BS EN IEC 61400-26-1:2019

BSI Standards Publication

Wind energy generation systems

Part 26-1: Availability for wind energy generation systems (IEC 61400-26-1:2019)

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee PEL/88, Wind turbines.

A list of organizations represented on this committee can be obtained on request to its secretary.

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and all of their amendments and corrigenda (if any)

English Version

Wind energy generation systems - Part 26-1: Availability for wind energy generation systems (IEC 61400-26-1:2019)

Systèmes de génération d'énergie éolienne - Partie 26-1: Disponibilité des systèmes de génération d'énergie éolienne
(IEC 61400-26-1:2019)

Windenergieanlagen - Teil 26-1: Verfügbarkeit von Windenergieanlagen
(IEC 61400-26-1:2019)

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European foreword

The text of document 88/665/CDV, future edition 1 of IEC 61400-26-1, prepared by IEC/TC 88 "Wind energy generation systems" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61400-26-1:2019.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-04-03
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-07-03

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IEC 61400-25-2:2006	NOTE	Harmonized as EN 61400-25-2:2007 (not modified)
IEC 61400-25-3:2006	NOTE	Harmonized as EN 61400-25-3:2007 (not modified)
IEC 61400-25-4:2008	NOTE	Harmonized as EN 61400-25-4:2008 (not modified)

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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.
NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.
NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60050-415	-	International Electrotechnical Vocabulary - Part 415: Wind turbine generator systems	-	-
IEC 61400-1	-	Wind energy generation systems - Part 1: Design requirements	EN IEC 61400-1	-

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WIND ENERGY GENERATION SYSTEMS –

Part 26-1: Availability for wind energy generation systems

FOREWORD

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International Standard IEC 61400-26-1 has been prepared by IEC technical committee 88: Wind energy generation systems.

This first edition cancels and replaces IEC TS 61400-26-1:2011, IEC TS 61400-26-2:2014 and IEC TS 61400-26-3:2016.

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

CDV	Report on voting
88/665/CDV	88/705/RVC

Full information on the voting for the approval of this International Standard 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

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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.

Mandatory information categories defined in this document are written in capital letters; optional information categories are written in bold letters.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
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INTRODUCTION

The intention of this International Standard is to define a common basis for exchange of information on availability metrics between stakeholders in the wind power generation business such as owners, utilities, lenders, operators, manufacturers, maintenance providers, consultants, regulatory bodies, certification bodies and insurance companies. From this diverse group of stakeholders, a number of external and internal interfaces arise in the operation and delivery of power. Some of these are energy related and many are informational. Since the intention is for a common basis of informational exchange, many of these interfaces are illustrated in Figure 1, which identifies external and internal elements related to energy production and asset management and which also benefit from a defined set of terms. This is achieved by providing an information model specifying how time designations shall be split into information categories.

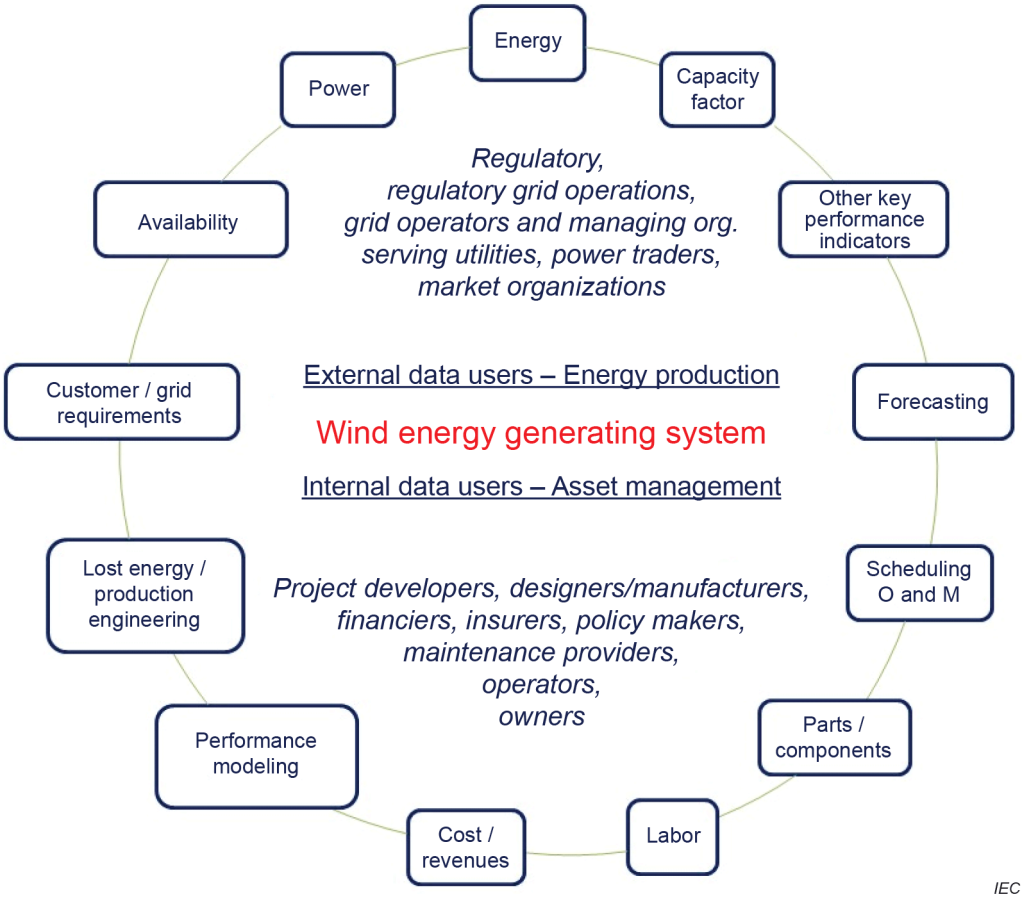

Figure 1 – Data stakeholders for a wind energy generation system

Throughout the document, reference is made to wind energy generation systems (WEGS); however, the document may be used for a single wind turbine (WTGS), as well as for any number of WTGSs combined with additional components to represent a complete wind power station (WPS). The designation WEGS used throughout the document thus shall be understood as the specifications being applicable to individual wind turbines as well as for wind power stations.

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The information model specifies the terminology for reporting availability indicators. Availability indicators include time-based and production-based availability. A WEGS includes all equipment up to the point of interconnection[1], or in case of a single WTGS in a WPS, the interconnection point defined by the user. Availability indicators are based upon fractions of time and the amount a service is providing or capable of providing within the time fractions, taking internal and external aspects into account. Internal aspects will include the WEGS' components and their condition. External aspects are wind and other weather conditions, as well as grid and substation conditions.

[1] Defined in IEC 60050-415:1999, Definition 415-04-01.

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WIND ENERGY GENERATION SYSTEMS –

Part 26-1: Availability for wind energy generation systems

1 Scope

This part of IEC 61400 defines an information model from which time-based, and production-based availability indicators for services can be derived and reported.

The purpose is to provide standardised metrics that can be used to create and organise methods for availability calculation and reporting according to the user's needs.

The document provides information categories, which unambiguously describe how data is used to characterise and categorise the operation. The information model specifies category priority for discrimination between possible concurrent categories. Further, the model defines entry and exit criteria to allocate fractions of time and production values to the proper information category. A full overview of all information categories, exit and entry criteria is given in Annex A, see Figure A.1.

The document can be applied to any number of WTGSs, whether represented by an individual turbine, a fleet of wind turbines, a wind power station or a portfolio of wind power stations. A wind power station is typically made up of all WTGSs, functional services and balance of plant elements as seen from the point of common coupling.

Examples are provided in informative annexes which provide guidelines for calculation of availability indicators:

- examples of optional information categories, Annex B;
- examples of application of the information categories for determination of availability, Annex C;
- examples of application scenarios, Annex D;
- examples on methods for determination of potential production, Annex E;
- examples of how to expand the model to balance of plant elements, Annex F.

This document does not prescribe how availability indicators shall be calculated. The standard does not specify the method of information acquisition, how to estimate the production terms or to form the basis for power curve performance measurements – which is the objective of IEC 61400-12.

A degree of uncertainty is inherent in both the measurement of a power curve and the calculation of potential energy production. The stakeholders should agree upon acceptable uncertainty parameters.

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 60050-415, *International Electrotechnical Vocabulary – Part 415: Wind turbine generator systems*

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IEC 61400-1, *Wind energy generation systems – Part 1: Design requirements*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050-415 and the following 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
actual service delivery
quantified level of a service provided by the WEGS as measured

Note 1 to entry: Actual service delivery can only be assigned to measurable services.

3.1.2
balance of plant
BOP
infrastructural components of the WPS except for the WTGS(s) and its internal components and subsystems

Note 1 to entry: The infrastructure normally consists of site electrical facilities, monitoring and control (often called SCADA) as well as civil plant (such as foundations and roads) supporting the operation and maintenance of the WTGS(s).

3.1.3
constrained potential service delivery
calculated level of a service that could have been provided by the WEGS based on operating specifications such as external set-points or contractually imposed constraints combined with design criteria, technical specifications and site conditions

3.1.4
design specifications
the collection of precise and explicit information about requirements for a product design

Note 1 to entry: It provides in-depth details about the functional and non-functional design requirements including assumptions, constraints, performance, dimensions, weights, reliability and standards. For example, specifications and design considerations given in the IEC 61400-1 standard define the process for producing design specifications for WEGS.

3.1.5
external conditions
conditions outside of the WEGS that affect the operation, such as (i) operating specifications, (ii) environmental conditions and (iii) grid conditions

3.1.6
grid
electrical network to which the WEGS is electrically connected

Note 1 to entry: The WEGS delivers its services into the grid. The interface between the grid and the WEGS internal electrical system is the network connection point often referred to as the point of common coupling (PCC).

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3.1.7
intended function
ability of an apparatus, machine or system to consistently perform its required function within its design specification

3.1.8
lost service
service not supplied, e.g. lost production or lost energy

Note 1 to entry: See 4.5.5.

3.1.9
physical potential service delivery
calculated level of a service that could have been provided by the WEGS based on design criteria, technical specifications and site conditions

Note 1 to entry: The potential service is the physically possible level of service.

3.1.10
potential service delivery
calculated value of physical potential service delivery or constrained potential service delivery as is appropriate

3.1.11
retrofit
the incorporation of new technology or new design parts resulting from an approved engineering change to an already supplied item

3.1.12
supervisory control and data acquisition
SCADA
system operating with signals over communication channels so as to provide control of equipment and for gathering and analysing real-time data

3.1.13
service
provision delivered by the WEGS

Note 1 to entry: Services typically include, but are not limited to, supply of active power, reactive power and support of electrical stability of the grid. Aviation warning is another example of a service.

3.1.14
site conditions
conditions affecting the service of the WEGS, e.g. topographic, climatic and meteorological conditions, sector management, electrical environment and contractual constraints

3.1.15
grid operator
operator that transmits electrical generation over the grid to regional or local electricity distribution operators

3.1.16
wind power station
WPS
station consisting of the WTGS(s) and the BOP which supports transfer of energy between the WTGS(s) and the grid

3.1.17
maintenance provider
provider typically providing the maintenance of the WEGS or parts therein

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Note 1 to entry: Maintenance can be performed by multiple providers with specific scope defined.

3.1.18
operator
operator typically responsible for providing the services of the WEGS to off-takers

3.2 Abbreviated terms

IA	INFORMATION AVAILABLE category
IAO	Information available OPERATIVE category
IAOS	Information available operative IN SERVICE category
IAOSFP	Information available operative in service with FULL PERFORMANCE category
IAOSPP	Information available operative in service with PARTIAL PERFORMANCE category
IAOSRS	Information available operative in service with READY STANDBY category
IAOOS	Information available operative OUT OF SERVICE category
IAOOSTS	Information available operative out of service TECHNICAL STANDBY category
IAOOSEN	Information available operative out of service OUT OF ENVIRONMENTAL SPECIFICATION category
IAOOSRS	Information available operative out of service REQUESTED SHUTDOWN category
IAOOSEL	Information available operative out of service OUT OF ELECTRICAL SPECIFICATION category
IANO	Information available NON-OPERATIVE category
IANOSM	Information available non-operative SCHEDULED MAINTENANCE category
IANOPCA	Information available non-operative PLANNED CORRECTIVE ACTION category
IANOFO	Information available non-operative FORCED OUTAGE category
IANOS	Information available non-operative SUSPENDED category
IAFM	Information available FORCE MAJEURE category
IAS_P	INFORMATION AVAILABLE category – potential service delivery
IAS_A	INFORMATION AVAILABLE category – actual service delivery
$IAOS_P$	Information available OPERATIVE category – potential service delivery
$IAOS_A$	Information available OPERATIVE category – actual service delivery
$IAOSS_P$	Information available operative IN SERVICE category – potential service delivery
$IAOSS_A$	Information available operative IN SERVICE category – actual service delivery
$IAOSFPS_P$	Information available operative in service with FULL PERFORMANCE category – potential service delivery
$IAOSFPS_A$	Information available operative in service with FULL PERFORMANCE category – actual service delivery
$IAOSPPS_P$	Information available operative in service with PARTIAL PERFORMANCE category – potential service delivery
$IAOSPPS_A$	Information available operative in service with PARTIAL PERFORMANCE category – actual service delivery
$IAOSPP_{DR}S_P$	Information available operative in service with partial performance category, optional **derated** – potential service delivery

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$IAOSPP_{DR}S_A$	Information available operative in service with partial performance category, optional **derated** – actual service delivery
$IAOSPP_{DG}S_P$	Information available operative in service with partial performance category, optional **degraded** – potential service delivery
$IAOSPP_{DG}S_A$	Information available operative in service with partial performance category, optional **degraded** – actual service delivery
$IAOSRSS_P$	Information available operative in service with READY STANDBY category – potential service delivery
$IAOSRSS_A$	Information available operative in service with READY STANDBY category – actual service delivery
$IAOOSS_P$	Information available operative OUT OF SERVICE category – potential service delivery
$IAOOSS_A$	Information available operative OUT OF SERVICE category – actual service delivery
$IAOOSTSS_P$	Information available operative out of service TECHNICAL STANDBY category – potential service delivery
$IAOOSTSS_A$	Information available operative out of service TECHNICAL STANDBY category – actual service delivery
$IAOOSENS_P$	Information available operative out of service OUT OF ENVIRONMENTAL SPECIFICATION category – potential service delivery
$IAOOSENS_A$	Information available operative out of service OUT OF ENVIRONMENTAL SPECIFICATION category – actual service delivery
$IAOOSEN_CS_P$	Information available operative out of service out of environmental specification optional category **calm winds** – potential service delivery
$IAOOSEN_CS_A$	Information available operative out of service out of environmental specification optional category **calm winds** – actual service delivery
$IAOOSEN_OS_P$	Information available operative out of service out of environmental specification optional category **other environmental** – potential service delivery
$IAOOSEN_OS_A$	Information available operative out of service out of environmental specification optional category **other environmental** – actual service delivery
$IAOOSELS_P$	Information available operative out of service OUT OF ELECTRICAL SPECIFICATION category – potential service delivery
$IAOOSELS_A$	Information available operative out of service OUT OF ELECTRICAL SPECIFICATION category – actual service delivery
$IAOOSRSS_P$	Information available operative out of service REQUESTED SHUTDOWN category – potential service delivery
$IAOOSRSS_A$	Information available operative out of service REQUESTED SHUTDOWN category – actual service delivery
$IANOS_P$	Information available NON-OPERATIVE category – potential service delivery
$IANOS_A$	Information available NON-OPERATIVE category – actual service delivery
$IANOSMS_P$	Information available non-operative SCHEDULED MAINTENANCE category – potential service delivery
$IANOSMS_A$	Information available non-operative SCHEDULED MAINTENANCE category – actual service delivery
$IANOPCAS_P$	Information available non-operative PLANNED CORRECTIVE ACTION category – potential service delivery

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$IANOPCAS_A$	Information available non-operative PLANNED CORRECTIVE ACTION category – actual service delivery
$IANOPCA_RS_P$	Information available non-operative planned corrective action optional category **retrofit** – potential service delivery
$IANOPCA_RS_A$	Information available non-operative planned corrective action optional category **retrofit** – actual service delivery
$IANOPCA_US_P$	Information available non-operative planned corrective action optional category **upgrade** – potential service delivery
$IANOPCA_US_A$	Information available non-operative planned corrective action optional category **upgrade** – actual service delivery
$IANOPCA_OS_P$	Information available non-operative planned corrective action optional category **other corrective action** – potential service delivery
$IANOPCA_OS_A$	Information available non-operative planned corrective action optional category **other corrective action** – actual service delivery
$IANOFOS_P$	Information available non-operative FORCED OUTAGE category – potential service delivery
$IANOFOS_A$	Information available non-operative FORCED OUTAGE category – actual service delivery
$IANOFO_RS_P$	Information available non-operative forced outage optional category **response** – potential service delivery
$IANOFO_RS_A$	Information available non-operative forced outage optional category **response** – actual service delivery
$IANOFO_DS_P$	Information available non-operative forced outage optional category **diagnostic** – potential service delivery
$IANOFO_DS_A$	Information available non-operative forced outage optional category **diagnostic** – actual service delivery
$IANOFO_LS_P$	Information available non-operative forced outage optional category **logistic** – potential service delivery
$IANOFO_LS_A$	Information available non-operative forced outage optional category **logistic** – actual service delivery
$IANOFO_FS_P$	Information available non-operative forced outage optional category **failure repair** – potential service delivery
$IANOFO_FS_A$	Information available non-operative forced outage optional category **failure repair** – actual service delivery
$IANOSS_P$	Information available non-operative SUSPENDED category – potential service delivery
$IANOSS_A$	Information available non-operative SUSPENDED category – actual service delivery
$IANOS_SS_P$	Information available non-operative suspended optional category **suspended scheduled maintenance** – potential service delivery
$IANOS_SS_A$	Information available non-operative suspended optional category **suspended scheduled maintenance** – actual service delivery
$IANOS_PS_P$	Information available non-operative suspended optional category **suspended planned corrective action** – potential service delivery
$IANOS_PS_A$	Information available non-operative suspended optional category **suspended planned corrective action** – actual service delivery
$IANOS_FS_P$	Information available non-operative suspended optional category **suspended forced outage** – potential service delivery
$IANOS_FS_A$	Information available non-operative suspended optional category **suspended forced outage** – actual service delivery

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$IAFMS_P$	Information available FORCE MAJEURE category – potential service delivery
$IAFMS_A$	Information available FORCE MAJEURE category – actual service delivery
IU	INFORMATION UNAVAILABLE category

4 Information model

4.1 Basic model

The information model comprises a number of information categories organised in layers. All calendar time shall be accounted for by distribution of time fractions into the information categories in the first layer of the model. The information category that characterises the operational state shall hold the time fractions that can be allocated to that category. A shift to another category shall be made when the operational state is no longer valid for that category. Any fraction of time can only be assigned to one category. The information model provides a hierarchical structure of four levels of defined information categories, which are mandatory and required for data collection. Further subdivision of information categories beyond the four mandatory levels is optional. Attributes of higher information categories are inherited by underlying lower information categories as illustrated in Figure 2. Time designations shall be allocated at the lowest mandatory level, level 4, or at a lower optional level with a greater granularity (level 5 or lower). The higher hierarchical information levels shall contain the aggregation of the related information categories on the lower levels. The individual information categories are introduced in 4.2.

Each information category has an associated entry point and exit point. The entry point describes the criteria that shall be fulfilled to allocate time into this specific information category. The exit point describes the criteria to be fulfilled to end time allocation to the specific information category, see Clause 5.

Priorities are assigned to the information categories. In case entry conditions are fulfilled concurrently for two or more information categories, time shall be assigned into the information category with the highest priority only. Information category priorities are described in 4.3.

4.2 Information categories

Figure 2 gives an overview of the information categories. Abbreviations for the information categories are indicated in brackets with bold letters. The abbreviations are defined in Clause 3. The properties of the information categories are described in detail in Clause 5.

The optional information categories defined in level 5 are included to allow users to customize reporting details to meet specific requirements. When applied, the optional fifth level shall be used as specified in this document. Further levels may be developed and applied at the user's own initiative. This document imposes no limits on the number of optional information categories or levels added by the user. Examples illustrating use of the optional information categories shown in Figure 2 are described in Annex B.

Mandatory information categories defined in this document are written in capital letters; optional information categories are written in bold letters.

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<table>
<tr><th colspan="5">Information categories</th></tr>
<tr><th>Mandatory
level 1</th><th>Mandatory
level 2</th><th>Mandatory
level 3</th><th>Mandatory
level 4</th><th>Optional
level 5
– description see Annex B</th></tr>
<tr><td rowspan="14">INFORMATION AVAILABLE (5.1)
(IA)</td><td rowspan="8">OPERATIVE (5.2)
(IAO)</td><td rowspan="3">IN SERVICE
(5.3)
(IAOS)</td><td>FULL PERFORMANCE
(5.3.2) (IAOSFP)</td><td></td></tr>
<tr><td rowspan="2">PARTIAL PERFORMANCE
(5.3.3) (IAOSPP)</td><td>derated</td></tr>
<tr><td>degraded</td></tr>
<tr><td>READY STANDBY
(5.3.4) (IAOSRS)</td><td></td></tr>
<tr><td rowspan="5">OUT OF SERVICE
(5.4)
(IAOOS)</td><td>TECHNICAL STANDBY
(5.4.2) (IAOOSTS)</td><td></td></tr>
<tr><td rowspan="2">OUT OF ENVIRONMENTAL SPECIFICATION
(5.4.3) (IAOOSEN)</td><td>calm winds</td></tr>
<tr><td>other environmental</td></tr>
<tr><td>REQUESTED SHUTDOWN
(IAOOSRS) (5.4.4)</td><td></td></tr>
<tr><td>OUT OF ELECTRICAL SPECIFICATION
(5.4.5) (IAOOSEL)</td><td></td></tr>
<tr><td rowspan="6">NON-OPERATIVE (5.5)
(IANO)</td><td colspan="2">SCHEDULED MAINTENANCE (5.5.2)
(IANOSM)</td><td></td></tr>
<tr><td colspan="2" rowspan="3">PLANNED CORRECTIVE ACTION (5.5.3)
(IANOPCA)</td><td>retrofit</td></tr>
<tr><td>upgrade</td></tr>
<tr><td>other corrective action</td></tr>
<tr><td colspan="2" rowspan="4">FORCED OUTAGE (5.5.4)
(IANOFO)</td><td>response</td></tr>
<tr><td>diagnostic</td></tr>
<tr><td>logistic</td></tr>
<tr><td>failure repair</td></tr>
<tr><td colspan="2" rowspan="3">SUSPENDED (5.5.5)
(IANOS)</td><td>suspended scheduled maintenance</td></tr>
<tr><td>suspended planned corrective action</td></tr>
<tr><td>suspended forced outage</td></tr>
<tr><td colspan="2">FORCE MAJEURE (5.6)
(IAFM)</td><td></td></tr>
<tr><td colspan="3">INFORMATION UNAVAILABLE (5.7)
(IU)</td><td></td></tr>
</table>

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Figure 2 – Information category overview

4.3 Information category priority

Time present in the information categories shall be exclusive and continuous. In case the conditions, for allocating a time period to more than one information category, are fulfilled at the same time, the information category priorities determine which category takes precedence for the allocation of the time period being considered. Assignment of priorities to the information categories provides a uniform and transparent method for designation of time. Figure 3 illustrates the information category priorities.

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The order of priorities is mandatory for compliance with this document. The priorities are ranked from one to thirteen with one as the lowest and thirteen as the highest priority. Priorities for optional information categories can be introduced for specific purposes. In such cases, the mandatory priorities can be extended with a priority for the optional information category.

<table>
<tr><th colspan="5">Information categories</th></tr>
<tr><th>Mandatory level 1</th><th>Mandatory level 2</th><th>Mandatory level 3</th><th>Mandatory level 4</th><th>Mandatory priority</th></tr>
<tr><td rowspan="11">INFORMATION AVAILABLE (IA)</td><td rowspan="8">OPERATIVE (IAO)</td><td rowspan="3">IN SERVICE (IAOS)</td><td>FULL PERFORMANCE (IAOSFP)</td><td>1</td></tr>
<tr><td>PARTIAL PERFORMANCE (IAOSPP)</td><td>2</td></tr>
<tr><td>READY STANDBY (IAOSRS)</td><td>3</td></tr>
<tr><td rowspan="5">OUT OF SERVICE (IAOOS)</td><td>TECHNICAL STANDBY (IAOOSTS)</td><td>4</td></tr>
<tr><td>OUT OF ENVIRONMENTAL SPECIFICATION (IAOOSEN)</td><td>5</td></tr>
<tr><td>REQUESTED SHUTDOWN (IAOOSRS)</td><td>6</td></tr>
<tr><td>OUT OF ELECTRICAL SPECIFICATION (IAOOSEL)</td><td>7</td></tr>
<tr><td rowspan="4">NON-OPERATIVE (IANO)</td><td colspan="2">SCHEDULED MAINTENANCE (IANOSM)</td><td>8</td></tr>
<tr><td colspan="2">PLANNED CORRECTIVE ACTION (IANOPCA)</td><td>9</td></tr>
<tr><td colspan="2">FORCED OUTAGE (IANOFO)</td><td>10</td></tr>
<tr><td colspan="2">SUSPENDED (IANOS)</td><td>11</td></tr>
<tr><td colspan="3">FORCE MAJEURE (IAFM)</td><td>12</td></tr>
<tr><td colspan="4">INFORMATION UNAVAILABLE (IU)</td><td>13</td></tr>
</table>

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Figure 3 – Information category priority

There might be conflicts within the optional categories as the **derated** category and the **degraded** category might appear simultaneously. The situation is discussed in the informative Annex B.

4.4 Services

The information categories shall be applied individually to all relevant services, provided by the WEGS, to obtain availability indicators. Services may be, but are not limited to, supply of active power, supply of reactive power and support of electrical stability of the grid. Categories shall be assigned independently to each service and are in many cases not identical within the same time period.

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4.5 Service delivery layers

4.5.1 General

To allow for service delivery based availability in the information model, three layers are defined:

- time layer;
- actual service delivery layer;
- potential service delivery layer.

The three layers are specified for the mandatory levels 1 to 4. Figure 4 illustrates the complete information model with three layers and forms the basis for determination of lost service (typically energy) in the following subclause.

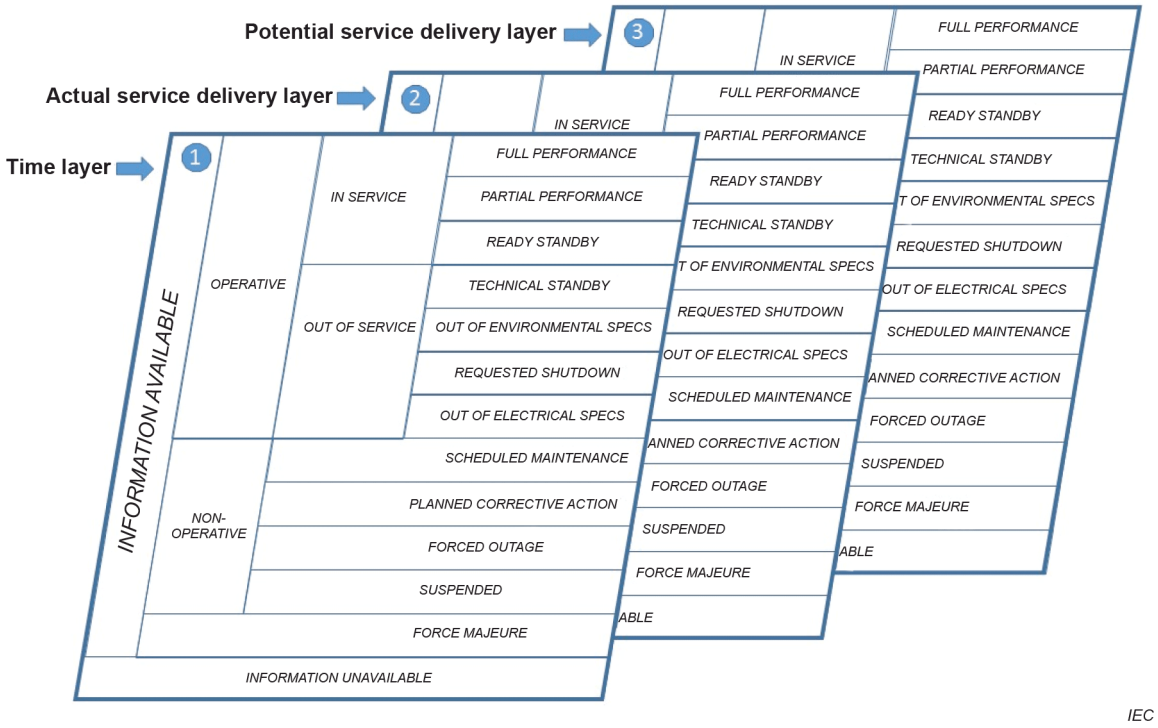

Figure 4 – Three-layer information model

4.5.2 Time layer

The time layer is identical to the Basic model described in 4.1, 4.2 and 4.3.

4.5.3 Actual service delivery layer

In layer 2, a value for the actual service rather than time is recorded. The value recorded is the actual service delivered during the same period as in the corresponding category in layer 1.

4.5.4 Potential service delivery layer

Layer 3 contains information on the potential amount of service delivery during the same periods as in the corresponding category in layers 1 and 2.

Methods for determination of the potential service is discussed in Annex E. However, the method for establishing the potential service is outside the scope of this document. Data populating this layer shall represent the service delivery that could have been realised if the

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WEGS had been operating as per the FULL PERFORMANCE, taking into account the external conditions.

The potential service delivery shall be either the physical potential service delivery or constrained potential service delivery depending on what is relevant for the service. Typically, for active production, it may be appropriate to select the physical potential production and for reactive production, the constrained potential production. See Annex E for methods to determine potential production.

4.5.5 Lost service

When values for actual service delivery and potential service delivery are determined, lost service values shall be derived as follows, see Figure 5.

- No lost service shall be associated with the respective information category, when the service is operating in FULL PERFORMANCE.
- Lost service shall be determined by the difference between the potential service value and the actual service value during the time the service is operating in PARTIAL PERFORMANCE.
- Lost service shall equal the potential service during the time when the service is in INFORMATION AVAILABLE and not in IN SERVICE (see footnote in Figure 5).

It is recognized that while operating in FULL PERFORMANCE, actual service might not equal full potential service due to various factors that might affect the performance of the WEGS, such as blade fouling or misalignment, or the calculation of potential service. The characterization of the WEGS services is beyond the scope of this document. Examples of turbine performance while in the FULL PERFORMANCE information category are included in Annex D.

It is not possible or meaningful to measure a level or degree of some services, especially when the service is of a binary nature. Only time based indicators are applicable to those services. Aviation lights are an example, which can be either 'in operation' or 'out of operation' but do not have an actual or potential service attached.

4.6 Modelling multiple services

The information model supports tracking of multiple services. In order to do so, the three-layer information model is applied to each of the services. Figure 6 illustrates an example with four services.

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Information categories – Layer 1				**Layer 2**	**Layer 3**	**Layer 2 subtracted from layer 3**
Mandatory level 1	Mandatory level 2	Mandatory level 3	Mandatory level 4	Actual service delivery	Potential service delivery	Lost service
INFORMATION AVAILABLE (**IA**)	OPERATIVE (**IAO**)	IN SERVICE (**IAOS**)	FULL PERFORMANCE (**IAOSFP**)	**$IAOSFPS_A$**	**$IAOSFPS_P$**	**0**
			PARTIAL PERFORMANCE (**IAOSPP**)	**$IAOSPPS_A$**	**$IAOSPPS_P$**	**$IAOSPPS_P$ – $IAOSPPS_A$**
			READY STANDBY (**IAOSRS**)	**$IAOSRSS_A$**	**$IAOSRSS_P$**	**$IAOSRSS_P$ – $IAOSRSS_A$**
		OUT OF SERVICE (**IAOOS**)	TECHNICAL STANDBY (**IAOOSTS**)	0	**$IAOOSTSS_P$**	**$IAOOSTSS_P$**
			OUT OF ENVIRONMENTAL SPECIFICATION (**IAOOSEN**)	0	**$IAOOSENS_P$**	**$IAOOSENS_P$**
			REQUESTED SHUTDOWN (**IAOOSRS**)	0	**$IAOOSRSS_P$**	**$IAOOSRSS_P$**
			OUT OF ELECTRICAL SPECIFICATION (**IAOOSEL**)	0	**$IAOOSELS_P$**	**$IAOOSELS_P$**
	NON-OPERATIVE (**IANO**)	SCHEDULED MAINTENANCE (**IANOSM**)		0	**$IANOSMS_P$**	**$IANOSMS_P$**
		PLANNED CORRECTIVE ACTION (**IANOPCA**)		0	**$IANOPCAS_P$**	**$IANOPCAS_P$**
		FORCED OUTAGE (**IANOFO**)		0	**$IANOFOS_P$**	**$IANOFOS_P$**
		SUSPENDED (**IANOS**)		0	**$IANOSS_P$**	**$IANOSS_P$**
	FORCE MAJEURE (**IAFM**)			0	**$IAFMS_P$**	**$IAFMS_P$**
INFORMATION UNAVAILABLE (**IU**)				*	*	*

* In the category INFORMATION UNAVAILABLE, data is missing or cannot be quantified; a value cannot be determined.

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Figure 5 – Information categories, definitions for layer 2 and layer 3, mandatory categories

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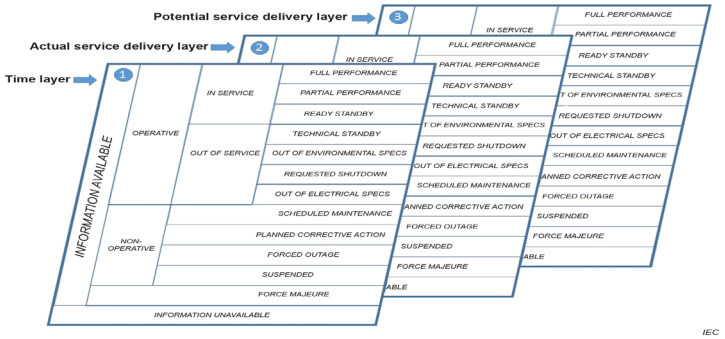
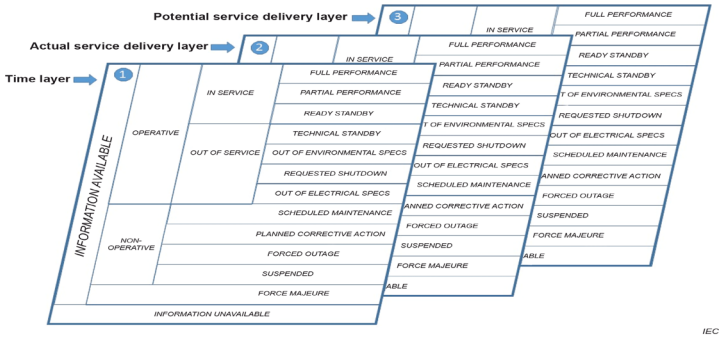
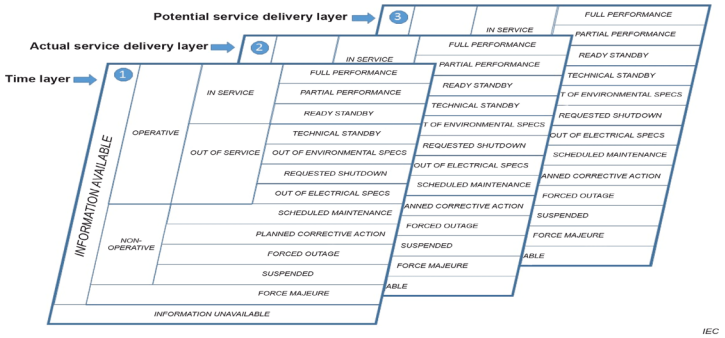
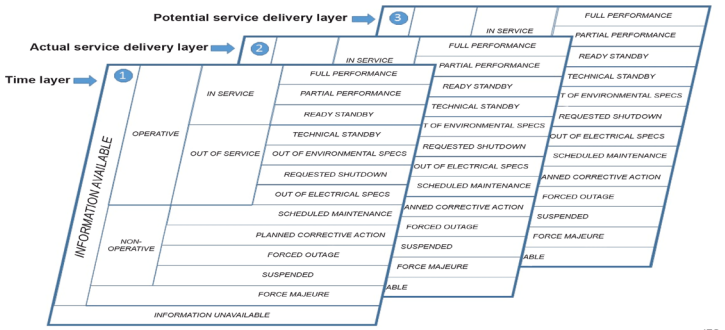
Service	WEGS
Active energy service	
Reactive energy service	
High frequency response service	
Low frequency response service	

Figure 6 – Examples of an information model representing active energy, reactive energy, high and low frequency response services

4.7 Determination of information categories for the WPS

Determination of the proper information category for the WPS level is not simply made up of the minimum, maximum, sum or average of the elements making up the WPS. The key to determining the proper information category is by evaluating compliance with existing

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criteria defined in Clause 5. Methods for determining the information categories are discussed in Annex C.

Basic principles and assumptions for the WPS information model are:

- mandatory categories are identical in the WTGS model and the WPS model;
- optional categories are not necessarily identical in the WTGS model and the WPS model;
- measurements of WPS actual service delivery values are made as they will appear at the PCC.

While evaluating the priority, the issue is not to confuse the priorities of the individual WTGS with the priority of the WPS, e.g. a WTGS can be in FORCED OUTAGE information category and the WPS can at the same time be in PARTIAL PERFORMANCE. The specification permits the user, with caution, to prioritize data based on alternate views of the model, WPS or WTGS. When the model view is applied consistently there is no inconsistency in the expression of availability.

4.8 Application of the information model to components of the WEGS

An information model for a component level and BOP may also be developed based on the principles for the WEGS model. An example of how to apply the principles for BOP is discussed and illustrated in Annex F. The model illustrated in Annex F is optional.

5 Information categories

5.1 INFORMATION AVAILABLE

Definition – The category INFORMATION AVAILABLE is applied to all time periods, during which operational information and information on external conditions is retrieved, logged and stored manually or automatically to the extent that the characteristics of information categories can be discriminated. INFORMATION AVAILABLE is the top level for all mandatory information sub-categories as depicted at level 1 in Figure 2. Qualification for INFORMATION AVAILABLE requires sufficient information to determine that criteria for one of the mandatory level 4 categories with priority levels 1 to 12 are fulfilled.

It is recognised that there might be circumstances when information is not or only partially available. In case of insufficient information, the category INFORMATION UNAVAILABLE is likely to apply, see 5.7.

Information to determine the mandatory information category can be derived from multiple sources. Sources can be

- controller data from individual WTGSs;
- SCADA;
- BOP operation;
- metering information;
- manual entries.

For example, the information category can be determined as INFORMATION AVAILABLE if data transmission from every single WTGS of a WPS is interrupted, if data from a measurement system still gives adequate information to determine the category of the WPS.

Entry point – The operating status data are available to the extent that a category at level 4 can be determined, logged and stored.

Exit point – It is not possible to determine, log or store the level 4 category.

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5.2 OPERATIVE

Definition – The WEGS is in the category OPERATIVE when capable of performing the intended functions, regardless of whether it is actually active and regardless of the capacity level that can be provided.

The OPERATIVE category is underlying the INFORMATION AVAILABLE category and has two underlying information categories as listed below and depicted in Figure 2.

- IN SERVICE – as defined in 5.3;
- OUT OF SERVICE – as defined in 5.4.

The OPERATIVE category is mandatory.

Entry point – The WEGS is able to perform the intended functions, regardless of whether it is actually active and regardless of the capacity level that can be provided.

Exit point – The WEGS is not able to maintain the intended functions.

5.3 IN SERVICE

5.3.1 General

Definition – The WEGS is performing the service.

The IN SERVICE category is an underlying category of the OPERATIVE category and has three underlying mandatory information categories as listed below and depicted in Figure 2.

- FULL PERFORMANCE – as defined in 5.3.2;
- PARTIAL PERFORMANCE – as defined in 5.3.3;
- READY STANDBY – as defined in 5.3.4.

The IN SERVICE information category is mandatory.

Entry point – The WEGS starts performing the intended functions.

Exit point – The WEGS stops performing the intended functions.

5.3.2 FULL PERFORMANCE

Definition – The WEGS is operative and functioning per design specifications with no technical restrictions or limitations beyond the ones specified in the design specifications.

No lost service shall be associated with the respective information category, when the WEGS is operating in FULL PERFORMANCE.

FULL PERFORMANCE is characterised by, but is not necessarily including all or limited to the following examples:

- all WTGSs performing according to design specifications;
- all WTGSs delivering active power according to design power curves;
- all BOP equipment performing its designed function at rated capacity;
- all WTGS delivering full rotor inertial energy for low frequency compensation.

The FULL PERFORMANCE category is an underlying category of IN SERVICE and has no predefined underlying mandatory information categories as depicted in Figure 2.

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The FULL PERFORMANCE category is mandatory.

Entry point – The WEGS is performing the intended function with the full capacity at the given conditions.

Exit point – The WEGS is not delivering the intended function with the full capacity at the given conditions.

5.3.3 PARTIAL PERFORMANCE

Definition – The WEGS is operating at reduced performance due to internal or external conditions.

PARTIAL PERFORMANCE may include, but is not limited to, the following examples:

- for a WPS, a technical fault or safety related events shutting down individual WTGSs;
- shortage in capacity of BOP components;
- grid management (partial curtailment);
- reduced load capability (individual WTGSs);
- financial considerations;
- asset management;
- WTGS(s) constrained but still operating within design specification.

The PARTIAL PERFORMANCE category is an underlying category of IN SERVICE and has no predefined underlying mandatory information categories as depicted in Figure 2.

The PARTIAL PERFORMANCE category is mandatory.

Entry point – The WEGS is not providing the intended function with the full specified capacity.

Exit point – The conditions for being in PARTIAL PERFORMANCE no longer exist.

5.3.4 READY STANDBY

Definition – The WEGS is in the category READY STANDBY when ready to respond to a predefined event. READY STANDBY is not applicable to the active energy service.

READY STANDBY may include, but is not limited to, the following examples:

- a low frequency compensation service activated and awaiting a frequency drop;
- aviation warning light service awaiting an indication of approaching aircrafts;
- radar for bird migration awaiting a reading;
- VAr compensation system having elements disconnected but ready to engage.

The READY STANDBY category is an underlying category of IN SERVICE and has no predefined underlying mandatory information categories as depicted in Figure 2.

The READY STANDBY category is mandatory.

Entry point – The WEGS is ready and able to respond to a pre-defined event.

Exit point – The WEGS is no longer able to respond to a pre-defined event or is now responding.

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