

TECHNICAL SPECIFICATION



Photovoltaic power systems (PVPS) – Information model for availability

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.160

ISBN 978-2-8322-6638-0

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

CONTENTS

FOREWORD.....	5
INTRODUCTION.....	7
1 Scope.....	8
2 Normative references	9
3 Terms and definitions	9
4 Overview	12
4.1 Understanding the use of this document	12
4.2 The information model	13
5 Information categories	16
5.1 General.....	16
5.2 Information available (PVPS)	18
5.3 Operative	18
5.4 In service	19
5.5 Full capability.....	19
5.6 Partial capability	20
5.7 Service set points	20
5.8 Out of service	21
5.9 Out of environmental specification	22
5.10 Requested shutdown	23
5.11 Out of electrical specification	23
5.12 Nonoperative	24
5.13 Scheduled maintenance	24
5.14 Planned corrective action.....	25
5.15 Forced outage.....	25
5.16 Suspended.....	26
5.17 Force majeure.....	26
5.18 Information unavailable (PVPS)	27
6 Information model for PVPS	27
6.1 Time-based capability information model	27
6.2 Time-based total PVPS capacity availability.....	28
6.3 Application of the information model to different plant levels	28
6.4 Asset management functions of the PVPS	29
6.5 Limitations	30
6.6 Information category priority	30
Annex A (informative) Information category-based availability indicators.....	33
A.1 General.....	33
A.2 Operational availability.....	33
A.3 Technical availability.....	34
A.4 Use of the tool	35
Annex B (informative) Energy-based tracking.....	36
B.1 General.....	36
B.2 Specific resource and modeling-based performance (using IEC TS 61724).....	36
B.3 Energy-weighted availability approach	36
B.4 Fractional power estimation techniques	37
B.5 Addressing lost production in the information model	39

Annex C (informative) Reliability, availability, maintainability (RAM) definitions/formulas, availability/stakeholder types, data, and optional categories	41
C.1 General.....	41
C.2 RAM definitions and metrics applicable to forced and maintenance outages	42
C.3 Stakeholders and types of availability	42
C.4 Data.....	44
C.5 Forced outage – optional categories	45
C.5.1 General	45
C.5.2 Response time (R).....	46
C.5.3 Diagnostic time (D).....	46
C.5.4 Logistic time (L).....	46
C.5.5 Repair time (F)	47
C.5.6 Partial capability – optional category of degraded.....	47
C.5.7 Partial capability – optional category of derated.....	48
C.5.8 Partial capability – optional category of other.....	49
Annex D (informative) Verification scenarios.....	50
D.1 Grid outage.....	50
D.1.1 Scenario description	50
D.1.2 Analysis and conclusion	50
D.2 Entry and exit points	51
D.3 Inverter outages.....	53
D.4 Inverter overtemperature outage	54
D.4.1 General	54
D.4.2 Assessment and conclusion.....	54
D.5 Tracking system outage	55
D.5.1 Scenario description	55
D.5.2 Analysis and conclusion	55
D.6 Information category priority	56
D.6.1 General	56
D.6.2 Assessment.....	57
D.7 Verification scenario – Energy: Measured, expected, and lost.....	57
D.7.1 Scenario description	57
D.7.2 Assessment.....	58
D.8 Spinning reserve equivalent.....	60
D.9 Multiple aggregated systems.....	61
D.9.1 Scenario	61
D.9.2 Approach and methodology	61
D.9.3 How is the energy calculated?	61
D.9.4 Assessment.....	61
D.10 Service set points operation.....	61
D.10.1 General	61
D.10.2 Scenario	62
D.10.3 Assessment.....	62
D.11 Information unavailable data	62
D.11.1 General	62
D.11.2 Scenario	62
D.11.3 Conclusion	63
D.12 Redundancy capable PVPS with reliability block diagram.....	63
D.12.1 General	63

D.12.2	Scenario	64
D.12.3	Analysis.....	64
D.13	Levels of monitoring.....	65
D.13.1	General	65
D.13.2	Scenario	65
D.13.3	Assessment.....	65
Annex E (informative)	Information management practices	66
E.1	General.....	66
E.2	Masking	66
E.3	Condition monitoring of components/subcomponents	67
E.4	Monitoring.....	68
E.5	Data with analysis is a powerful tool for understanding PV system performance	69
E.6	Recognizing that costs influence decisions throughout the Life Cycle	71
Bibliography	72
Figure 1	– Data stakeholders for a PVPS	7
Figure 2	– PVPS component-to-revenue path	13
Figure 3	– Process for understanding the use of this document	15
Figure 4	– PVPS plant levels	29
Figure B.1	– RBD of a PVPS.....	38
Figure C.1	– Typical flow time for failure/correction.....	45
Figure D.1	– RBD of PVPS with multiple outages	52
Figure D.2	– Redundancy capable PVPS RDB	64
Table 1	– Stakeholder roles and objectives for reliability and maintenance data	8
Table 2	– Information category overview for a PVPS.....	17
Table 3	– Information category priority for PVPS.....	31
Table A.1	– Allocation to information categories.....	35
Table B.1	– Information categories and additional layers of measured, expected, and lost production	39
Table C.1	– Reliability metrics description.....	44
Table D.1	– Verification scenarios – grid event	50
Table D.2	– Verification scenarios – grid/electrical network aspects.....	51
Table D.3	– Verification scenarios – inverter outage	53
Table D.4	– Inverter overtemperature outage	54
Table D.5	– Tracking system outage	56
Table D.6	– Information category priority	57
Table D.7	– Combined performance and availability.....	58
Table D.8	– Key metrics.....	58
Table D.9	– Measured, expected, and lost	59
Table D.10	– Spinning reserve.....	60
Table D.11	– Redundancy capable PVPS	64
Table E.1	– Monitoring system classification and suggested applications (IEC 61724-1).....	68

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**PHOTOVOLTAIC POWER SYSTEMS (PVPS) –
INFORMATION MODEL FOR AVAILABILITY****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 TS 63019, which is a Technical Specification, has been prepared by IEC technical committee 82: Solar photovoltaic energy systems.

The text of this International Standard is based on the following documents:

DTS	Report on voting
82/1447/DTS	82/1505A/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.

Information model categories are written in capital letters.

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

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

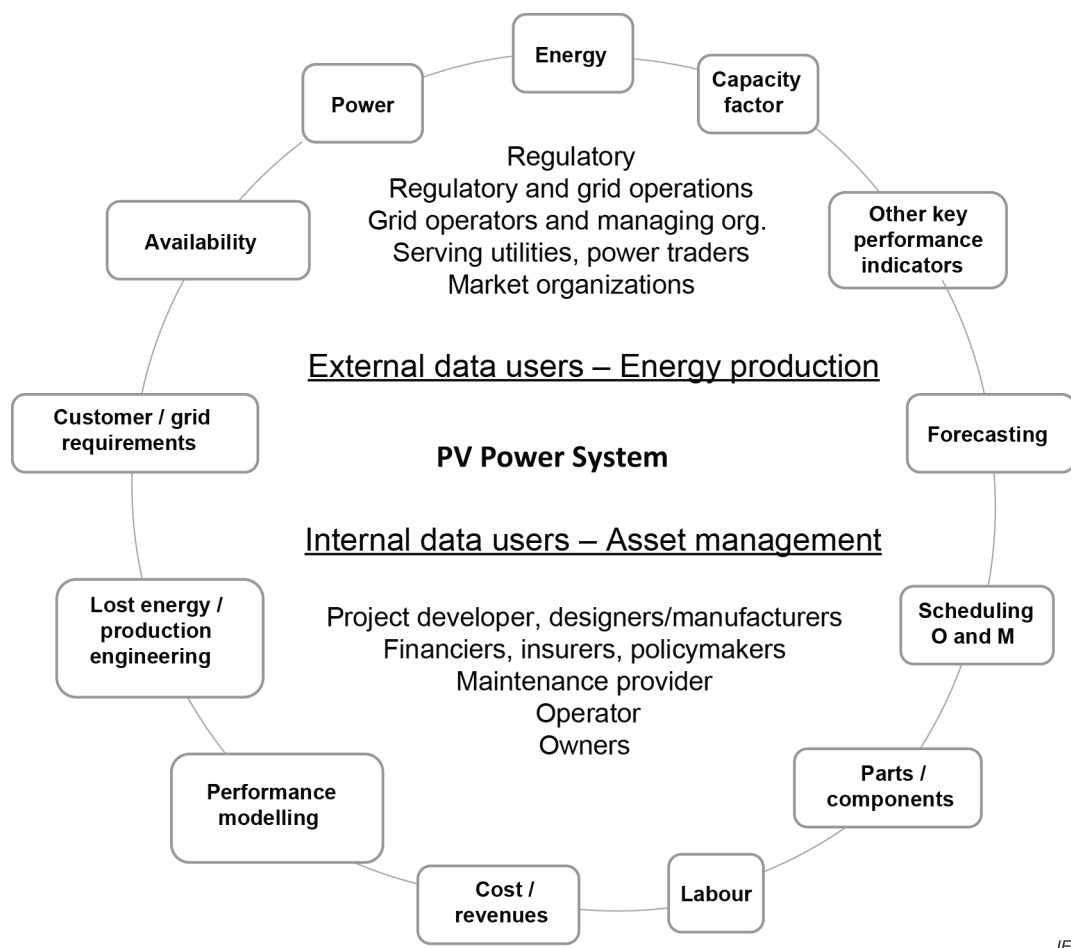
A bilingual version of this publication may be issued at a later date.

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 publication using a colour printer.

INTRODUCTION

This technical specification (TS) defines a common basis for the exchange of information on photovoltaic power system (PVPS) availability metrics among owners, utilities, lenders, operators, manufacturers, engineer/procure/construction firms, specifiers/designers, consultants, regulatory bodies, certification bodies, insurance companies, and other stakeholders. From this diverse group of stakeholders, external and internal interfaces arise in the operation and delivery of power. Although these are mostly power- and energy-related, some are informational or for power system control. The intention is for information exchange on capability- and energy-related data to form a nucleus for separate information needed by stakeholders, as illustrated in Figure 1.

It identifies external and internal elements related to the capability, health, and condition of components, subsystems, and the system itself, as well as energy production, plant operation, and asset management, which also benefit from a defined set of terms. This is achieved by providing an information model specifying how (PVPS) time designations shall be assigned by information categories. An information model facilitates how the unavailability of time of components, subsystems, and systems, as well as the lost power and other capabilities affect the PVPS. The ability to estimate the resulting lost energy and/or loss of PVPS capability forms the basis for how to allocate time for reporting availability metrics or, more directly, unavailability.



IEC

Figure 1 – Data stakeholders for a PVPS

PHOTOVOLTAIC POWER SYSTEMS (PVPS) – INFORMATION MODEL FOR AVAILABILITY

1 Scope

A common basis of understanding results from defined metrics that can be useful to the stakeholders, populated by data collected in the operation of the PVPS:

- a) To provide a standardized approach to characterize availability and unavailability for a PVPS.
- b) To provide standard methodologies for determining the appropriate forms of availability of the PVPS during varying time periods, including real-time capability assessment or longer, for reporting availability metrics to stakeholders.

Table 1 – Stakeholder roles and objectives for reliability and maintenance data

Roles	Objective
Owner	Decision support for investments
Operator	Reporting performance indicators
	Determining availability and weaknesses
	Identifying maintenance strategies
Service provider	Maintenance optimization
	Optimizing keeping stock of spare parts
Original equipment manufacturers/ supplier	Design optimization
Financier/insurer	Risk assessment
Grid operator	Highly reliable and stable bulk power system
Source: International Energy Agency (IEA)	

This document provides a framework from which the availability metrics of a PVPS can be derived and reported. It describes how data are categorized and defines generic information categories to which time can be assigned for a PVPS considering internal and external conditions based on fraction of time, system health, and condition by specifying the following:

- generic information categories of a PVPS considering availability and production.
- information category priority to discriminate between concurrent categories.
- entry and exit point for each information category to allocate designation of time.

The PVPS comprises all photovoltaic (PV) modules, inverters, DC and AC collection systems, grid interconnection equipment, the site, its infrastructure, and all functional service elements. This is further explained in 6.3 and 6.4.

Formulas in this document provide normative guidance for standardization. Beyond that, it is not the intention of this document to specify exactly how other undefined, time-based availability metrics shall be calculated. The annexes are examples and guiding principles for developing methods for calculation and estimation of availability metrics, subject to the knowledge and concurrence for use by the involved stakeholders. Estimates and calculations also have recommendations on how they are to be used as part of the informative function.

It is not within the scope of this document to determine the method of information acquisition. Relevant IEC documents on data collection and information acquisition are included in the following normative references. IEC 61724-1 has requirements and IEC TS 61724-3:2016, 6.2.5, specifically identifies measured data on this topic.

Data generated during the operation of a PVPS are valuable, establishing who owns the monitoring data and who will have access to the data and for what purpose should be established. Different stakeholders will have different needs, as summarized in Table 1 (IEA). In Annex E, the monitoring systems are addressed in greater detail.

Availability metrics cannot be derived without important outage information. Questions can require the PVPS operation to properly collect the requisite data, such as what equipment or portion of the plant is failing, how long, how often, and how much energy is being lost and categorized by the information model. Asset management questions include the source of the outage (i.e., Whose clock is it on? Was the outage due to internal or external forces? What power and energy was generated? And, what was expected?).

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 61724-3:2016, *Photovoltaic system performance – Part 3: Energy evaluation method*

IEEE Std 762™-2006, *IEEE Standard definitions for use in reporting electric generating unit reliability, availability, and productivity*