are able to match the new requirements; or
- Go back to the manufacturers for the selection of a new range of products to be tested.

6.4.4 Test 3: ability to provide the required service under daylight unfavourable conditions

6.4.4.1 General

The purpose of this test is to check the ability of a PV-IES product to perform the required service under daylight sunny conditions considered as unfavourable (as it could be for example during rainy seasons).

The systems shall be tested under the same reference load profile as used in Test 2.

6.4.4.2 Sampling

All the samples of each model which passed Test 2 shall go through to Test 3.

6.4.4.3 Equipment

The same as used for Test 2.

6.4.4.4 Operating conditions

Test 3 shall be performed immediately after Phase B of Test 2.

Figure 3 illustrates the cycles to be performed.

The time for start and stop is chosen a short while before sunrise.

It is the responsibility of the project developer to specify the procedure to simulate a daylight unfavourable condition as close as possible to the unfavourable conditions of the project.

It is suggested that a method of achieving reduced irradiation close to the unfavourable conditions described in the GS is to cover the PV modules for a part of the day. The laboratory operator may ensure the same irradiation conditions for the tests systems.

The charging of the battery is controlled by the charge controller provided within the system.

The loads are switched on and off according to the load profile, either manually by the laboratory operator or automatically by a programmable controller.

AVA Documents
Document Sharing Hub

Full document details: IEC TS 62257-9-6 2019 RLV

Between sunrise and sunset, the system is intended to be both able to charge the battery and to supply energy to loads (according to the load profile).

After sunset, the system is intended to be able to supply the loads according to the load profile which reflects as close as possible the way of life of the future customers.

The sunrise-sunset cycle shall be repeated *z* days ($z \geq 30$) until 30 "bad sunny days" have been recorded.

For the duration of the test, the laboratory operator will live at the same rhythm as the future customers.

The laboratory operator shall observe and record the start and the end of the service according to each step of the load profile.

Instruction sheets and record sheets for the operator are the same as those used in Test 2 (Annex D).

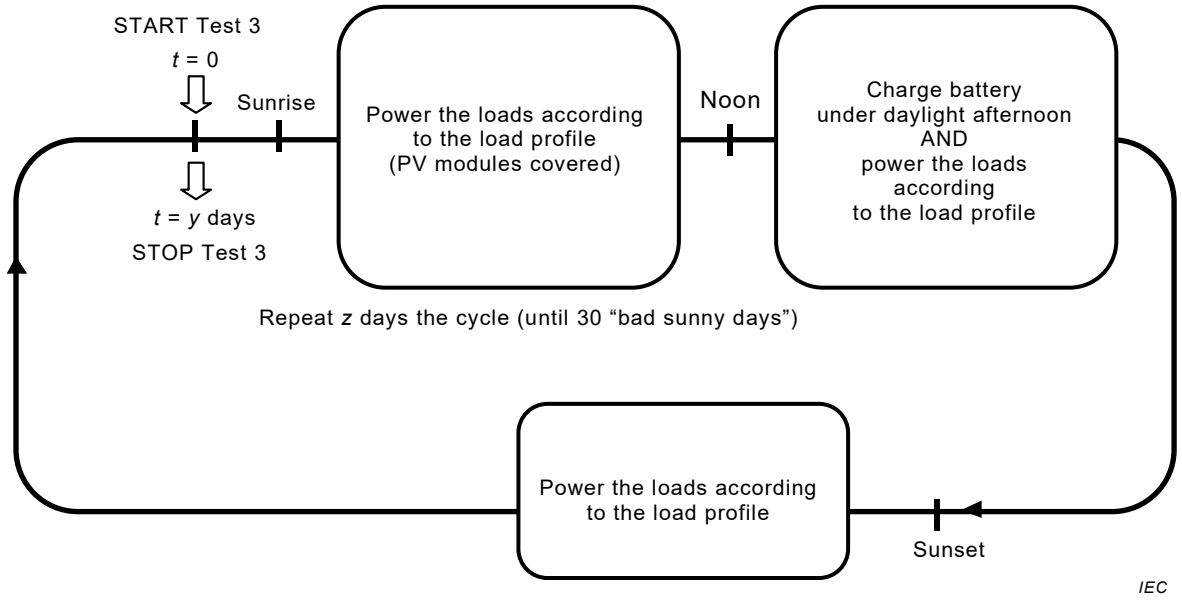


Figure 3 – Test 3, operating cycles

6.4.4.5 Results

The different tested systems shall be compared through the different quotations based on the total weighted quality of service index (see 6.3) and also on economic considerations (see IEC TS 62257-4).

The laboratory operator shall calculate the maximum value of the $TWQI_T$ in the conditions of the test.

a) Pass criteria

For each tested systems, the service ratio, S; under unfavourable conditions S_{bad} shall be ≥ 0,35.

b) Fail criteria

If the service ratio S < 0,35 the concerned system models shall be rejected.

Documents
Document Sharing Hub
Full document details: IEC TS 62257-9-6 2019 RLV