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TECHNICAL SPECIFICATION

colour inside

Electrical energy storage (EES) systems –
Part 3-3: Planning and performance assessment of electrical energy storage systems – Additional requirements for energy intensive and backup power applications

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 3-3: Planning and performance assessment of electrical energy storage systems – Additional requirements for energy intensive and backup power applications

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IEC TS 62933-3-3 has been prepared by IEC technical committee 120: Electrical Energy Storage (EES) Systems. It is a Technical Specification.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
120/262/DTS	120/275/RVDTS

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 Technical Specification 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.

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 document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

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- withdrawn,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

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INTRODUCTION

Electrical energy storage (EES) systems can provide solutions to multiple energy storage scenarios. The objective of this document is to provide requirements, guidelines and references when EES systems are designed, controlled and operated for energy intensive, islanded grid and backup power supply applications.

ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 3-3: Planning and performance assessment of electrical energy storage systems – Additional requirements for energy intensive and backup power applications

1 Scope

This part of IEC 62933 provides requirements, guidelines and references when EES systems are designed, controlled and operated for energy intensive, islanded grid and backup power supply applications. In energy intensive applications, the EES system provides long charge and discharge phases at variable powers to the supported grid or user equipment. In islanded operation, the EES system provides energy to the islanded grid and coordinates other power generation systems in the islanded grid. In backup power supply and emergency support, the EES system provides energy to the internal grid or a set of emergency loads when the main grid power supply is not available.

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 61850-7-420, *Communication networks and systems for power utility automation – Part 7–420: Basic communication structure – Distributed energy resources and distribution automation logical nodes*

IEC TR 61850-90-9, *Communication networks and systems for power utility automation – Part 90-9: Use of IEC 61850 for Electrical Energy Storage Systems*

IEC 62933-1:2018, *Electrical energy storage (EES) systems – Part 1: Vocabulary*

IEC 62933-2-1, *Electrical energy storage (EES) systems – Part 2-1: Unit parameters and testing methods – General specification*

IEC TS 62933-2-2, *Electrical energy storage (EES) systems – Part 2-2: Unit parameters and testing methods – Application and performance testing*

IEC TS 62933-3-1:2018, *Electrical energy storage (EES) systems – Part 3-1: Planning and performance assessment of electrical energy storage systems – General specification*

IEC TS 62933-3-2:2022, *Electrical energy storage (EES) systems – Part 3-2: Planning and performance assessment of electrical energy storage systems – Additional requirements for power intensive and renewable energy sources integration related applications*

3 Terms, definitions, abbreviated terms and symbols

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 62933-1 and the following apply.

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

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

3.1.1
backup power supply
provision of power to all internal loads connected to user side equipment during a specified time period without relying on an external power source in the event of electrical grid outage

3.1.2
black start capability
capability of the EES system to start the electric power system (IEV 601-01-01) only with internal energy resources

3.1.3
allowed charging time
time period when an EES system is allowed to charge the accumulation subsystem in the peak shaving application

3.1.4
allowed discharging time
time period when an EES system is allowed to discharge the accumulation subsystem in the peak shaving application

3.1.5
duty cycle roundtrip efficiency
energy discharged measured at the primary POC divided by the energy absorbed by the EES system, as a sum of what is measured at all the POCs (primary and auxiliary), during duty cycles in a specified operating mode at continuous operating conditions with the same final state of charge as the initial state of charge

[SOURCE: IEC 62933-1:2018, 4.12.1, modified – the notes have been deleted.]

3.1.6
emergency load
set of devices and equipment that should be operated during electrical grid outage

3.1.7
emergency support
provision of power to emergency loads within a specified time and duration without relying on an external power source in the event of electrical grid outage

3.1.8
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

[SOURCE: IEC 62933-1:2018, 3.12, modified – the terms “long duration application” and “long term application” have been deleted and the notes have been deleted.]

3.1.9
fluctuation reduction of consumption
reduction of power oscillation of power consumption at the grid connection point by absorbing the active power of the grid by EES systems at low power demand phases and by feeding in additional active power by EES systems at high power demand phases

3.1.10
islanded grid
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

3.1.11
islanded operation
function to provide power to the islanded grid and to control the coordination with other power generation systems and the system voltage and frequency

3.1.12
load profile
line graph illustrating the variation in loads over a specific time

3.1.13
peak shaving
limitation of the power consumption from the power grid to a maximum value by providing the power exceeding the maximum value from other active power sources

3.1.14
rated AC current
AC current that the EES system can provide to the grid continuously and can accept from the grid continuously without exceeding the maximum operating temperature of the EES system

3.1.15
self-discharge
phenomenon by which the EES system accumulation subsystem loses energy in other ways than by discharge through the primary POC

[SOURCE: IEC 62933-1:2018, 4.12.7, modified – the note has been deleted.]

3.2 Abbreviated terms and symbols

3.2.1 Abbreviated terms

ACB	air circuit breaker
ATS	automatic transfer switch
BMS	battery management system
CVCF	constant voltage constant frequency
DER	distributed energy resources
DNP	distributed network protocol
EES	electrical energy storage
EMS	energy management system
GHG	greenhouse gas
HVAC	heating, ventilation, and air conditioning
PCS	power conversion system
PMS	power management system
POC	point of connection
PV	photovoltaics
SOC	state of charge
SOH	state of health
TR	transformer

UVRT under voltage ride through

VT voltage transformer

3.2.2 Symbols

f frequency

P active power

Q reactive power

S apparent power

Y star configuration

Δ delta configuration

4 General planning and performance assessment considerations for EES systems

Clause 4 presents the general and common requirements for various applications of EES systems. IEC TS 62933-3-1 shall be applied. Clause 4 of IEC TS 62933-3-2:2022 is also applicable.

5 Peak shaving and load levelling

5.1 Application of EES system

5.1.1 Functional purpose

The EES system performs a shift, in time, of available energy to achieve more uniformity in power generation and consumption pattern. With this activity, peaks in power consumption and associated power generation demand are smoothed. This results in a reduction in behind-the-meter demand charges by an appropriate timing of the activation of power generation or power storage assets.

NOTE This document covers peak shaving and load levelling application from the perspective of behind the meter.

5.1.2 Application related requirements

5.1.2.1 General

In the peak shaving and fluctuation reduction of consumption applications, in addition to the application independent requirements listed in 4.1.2 of IEC TS 62933-3-2:2022, the following application specific requirements shall be considered.

5.1.2.2 Specific requirements

In energy fluctuation reduction applications, the following application specific recommendations should be considered:

- load profile;
- charging-discharging time;
- rated AC current;
- duty cycle efficiency.

5.2 Conditions and requirements for connection to the grid

Subclause 4.2 of IEC TS 62933-3-2:2022 is applicable.

5.3 Design of the EES systems

5.3.1 Structure of the EES systems

The EES system structure and components defined in 4.3.2 of IEC TS 62933-3-2:2022 shall also be applied to the peak shaving and fluctuation reduction of consumption applications.

5.3.2 Subsystem specifications and requirements

Subclause 4.3.3 of IEC TS 62933-3-2:2022 is applicable. Further, additional technology dependent requirements are defined in Annex B.

5.3.3 Grid integration of the EES systems

Subclause 4.3.4 of IEC TS 62933-3-2:2022 is applicable. Further, additional technology dependent requirements are defined in Annex A.

5.3.4 Operation and control

5.3.4.1 Overview

Subclause 4.3.5 of IEC TS 62933-3-2:2022 is applicable. In addition, the following recommendations should be considered.

5.3.4.2 General

There are three types of operation periods of the EES system for peak shaving and fluctuation reduction of consumption applications, namely peak period, idle period, and off-peak period. The EES system operation modes for each operation period are listed in Table 1.

Table 1 – Operation modes of EES system for peak shaving and fluctuation reduction of consumption

Operation mode (type of period)	Discharge (peak period)	Standby (idle period)	Charge (off-peak period)
Scheduling principle	Try not to take power from the grid.	Minimize the interaction with the grid.	Try not to discharge to the grid.
Approach	The EES system discharges to the grid.	Avoid charging and discharging from the grid to EES system.	EES system charges from the grid.
Purpose	Reduce the pressure on the grid during peak period.	Maintain stable operation of the grid.	Restore EES system to a predefined SOC. Absorb excess energy from the grid and increase energy efficiency.

The EES system for peak shaving and fluctuation reduction of consumption can be operated to provide one or multiple charge and discharge sequences or cycles per day. Figure 1 shows the operation modes and effect of the EES system using "one charging and one discharging" as an example. In Figure 1, the dashed line indicates the target input power from the grid and the solid line indicates the load over time. When the load level is below the target input power during the off-peak period, the EES system charges from the grid. When the load level exceeds the target input power during the peak period, the EES system performs a discharging operation.

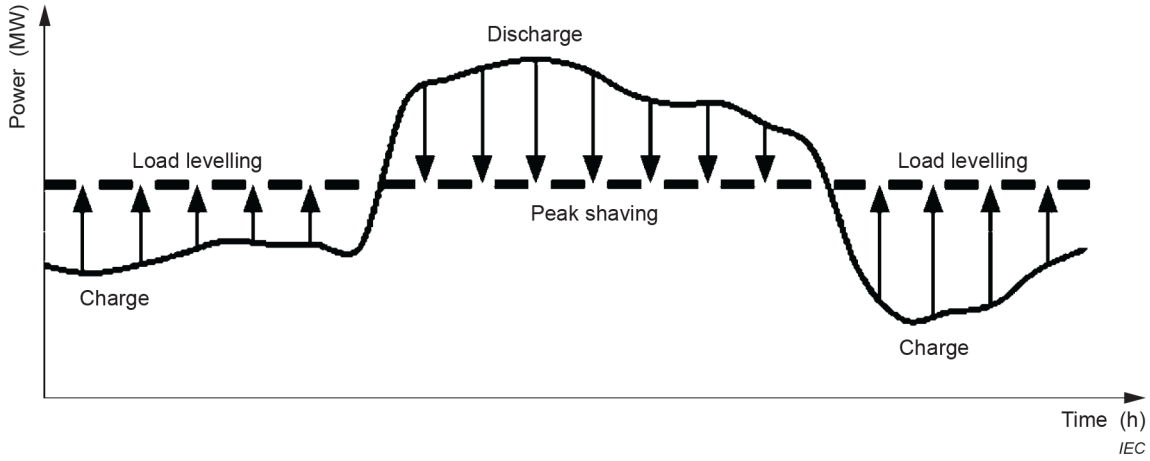

Figure 1 – Example of peak shaving and fluctuation reduction of consumption consisting of charge and discharge events

5.3.4.3 Operation modes of control subsystem

The operation modes of the EES system are charge, discharge, and standby. The operation modes over time are determined by a duty cycle. When determining the duty cycle, the following recommendations should be considered.

- The EES system should be charged at the off-peak period (usually at night), and the EES system should be put into standby mode after the accumulation subsystem is fully charged.
- The EES system can be operated in various duty cycles, such as "one charge and one discharge", "one charge and two discharges", "two charges and two discharges", and "multiple charges and multiple discharges". The specific charge-discharge power and time of the EES system are set by the operating mechanism and the scheduling mechanism.
- The scheduling mechanism manages the EES system at peak period to discharge, and the power response time of the EES system does not exceed a predetermined time.
- The EES system can automatically receive the dispatching curve issued by the grid system and operate according to the power generation plan curve. The deviation between the actual output curve and the scheduling command curve needs to be determined before this operation.

In the case that the power curve is not formulated by the grid dispatch organization, the EES system should distribute the charge-discharge power and time according to the loads and the internal constraints of the EES system.

Subclause 5.3.4.3 presents one charge and one discharge duty cycle, and two charges and two discharges duty cycle as examples. Other duty cycles may be used depending on the situation, and are presented in IEC 62933-2-1 and IEC TS 62933-2-2.

a) One charge and one discharge duty cycle

Figure 2 displays the example of duty cycles for a midnight-to-midnight day with an afternoon peak. Each duty cycle in the figure consists of a total of 12 h duration for charging. The required discharge duration and a standby duration after charge and discharge bring the total duration for each of the A, B, and C duty cycles to one 24 h cycle. The peak period for discharging starts at 13:00 for duty cycle A, 14:00 for duty cycle B, and 15:00 for duty cycle C, respectively. Prior to the peak period, the EES system should be charged to maximum SOC. When operating the A, B, and C cycles, the EES system should be returned to the same SOC as the SOC at the start of the duty cycle, which in this case is the maximum SOC. Thus, each duty cycle A, B, and C consists of a discharge followed by standby, charge, and standby to bring the EES system to the initial SOC.

- Off-peak period (charge mode): During the off-peak period, the EES system is charged generally with a sequential constant power–constant voltage charging profile to bring