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INTERNATIONAL STANDARD

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Electrical energy storage (EES) systems – Part 1: Vocabulary

Systèmes de stockage de l'énergie électrique (EES) – Partie 1: Vocabulaire

IEC 62933-1:2018-02(en-fr)

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Electrical energy storage (EES) systems – Part 1: Vocabulary

Systèmes de stockage de l'énergie électrique (EES) – Partie 1: Vocabulaire

INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

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ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 1: Vocabulary

FOREWORD

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The text of this standard is based on the following documents:

FDIS	Report on voting
120/116/FDIS	120/119/RVD

Full information on the voting for the approval of this 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.

A list of all parts in the IEC 62933 series, published under the general title *Electrical energy storage (EES) systems*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site 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- withdrawn,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
- amended.

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INTRODUCTION

The purpose of this terminology document is to provide terms and definitions for all the publications under the responsibility of TC 120, that standardize electrical energy storage systems (EES systems) including unit parameters, test methods, planning, installation, safety and environmental issues. An EES system includes any type of grid-connected energy storage which can both store electrical energy and provide electrical energy (from electricity to electricity).

All TC 120 normative documents are subject to revision, this part of IEC 62933 will be revised together with other TC 120 publications in order to avoid mismatches.

From the technical point of view, an EES system can be a complex multi stage system with several possible energy conversions. Each stage is made by components well standardized (e.g. transformers, power converter systems) or innovative components (e.g. new types of batteries). Several IEC product standards give definitions necessary for the understanding of certain terms used for these components. The International Electrotechnical Vocabulary (IEV, IEC 60050, http://www.electropedia.org), the IEC Glossary (http://std.iec.ch/glossary) and the ISO Online Browsing Platform (OBP, http://www.iso.org/obp) allow on-line access to this information. This terminology document completes the scenario by giving definitions necessary at the system level.

Without a strong standardization of EES systems terminology, focal terms can have a different meaning in EES systems related to different storage technologies. This aspect is critical also from the market point of view, it impacts economics and this can become a barrier for tender processes. The correct comparison among different options is fundamental, therefore basic terms and definitions impact economic decisions.

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

The use of abbreviated terms has been optimized, on the one hand to avoid tedious repetition and, on the other hand to avoid confusion. A minimum set of abbreviated terms was identified and used in the definitions, the other terms are written out in full spelling when needed. The widely accepted abbreviated terms are:

EESS – EES System – Electrical energy storage system;

EES – Electrical energy storage;

POC – Point of connection.

ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 1: Vocabulary

1 Scope

This part of IEC 62933 defines terms applicable to electrical energy storage (EES) systems including terms necessary for the definition of unit parameters, test methods, planning, installation, safety and environmental issues.

This terminology document is applicable to grid-connected systems able to extract electrical energy from an electric power system, store it internally, and inject electrical power to an electric power system. The step for charging and discharging an EES system may comprise an energy conversion.

2 Normative references

There are no normative references in this document.

3 Terms and definitions for EES systems classification

3.1
electrical energy storage
EES
installation able to absorb electrical energy, to store it for a certain amount of time and to release electrical energy during which energy conversion processes may be included

EXAMPLE A device that absorbs AC electrical energy to produce hydrogen by electrolysis, stores the hydrogen, and uses that gas to produce AC electrical energy is an electrical energy storage.

Note 1 to entry: The term “electrical energy storage” may also be used to indicate the activity that an apparatus, described in the definition, carries out when performing its own functionality.

Note 2 to entry: The term “electrical energy storage” should not be used to designate a grid-connected installation, "electrical energy storage system" is the appropriate term.

3.2
electrical energy storage system
EES system
EESS
grid-connected installation with defined electrical boundaries, comprising at least one electrical energy storage, which extracts electrical energy from an electric power system, stores this energy internally in some manner and injects electrical energy into an electrical power system and which includes civil engineering works, energy conversion equipment and related ancillary equipment

Note 1 to entry: The EES system is controlled and coordinated to provide services to the electric power system operators or to the electric power system users.

Note 2 to entry: In some cases, an EES system may require an additional energy source (non electrical) during its discharge, providing more energy to the electric power system than the energy it stored (compressed air energy storage is a typical example where additional thermal energy is required).

Note 3 to entry: ”electric power system” is defined in IEC 60050-601:1985, 601-01-01.

3.3
utility grid
part of an electric power network that is operated by a utility or grid operator within a defined area of responsability

Note 1 to entry: Utility grid is normally used for electricity transfer from or to grid users or other grids. The grid users can be electricity producers or consumers. The area of responsability is fixed by national legislation or regulation.

Note 2 to entry: "electric power network" is defined in IEC 60050-601:1985, 601-01-02.

3.4
grid-connected, adj
connected to an electric power system

Note 1 to entry: "electric power system" is defined in IEC 60050-601:1985, 601-01-01.

3.5
low voltage EESS
EES system designed to be connected to a low voltage primary POC

Note 1 to entry: Low voltage (abbreviated term: LV) is defined in IEC 60050-601:1985, 601-01-26.

3.6
medium voltage EESS
EES system designed to be connected to a medium voltage primary POC

Note 1 to entry: Medium voltage (abbreviated term: MV) is defined in IEC 60050-601:1985, 601-01-28.

3.7
high voltage EESS
EES system designed to be connected to a high voltage primary POC

Note 1 to entry: High voltage (abbreviated term: HV) is defined in IEC 60050-601:1985, 601-01-27.

3.8
residential EESS
EES system designed for residential customer applications, excluding commercial, industrial or other professional activities

Note 1 to entry: A residential EES system is normally compliant with the applicable standards for residential devices (e.g. electromagnetic compatibility), tipically, its rated apparent power does not exceed the household installed power.

Note 2 to entry: "residential customer" is defined in IEC 60050-617:2009, 617-02-05.

3.9
commercial and industrial EESS
EES system designed for commercial or industrial customer applications or other professional activities

Note 1 to entry: A commercial and industrial EES system is normally compliant with the applicable standards for commercial or industrial devices (e.g. electromagnetic compatibility).

3.10
utility EESS
EES system as a component of a utility grid, which exclusively provides services to the utility grid

3.11
self-contained EES system
EES system whose components have been matched and assembled at the factory, that is shipped in one or more containers, and that is ready to be installed in the field

Note 1 to entry: ”container” is defined in IEC 62686-1:2015, 3.1.2.

3.12
long duration application
long term application
energy intensive application
EES system application generally not very demanding in terms of step response performances but with long charge and discharge phases at variable powers

Note 1 to entry: Reactive power exchange with the electric power system may be present along with the active power exchange.

Note 2 to entry: ”electric power system” is defined in IEC 60050-601:1985, 601-01-01.

3.12.1
active power flow control
long duration application of an EES system used to compensate partially or totally the active power flow in a determined subsection of an electric power system

EXAMPLE Load shaving or levelling or shifting are active power flow controls.

Note 1 to entry: Active power flow control may require hours of continuous EES system charge or discharge.

Note 2 to entry: ”electric power system” is defined in IEC 60050-601:1985, 601-01-01.

3.12.2
feeder current control
long duration application of an EES system used to maintain a feeder current within defined limits through active power exchange with the electric power network

EXAMPLE Congestion relief is a feeder current control.

Note 1 to entry: Theoretically, reactive power exchange may also allow the feeder current control, but, because of the typical feeder power factors, only the active power exchange is really effective.

Note 2 to entry: ”electric power network” is defined in IEC 60050-601:1985, 601-01-02.

3.13
short duration application
short term application
power intensive application
EES system application generally demanding in terms of step response performances and with frequent charge and discharge phase transitions or with reactive power exchange with the electric power system

Note 1 to entry: ”electric power system” is defined in IEC 60050-601:1985, 601-01-01.

3.13.1
grid frequency control
short duration application of an EES system used for the stabilization of the electric power system frequency through active power exchange

Note 1 to entry: The balancing of temporal variations of grid frequency occurs typically over time periods of the order of seconds to minutes.

Note 2 to entry: ”electric power system” is defined in IEC 60050-601:1985, 601-01-01.

3.13.2
nodal voltage control
short duration application of an EES system used for the stabilization of the voltage at the primary POC or neighbouring nodes through active or reactive power exchange

Note 1 to entry: Reactive power is generally used in HV and MV grids, active power in LV grids, depending of the resistance-to-reactance (R/X) ratio of the relevant lines.

3.13.3
power quality events mitigation
short duration application of an EES system used to mitigate conducted disturbances in electric power systems such as short supply interruptions, voltage dips, voltage swells, voltage and currents harmonics, transient overvoltages, rapid voltage changes through active or reactive power exchange with the electric power network

Note 1 to entry: The mitigation of power quality events (except supply interruptions and harmonics) occurs typically over time periods of the order of milliseconds to seconds.

Note 2 to entry: In power quality events mitigation, active and reactive power exchange may be intended also in relation to harmonics and interharmonics.

Note 3 to entry: Theoretically, a supply interruption can have a long duration, practically, most of them have a duration ≤ 1 min. The mitigation of events with a duration > 1 min is defined as outage mitigation.

Note 4 to entry: "electric power network" is defined in IEC 60050-601:1985, 601-01-02; "power quality" is defined in IEC 60050-617:2009, 617-01-05; "power quality events" are defined in IEC TS 62749:2015.

3.13.4
reactive power flow control
short duration application of an EES system used to compensate partially or totally the reactive power flow in a determined subsection of an electric power system

EXAMPLE Power factor adjustment of loads, normally obtained by capacitor banks, is a reactive power flow control.

Note 1 to entry: "electric power system" is defined in IEC 60050-601:1985, 601-01-01.

3.14
hybrid and emergency application
EES system application generally very demanding in terms of step response performances but with frequent and long discharge phases at variable discharge power

3.14.1
outage mitigation
back-up power
hybrid and emergency application of an EES system used to provide electrical energy during a specified time and for a pre-defined maximum power, during which the main electrical energy supply is not available at the primary POC

Note 1 to entry: Theoretically, a supply interruption can have a long duration, practically, most of them have a duration ≤ 1 min. The mitigation of events with a duration ≤ 1 min is defined as power quality events mitigation.

Note 2 to entry: "power quality" is defined in IEC 60050-617:2009, 617-01-05; "power quality events" are defined in IEC TS 62749:2015.

4 Terms and definitions for EES systems specification

4.1
duty-cycle, <of an EES system>
combination of controlled phases (charge phase, pause, discharge phase, etc.) starting from an initial state of charge and ending to a final state of charge, used in the EES system characterization, specification and testing for a certain operating mode

4.1.1
charging/discharging cycle
EES system duty-cycle consisting of four controlled phases from an initial state of charge to a final state of charge, in particular: a charge phase, then a pause, then a discharge phase and finally a new pause

Note 1 to entry: In Figure 1, T_1 is the duration of the charge phase, E_1 is the energy measured at the primary POC during the charge phase, T_2 is the duration of the pause after charge, E_2 = 0 (so it is omitted in the figure), T_3 is the duration of the discharge phase, E_3 is the energy measured at the primary POC during the discharge phase, T_4 is

the duration of the pause after the discharge, E_4 = 0 (so it is omitted in the figure) and E_0 is the initial state of charge. T_2 = 0 or T_4 = 0 are possible options. The patterns of the charge and discharge phases are generally linear (constant active power); however different patterns are possible as well.

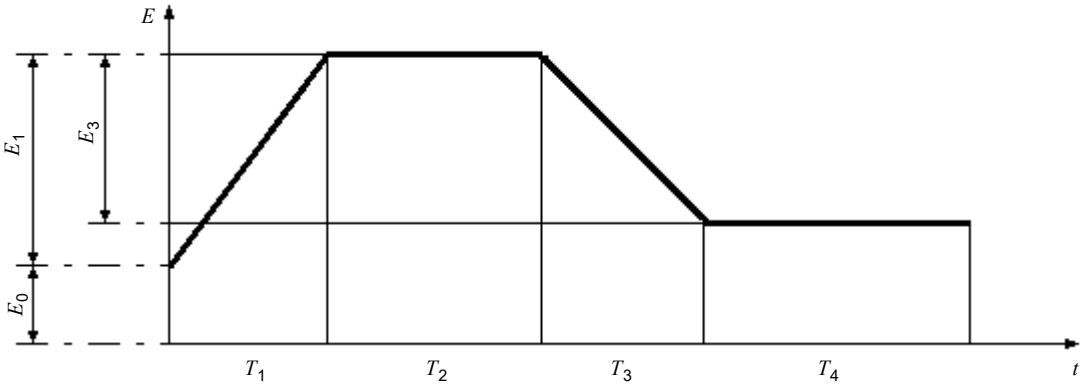

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Figure 1 – Illustrative example of EES system charging/discharging cycle

4.1.2
predetermined charging/discharging cycle
charging/discharging cycle used in the EES system characterization, specification and testing for a specific operating mode

EXAMPLE

a) E_0 compatible with the total discharge, which means state of charge = 0 %;

b) T_1 ≥ EES system nominal charging time;

c) T_3 ≥ EES system nominal discharging time;

d) $T_2 + T_4 \leq T_1$;

e) E_3 ≥ nominal energy capacity;

f) E_3 in order to return in the state of total discharge, state of charge = 0 %.

Note 1 to entry: The predetermined charging/discharging cycle is obtained by the definition of the E/T values and of the pattern of the charge and discharge phases in Figure 1.

4.2
continuous operating conditions
range of operating conditions within which the EES system is designed to operate within specified performance limits

Note 1 to entry: The continuous operating conditions are usually defined at least as follows, but other conditions may depend on the technology:

a) the voltage and frequency at POCs are within the continuous operating ranges;

b) the EES system is fully available;

c) the EES system is within the reference environmental conditions.

[SOURCE: IEC 61987-1:2006, 3.30, modified – The original definition has been adapted for the EES system and the note to entry has been added.]

4.3
point of connection
POC
reference point on the electric power system where an EES system is connected

Note 1 to entry: An EES system may have several POCs arranged in two different classes: primary POC and auxiliary POC. From an auxiliary POC it is not possible to charge electrical energy, in order to store it internally and, finally, discharge it to the electric power system, but a primary POC can be used to feed the auxiliary

subsystem and the control subsystem. In the absence of an auxiliary POC, the primary POC can be named simply as POC.

Note 2 to entry: ”electric power system” is defined in IEC 60050-601:1985, 601-01-01.

[SOURCE: IEC 60050-617:2009, 617-04-01 modified – The original definition has been adapted for the EES system and the notes to entry have been added.]

4.3.1
connection terminal
component of an EES system used for the connection to a POC

Note 1 to entry: An EES system may have several connection terminals arranged in two different classes: primary connection terminals and auxiliary connection terminals. In the absence of an auxiliary POC, the primary connection terminal can be named simply as connection terminal.

4.4
primary POC
point of connection where the EES system charges electrical energy from the electric power system, in order to store it internally and, finally, discharge it to the electric power system

Note 1 to entry: Generally, the primary POC is connected to the EES system primary subsystem through the primary connection terminal.

Note 2 to entry: ”electric power system” is defined in IEC 60050-601:1985, 601-01-01.

4.4.1
nominal active power, <of an EES system>
value of the active power by which the EES system is designated and identified

Note 1 to entry: This term may be particularized as nominal active power during charge (P_{CN}) and nominal active power during discharge (P_{DN}).

Note 2 to entry: Watt (W) is the common unit, other units may be chosen for convenience as well (kW, MW).

Note 3 to entry: The definition has been formulated along the same lines as that in IEC 60050-826:2004, 826-11-01.

4.4.2
nominal apparent power, <of an EES system>
value of the apparent power by which the EES system is designated and identified

Note 1 to entry: Volt ampere (VA) is the base unit, other units may be chosen for convenience as well (kVA, MVA).

Note 2 to entry: The definition has been formulated along the same lines as that in IEC 60050-826:2004, 826-11-01.

4.4.3
nominal energy capacity, <of an EES system>
E_{NC}
value of the energy capacity by which the EES system is designated and identified

Note 1 to entry: The term “nominal energy capacity” is not to be mixed up with the term “capacity” (used for cells, batteries, capacitors etc.), which is a quantity of electricity (electric charge), usually expressed in coulomb (C) or amperes-hour (Ah).

Note 2 to entry: Joule (J) is the base unit, other units may be chosen for convenience as well (kWh, MWh).

Note 3 to entry: The definition has been formulated along the same lines as that in IEC 60050-826:2004, 826-11-01.

4.4.4
nominal frequency, <of an EES system>
value of the frequency by which the EES system is designated and identified at the primary connection terminal

Note 1 to entry: Hertz (Hz) is the base unit.

Note 2 to entry: The definition has been formulated along the same lines as that in IEC 60050-826:2004, 826-11-01.

4.4.5
nominal voltage, <of an EES system>
value of the voltage by which the EES system is designated and identified at the primary connection terminal

Note 1 to entry: (V) is the base unit, other units may be chosen for convenience as well (kV).

[SOURCE: IEC 60050-826:2004, 826-11-01, modified – The original definition has been adapted for the EES system and the note to entry has been added.]

4.4.6
power capability chart
apparent power characteristic
input and output power rating
representation on the P/Q power plane defining the active and reactive power which the EES system is designed to exchange with the electric power system via the primary POC, in steady state operation and continuous operating conditions

Note 1 to entry: The power available is depicted by a region on the plane. The boundaries of the region represent the operating limits of the EES system. In Figure 2 the consumer meter arrow system is adopted, where: P_{CR} is the rated active power during charge; P_{DR} is the rated active power during discharge; Q_{IR} is the rated inductive reactive power and Q_{CR} is the rated capacitive reactive power.

The capability chart is divided in four quadrants by the P/Q axis (producer reference frame is adopted):

a) in the quadrant Q1 the EES system is discharging to the electric power system and its behaviour is like a capacitor;

b) in the quadrant Q2 the EES system is charging from the electric power system and its behaviour is like a capacitor;

c) in the quadrant Q3 the EES system is charging from the electric power system and its behaviour is like an inductor;

d) in the quadrant Q4 the EES system is discharging to the electric power system and its behaviour is like an inductor.

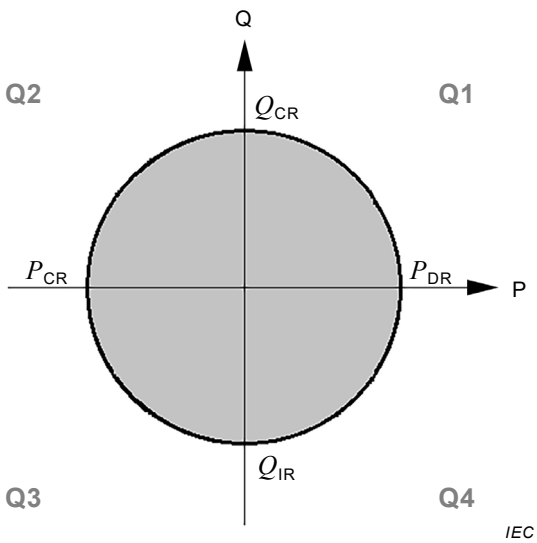

Figure 2 – Illustrative example of EES system power capability chart

Note 2 to entry: Watt and var (W, var) are base units, other units may be chosen for convenience as well (MW, Mvar).

Note 3 to entry: If restrictions are not declared, the capability chart is normally valid for the entire service life.

Note 4 to entry: "electric power system" is defined in IEC 60050-601:1985, 601-01-01; "producer reference frame" is defined in IEC TR 61850-90-7:2013.

4.4.7
rated active power
EES system maximum active power on the operating limits of the power capability chart

Note 1 to entry: Watt (W) is the common unit, other units may be chosen for convenience as well (kW, MW).

Note 2 to entry: In Figure 2, the rated active power is the maximum value between P_{CR} and P_{DR}.

4.4.8
rated apparent power
EES system maximum apparent power on the operating limits of the power capability chart

Note 1 to entry: Volt ampere (VA) is the base unit, other units may be chosen for convenience as well (kVA, MVA).

4.4.9
rated energy capacity
E_{RC}
designed value of the energy content of the EES system in continuous operating conditions, starting from a full state of charge and discharging continuously at rated active power during discharge, measured at the primary POC

Note 1 to entry: The term "rated energy capacity" is not to be mixed up with the term "capacity" (used for cells, batteries, capacitors etc.), which is a quantity of electricity (electric charge), usually expressed in coulomb (C) or amperes-hour (Ah).

Note 2 to entry: Joule (J) is the base unit, other units may be chosen for convenience as well (kWh, MWh).

4.4.10
rated frequency
value of the frequency for which the EES system primary connection terminal is designed

Note 1 to entry: The validity range around rated frequency is named continuous operating frequency range and describes the variation of frequency allowed around the rated value.

Note 2 to entry: Hertz (Hz) is the base unit.

4.4.11
rated power factor
power factor corresponding to the rated apparent power

Note 1 to entry: "power factor" is defined in IEC 60050-131:2002, 131-11-46.

4.4.12
rated reactive power
EES system maximum reactive power on the operating limits of the power capability chart

Note 1 to entry: Var (var) is the base unit, other units may be chosen for convenience as well (kvar, Mvar).

Note 2 to entry: In Figure 2, the rated reactive power is the maximum value between Q_{IR}, and Q_{CR}.

4.4.13
rated voltage
value of the voltage for which the EES system primary connection terminal is designed

Note 1 to entry: The validity range around this rated voltage is named continuous operating voltage range and describes the variation of voltage allowed around the rated value.

Note 2 to entry: Volt (V) is the base unit, other units may be chosen for convenience as well (kV).