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INTERNATIONAL STANDARD

NORME INTERNATIONALE

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Grid integration of renewable energy generation – Terms and definitions

Intégration de la production d'énergie renouvelable aux réseaux électriques – Termes et définitions

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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GRID INTEGRATION OF RENEWABLE ENERGY GENERATION – TERMS AND DEFINITIONS

FOREWORD

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

Draft	Report on voting
8A/75/FDIS	8A/79/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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

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- amended.

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INTRODUCTION

The purpose of this terminology document is to provide terms and definitions for all publications under the responsibility of SC 8A. In this document, renewable energy generation is the electric power generation which uses renewable energy as its primary source for the conversion into electricity.

All SC 8A normative documents to be published should keep consistency with this International Standard (IS). This IS will be revised together with other SC 8A publications in order to avoid mismatches when necessary.

From the technical point of view, grid integration of renewable energy generation is a interdisciplinary complex technical field which is concerned with basic equipment, system integration, control and protection, operation and dispatch, market and trade and so on. Without a strong standardization of terminology, focal terms can have a different understanding by different countries, parties, and technical areas. Harmonised vocabulary is critical also from the market point of view. It impacts economics and this can become a barrier to commerce. The correct comparison among different options is fundamental, therefore basic terms and definitions impact economic decisions.

Several IEC product standards give definitions of certain terms which are necessary for the understanding of how to design, manufacture and use of those products. The International Electrotechnical Vocabulary (IEV, IEC 60050, http://www.electropedia.org) and the IEC Glossary (http://std.iec.ch/glossary) allow on-line access to this information.

Terms and definitions of this document have been harmonized with the IEV, the IEC Glossary and other IEC documents as far as possible. Definitions not included in this terminology standard may be found elsewhere in other IEC documents.

The use of abbreviations has been optimized, on the one hand to avoid tedious repetition and, on the other hand, to avoid confusion. A minimum set of abbreviations is identified in Clause 4 of this document; the other terms are written out in full spelling when needed.

GRID INTEGRATION OF RENEWABLE ENERGY GENERATION – TERMS AND DEFINITIONS

1 Scope

This terminology document provides terms and definitions in the subject area of grid integration of renewable energy generation. The technical issues of grid integration mainly focus on the issues caused by renewable energy generation with variable sources and/or converter based technology, such as wind power and photovoltaic power generation. Some renewable energy generations such as hydro power and biomass power with a relatively continuously available primary energy source and a rotating generator are conventional sources of generation, and are therefore not covered in this document.

The intention of this document is to answer the question "what do the words mean" and not "under what conditions do the terms apply".

2 Normative references

There are no normative references in this document.

3 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 Terms and definitions for renewable energy generation

3.1.1
renewable energy
RE
primary energy, the source of which is constantly replenished and will not become depleted

Note 1 to entry: Examples of renewable energy are: wind, solar, geothermal, hydropower, etc.

Note 2 to entry: Fossil fuels are non renewable.

[SOURCE: IEC 60050-617:2009, 617-04-11 modified, examples of renewable energy are added in Note 1 to entry."]

3.1.2
variable renewable energy
VRE
subset of renewable energy, the source of which is not continuously available and cannot be stored or controlled

EXAMPLE Wind energy, solar energy, wave energy.

3.1.3
renewable energy generation
generation of electrical energy, which uses renewable energy as the primary energy source for the conversion into electricity

3.1.4
variable renewable energy generation
subset of renewable energy generation, which uses variable renewable energy as the primary energy source for the conversion into electricity

EXAMPLE Wind power generation, photovoltaic power generation, concentrated solar power generation, wave power generation.

Note 1 to entry: The primary energy from variable renewable energy sources is in most cases not able to be stored and therefore the electricity generated is constrained by the availability of the energy source.

3.1.5
renewable energy generating unit
REGU
smallest set of equipment which can generate electricity from renewable energy and can feed the electricity into an electric power network

Note 1 to entry: Several typical forms of renewable energy generating unit are shown in Annex A.

3.1.6
renewable energy power plant
collection of renewable energy generating units connected to an electric power network through one or more points of connection, including auxiliaries and connection equipment

Note 1 to entry: Two typical forms of renewable energy power plant are shown in Annex A.

3.1.7
power collection system
<renewable energy power plant> electrical system that collects the electricity from at least one renewable energy generating unit and feeds this electricity into an electric power network, usually comprising transformers and overhead lines or cables

3.1.8
substation
plant substation
<renewable energy power plant> transformer substation or switching substation of a renewable energy power plant through which the output power of all generating units is transmitted to the electric power network

3.1.9
point of generating unit connection
PGUC
point that is part of the generating unit and identified by the manufacturer as a reference point at which the generating unit is connected to the power collection system

3.1.10
point of connection
POC
reference point on the electric power network where the user's electrical facility is connected

[SOURCE: IEC 60050-617:2009, 617-04-01]

3.1.11
point of common coupling
PCC
point in an electric power system, electrically nearest to a particular load or the POC of a power plant, at which other loads/power plants are, or may be, connected

Note 1 to entry: These loads can be either devices, equipment or systems, or distinct customer's installations.

[SOURCE: IEC 60050-614:2016, 614-01-12, modified – "or the POC of a power plant" is added and "network users' installations" is changed to "customer's installations"]

3.1.12
cluster
<renewable energy power plant> two or more neighboring renewable energy power plants which are connected to the electric power network via a common substation

Note 1 to entry: Typical form of cluster is shown in Annex A.

3.1.13
distributed energy resources
DER
generators (with their auxiliaries, protection and connection equipment), including loads having a generating mode (such as electrical energy storage systems), connected to a low-voltage or a medium-voltage network

[SOURCE: IEC 60050-617:2017,617-04-20]

3.1.14
distributed generation
DG
generation of electric energy by multiple sources which are connected to the power distribution system

[SOURCE: IEC-60050-617:2009, 617-04-09]

3.1.15
virtual power plant
VPP
group of distributed energy resources and controllable loads which combine to function as a dispatchable unit

Note 1 to entry: A virtual power plant can be used for the purpose of participating in the electricity market or aggregating ancillary services.

[SOURCE: IEC 60050-617:2017, 617-04-27, modified − controllable loads are included in the definition since they form an essential part of virtual power plant]

3.2 Terms and definitions for grid aspects and requirements

3.2.1
power system

3.2.1.1
electric power system
electricity supply system
< broad sense> all installations and plant provided for the purpose of generating, transmitting and distributing electricity

[SOURCE: IEC 60050-601:1985, 601-01-01]

3.2.1.2
electric power network
particular installations, substations, lines or cables for the transmission and distribution of electricity

Note 1 to entry: The boundaries of the different parts of this network are defined by appropriate criteria, such as geographical situation, ownership, voltage, etc.

[SOURCE: IEC 60050-601:1985, 601-01-02]

3.2.1.3
bulk power system
BPS
bulk electricity system
portion of the electric power system comprising the facilities used for the generation and transmission of electric energy

Note 1 to entry: The extent of the bulk power system is usually limited to the means for production and transmission of electric energy to major industrial and distribution centers.

Note 2 to entry: In English, the term "composite system" is also used for this concept.

[SOURCE: IEC 60050-601:1985, 601-01-33]

3.2.2
electrical quantities

3.2.2.1
nominal voltage
U_n
<power plant> value of the voltage (line to line) by which a power plant is designated and identified, usually defined at the POC

[SOURCE: IEC 60050-826:2004, 826-11-01, modified − supplementary information is added to indicate that the nominal voltage of a power plant is usually defined at the point of connection]

3.2.2.2
rated power
rated active power
maximum continuous power output which a renewable energy generating unit or plant is designed to achieve under normal operating conditions

Note 1 to entry: In some standards and grid codes this term is referred as "rated capacity".

[SOURCE: IEC 60050-415:1999, 415-04-03, modified – "wind turbine" is changed to "renewable energy generating unit or plant" to adapt the scope of this standard]

3.2.2.3
nominal active power
P_n
nominal value of the active power generation of a renewable energy generating unit or power plant, which must be stated by the manufacturer or the designer

Note 1 to entry: It is used as a base for calculating quantities in relation to that generating unit or power plant.

3.2.2.4
nominal apparent power
S_n
apparent power from a renewable energy generating unit or power plant while operating at nominal current and nominal voltage and frequency within the maximum permissible reactive power

Note 1 to entry:

$$S_n = \sqrt{3} U_n I_n \quad (1)$$

3.2.2.5
nominal current
I_n
nominal value of the current from a renewable energy generating unit or power plant, which must be calculated from nominal active power and nominal voltage at specified or designed power factor

Note 1 to entry:

$$I_n = \frac{P_n}{\sqrt{3} U_n \cdot |PF|} \quad (2)$$

3.2.2.6
registered power
active/apparent power of a power plant registered by the plant owner at the network operator's or regulator's registry

3.2.2.7
active power ramp rate
rate of change of active power during a specified period

3.2.3
type of generator

3.2.3.1
synchronous machine type of generator
generating unit connected to an electric power network via a synchronous generator

3.2.3.2
asynchronous machine type of generator
generating unit connected to an electric power network via an asynchronous generator

3.2.3.3
converter type of generator
generating unit connected to an electric power network via a power electronic converter

3.2.4
short-circuit
accidental or intentional conductive path between two or more conductive parts forcing the electric potential differences between these conductive parts to be equal or close to zero

[SOURCE: IEC 60050-614:2016, 614-02-02]

3.2.5
short-circuit current
I_k
<renewable energy power plant> current that a renewable energy power plant delivers to the point of connection resulting from a short-circuit in the external electric power system

3.2.6
short-circuit power
S_k
the product of the current in the short-circuit at a point of a system and a conventional voltage, generally the operating voltage

Note 1 to entry: Using physical units for line current (A) and nominal voltage (V), the product should also include the factor $\sqrt{3}$.

[SOURCE: IEC 60050-601:1985, 601-01-14, modified − Note 1 to entry is added]

3.2.7
short-circuit ratio
SCR
ratio of the three-phase short-circuit power at POC/PGUC to the nominal active power of a renewable energy power plant or generating unit

Note 1 to entry: SCR is a common analytical indicator used in the industry to quantify system strength.

Note 2 to entry: There is no industry consensus on the exact definition and methodology for calculating the SCR, particularly for applications with several adjacent renewable energy power plants, or for a renewable energy power plant adjacent to HVDC terminals, see CIGRE TB 671.

3.2.8
weighted short-circuit ratio
WSCR
index based on short-circuit ratio to assist in defining operational limits for total transmission of active power from inverter-based generators across key power system interfaces

Note 1 to entry:

$$WSCR = \frac{\sum_{i=1}^{N} S_{ki} \cdot P_{ni}}{\left(\sum_{i=1}^{N} P_{ni}\right)^2} \quad (3)$$

Note 2 to entry: S_{ki} is the short-circuit power at bus i without current contribution from renewable energy power plants, P_{ni} is the nominal power of renewable energy power plant to be connected at bus i, N is the number of power plants fully interacting with each other, i is the summation index of the renewable energy power plants.

3.2.9
composite short-circuit ratio
CSCR
index based on short-circuit ratio, which calculates an aggregate SCR for multiple renewable energy power plants by creating a common bus and tying all renewable energy power plants of interest together at that common bus

Note 1 to entry:

$$CSCR = \frac{S_{kv}}{\sum_{i=1}^{N} P_{ni}} \quad (4)$$

Note 2 to entry: S_{kv} is the short-circuit power at the virtual common bus without current contribution from the renewable energy power plants. P_{ni} is the nominal power of renewable energy power plant i, N is the number of renewable energy power plants to be considered.

Note 3 to entry: Composite short-circuit ratio is used to estimate the equivalent system impedance seen by multiple renewable energy power plants.

3.2.10
short-circuit ratio with interaction factors
SCRIF
index based on short circuit ratio, which considers interaction voltage sensitivity between electrically close renewable energy power plants

Note 1 to entry:

$$SCRIF_i = \frac{S_{ki}}{P_{ni} + \sum_{j(j \neq i)} \left(IF_{ji} \cdot P_{nj} \right)} \quad (5)$$

Note 2 to entry: S_{ki} is the short-circuit power at the POC of renewable energy power plant i without current contribution from the other renewable energy power plants, P_{ni} is the nominal power of renewable energy power plant i, IF_{ji} is the voltage change at bus j (ΔU_j) for a voltage change at bus i (ΔU_i), as follows:

$$IF_{ji} = \frac{\Delta U_j}{\Delta U_i} \quad (6)$$

Note 3 to entry: SCRIF is proposed to capture the voltage change at one bus resulting from a voltage change at another bus. When multiple renewable energy power plants are located very close to each other, they share the grid strength and short circuit level; hence, the grid strength is actually much lower than the overall short-circuit level calculated at that bus or buses.

3.2.11
power quality
characteristics of the electric current, voltage and frequencies at a given point in an electric power system, evaluated against a set of reference technical parameters

Note 1 to entry: These parameters might, in some cases, relate to the compatibility between electricity supplied in an electric power system and the loads connected to that electric power system.

[SOURCE: IEC 60050-617:2009, 617-01-05]

3.2.12
harmonic
harmonic component
sinusoidal component of the Fourier series of a periodic quantity, the harmonic order of which is an integer number greater than one

Note 1 to entry: A component of harmonic order n (with n > 1) is generally designated "n^{th} harmonic". The designation of the fundamental component as the "1st harmonic" is not recommended.

[SOURCE: IEC 60050-103:2009, 103-07-25]

3.2.13
interharmonic component
sinusoidal component of the Fourier series of a periodic quantity the harmonic order of which is a non-integer rational number

Note 1 to entry: Interharmonic components occur only when a harmonic order is defined in relation to a reference fundamental frequency not identical to the fundamental frequency.

[SOURCE: IEC 60050-103:2009, 103-07-27]

3.2.14
voltage deviation
difference between the supply voltage at a given instant and the declared supply voltage

[SOURCE: IEC 60050-614:2016, 614-01-04]

3.2.15
voltage fluctuation
series of voltage changes or continuous variation of the RMS or peak value of the voltage

[SOURCE: IEC 60050-614:2016, 614-01-06]

3.2.16
voltage dip
sudden voltage reduction at a point in an electric power system, followed by voltage recovery after a short time interval, from a few periods of the sinusoidal wave of the voltage to a few seconds

[SOURCE: IEC 60050-614:2016, 614-01-08]

3.2.17
flicker
impression of unsteadiness of visual sensation induced by a light stimulus whose luminance or spectral distribution fluctuates with time

[SOURCE: IEC 60050-614:2016, 614-01-28]

3.2.18
unbalance factor
in a three-phase system, degree of unbalance expressed by the ratio (in per cent) of the RMS values of the negative sequence component (or the zero sequence component) to the positive sequence component of the fundamental component of the voltage or the electric current

[SOURCE: IEC 60050-614:2016, 614-01-33]

3.2.19
rate of change of frequency
ROCOF
rate at which the system frequency changes

3.2.20
island
<electric power system> part of an electric power system that is electrically disconnected from the remainder of the interconnected electric power system but remains energized from the local electric power sources

Note 1 to entry: An island can be either the result of the action of automatic protections or the result of a deliberate action.

Note 2 to entry: An electric island can be stable or unstable.

[SOURCE: IEC 60050-692:2017, 692-02-11 modified − the original term "electric island" is changed to "island"]