IEC TR 62933-2-201

Edition 1.0 2024-09

TECHNICAL REPORT

colour inside

**Electrical enery storage (EES) systems –
Part 2-201: Unit parameters and testing methods – Review of testing for battery energy storage systems (BESS) for the purpose of implementing repurpose and reuse batteries**

IEC TR 62933-2-201:2024-09(en)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications
The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform
The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, …). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished
Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc
If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch
Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org
The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC TR 62933-2-201

Edition 1.0 2024-09

TECHNICAL REPORT

colour inside

Electrical enery storage (EES) systems –
Part 2-201: Unit parameters and testing methods – Review of testing for battery energy storage systems (BESS) for the purpose of implementing repurpose and reuse batteries

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 13.020.30; 29.220.99

ISBN 978-2-8322-9516-8

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

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 2-201: Unit parameters and testing methods – Review of testing for battery energy storage systems (BESS) for the purpose of implementing repurpose and reuse batteries

FOREWORD

IEC TR 62933-2-201 has been prepared by IEC technical committee 120: Electrical Energy Storage (EES) systems. It is a Technical Report.

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

Draft	Report on voting
120/366/DTR	120/379/RVDTR

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 Report 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/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, or
- revised.

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

Battery energy storage systems (BESS) will become an important component of the energy infrastructure in the future as energy demand increases and the transition to sustainable power sources continues. Designing BESS using repurpose and reuse batteries requires a multidisciplinary approach that balances technical, economic, environmental, and regulatory considerations. This document reviews test methods and evaluations related to repurpose and reuse battery integration into BESS. As society seeks solutions to manage the dual challenges of energy storage and waste reduction, BESS evaluation methods become important. This report examines the obstacles to battery reuse based on the legal context and examples and aims to provide valuable insights that facilitate decision-making more efficiently.

ELECTRICAL ENERGY STORAGE (EES) SYSTEMS –

Part 2-201: Unit parameters and testing methods – Review of testing for battery energy storage systems (BESS) for the purpose of implementing repurpose and reuse batteries

1 Scope

This part of IEC 62933, which is a technical report, focuses on the necessity of using repurpose and reuse batteries in BESS. This document also illustrates, through case studies from various countries, how repurpose and reuse batteries are regulated as per legislation. Furthermore, business examples of BESS using repurpose and reuse batteries are investigated and issues derived in terms of both the design, manufacturing, testing, operation, and maintenance of BESS, considering the anticipated future deployment of BESS[1].

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 terminology 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
battery energy storage system
BESS
electrical energy storage system with an accumulation subsystem based on batteries with secondary cells

Note 1 to entry: Battery energy storage systems include flow battery energy systems.

3.2
reuse
operation by which secondary batteries that are not waste are used again in an application

[1] Companies and products named in this document are provided for reasons of public interest or public safety. This information is given for the convenience of users of this document and does not constitute an endorsement by IEC.

3.3
repurpose
utilize a product or its components in a role that it was not originally designed to perform

Note 1 to entry: This action deals specifically with products and assemblies and not materials, which fall under recycling.

Note 2 to entry: In some cases, repurposing will lead to a substantial modification, i.e., a new product which has to be placed on the market.

[SOURCE: ISO 8887-2:2023, 3.32]

3.4
battery module
group of cells connected together either in a series and/or parallel configuration with or without protective devices (e.g. fuse or PTC) and monitoring circuitry

[SOURCE: ISO 7176-31:2023, 3.3, modified – the term "module" has been removed.]

3.5
battery pack
energy storage device that includes cells or cell assemblies normally connected with cell electronics and overcurrent shut-off device including electrical interconnections and interfaces for external systems

Note 1 to entry: Examples for interfaces are cooling, high voltage, auxiliary low voltage and communication.

[SOURCE: ISO 18300:2016, 3.11, modified – the term "lithium-ion battery pack" has been removed.]

3.6
battery management system
BMS
electronic system associated with a battery which has functions to maintain safety and prevent damage

[SOURCE: ISO 7176-31:2023, 3.5]

3.7
battery rack
support, stand or grating with one or more levels or tiers for the installation of cells or monobloc containers in a stationary battery

[SOURCE: IEC 60050-482:2004,482-05-24]

4 Background

4.1 BESS market trends

The demand for storage batteries is expected to increase further in the future due to the following reasons:

- A study conducted by the National Renewable Energy Laboratory called the Renewable Electricity Futures Study [1][2] showed the predicted storage needs in relation to increase of renewable energy (RE) incorporated into electric grid.

---

[2] Numbers in square brackets refer to the Bibliography.

- By 2050, storage capacity was estimated at 28 GW in the Low-Demand Baseline scenario, 31 GW in the 30 % RE scenario, 74 GW in the 60 % RE scenario, and to reach a 90 % renewable energy scenario that included 48 % wind and solar required for around 140 GW of installed storage capacity.
- As the percentage of RE connected to grid system is increased, the need for storage increases accordingly.
- In general, RE is often an unstable power supply. It is considered effective to temporarily accumulate RE in BESS for the purpose of stable supply and to utilize it as needed.

Distribution grid operations can be improved by means of a BESS.

- Network congestion: In locations where network capacity is limited during peak renewable generation hours, a BESS can store the excess energy and release it into the network when renewable generation reduces.
- Power quality: A BESS can be used to absorb the excessive supply of renewable energy and keep the voltage below the upper limit prescribed in the grid code. The BESS can be either a grid-tied or a behind-the-meter installation.

For transmission network operators, a key concern arising from the integration of renewable energy sources is the effect of the variability and intermittence of generation. The various problems created can be addressed with the help of BESS such as: forecast errors, network congestion, and increased ramping requirements during peak hours.

According to a report [2] by Benchmark mineral intelligence predicting how lithium-ion battery megafactories around the world will increase their production capacity toward 2030, lithium-ion battery production capacity is expected to increase by 400 % over the next 10 years.

– The motivators of this increase are the demand for EVs (electric vehicles) and the progress of electrification in industrial equipment.
– Bloomberg's forecast of lithium-ion battery demand and market shares for automotive, consumer, and stationary applications [3] indicates that the market share for stationary storage batteries will remain around 10 % of the total battery market, but total demand will increase significantly to nearly 2 TWh.
– According to an IEA report on global electric vehicle sales from 2010 to 2021 [4], the total number of electric vehicles on the world's roads in 2021 was approximately 16,5 million, three times the number in 2018.
– The IEA's forecast of the global electric vehicle stock for 2020 to 2030 [5] shows that the global electric vehicle stock continues to grow strongly and is expected to reach 175 million units by 2030.The availability of large battery capacities is an opportunity, especially if second-life applications are considered and can be a motivation to explore synergies between electro mobility and battery storage to support renewable energies further.

4.2 Issues on battery supply

Bloomberg NEF forecasts metal demand for lithium-ion batteries from 2020 to 2030 [6], predicting that demand for the key element in LIB cathodes will increase each year and exceed 17,5 million tons by the end of the decade. Demand for lithium is set to grow the fastest, surging more than sevenfold between 2021 and 2030.

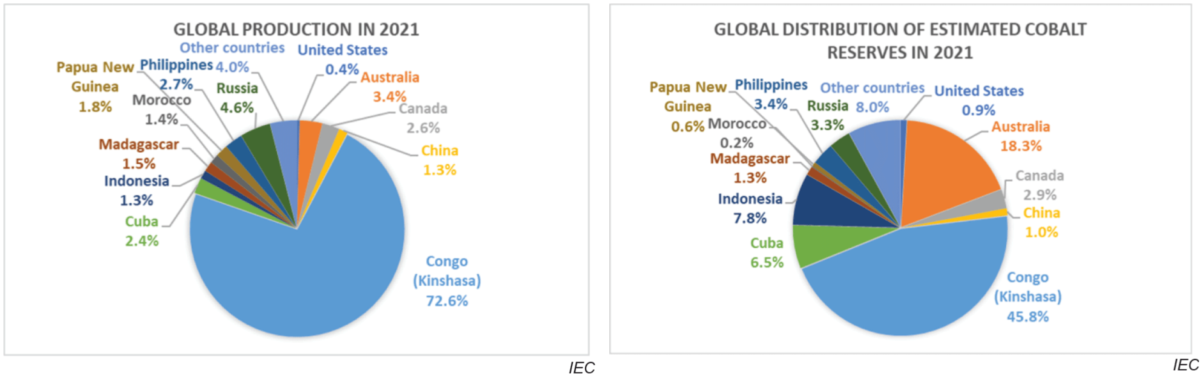
In the lithium metal supply and demand forecast scenario reported by Shekhar et al [7], lithium metal demand shows strong growth.

Lithium supply and demand can be considered adequate through 2020, but supply and demand are expected to tighten in the future.

After 2026, it is projected that it will be essential to systematically increase the supply of lithium rapidly from the planned 100 000 tons to a value matching the demand.

The price trend of lithium carbonate in China (Shanghai market) [8] shows that lithium carbonate prices have increased significantly in recent years and are not stable.

Effective supply-demand balancing will require the reuse of waste batteries.



a) Global cobalt production in 2021

b) Global distribution of estimated cobalt reserves in 2021

Figure 1 – Regional bias in natural resource reserves

Figure 1 (a) and (b) shows cobalt production and reserves in 2021. The earth's cobalt resources amount to 25 million tons (USGS, 2022) [9].

Most of these resources are located in the Copperbelt, a mining area that includes part of the Kantanga Province in the Democratic Republic of the Congo (DRC).

Considering the production of cobalt is about 170 ktons/year, unless a tremendous improvement in cobalt production, shortage of Co is apparent.

4.3 Motivation for the use of reuse batteries

As one way to compensate for the lack of resources, the use of batteries that are no longer needed in primary use is considered to be effective.

As electrification advances, the amount of battery waste increases.

Some of the used batteries are said to have residual performance that meets the requirement for secondary use.

Estimates of the number of waste batteries and where they originated [10] indicate that a large and rapidly growing number of waste batteries are being generated not only from EVs but also from buses and energy applications. Batteries used secondarily in this way have various histories and are expected to be distributed in the market in various forms.

4.4 Configuration of reuse batteries

There are key stages in the typical process of secondary use of used electric vehicle (EV) batteries (e.g., https://global.nissanstories.com/en/releases/4r). The stages include dismount battery pack from EV, refurbishing for reuse, integration of reuse batteries.

Given that the batteries in EV vehicles are in a packed state, the level of refurbishing process affects how the batteries are reused. Specifically, whether the battery is in the smallest cell state, the module state, or in the pack state affects how reuse batteries are incorporated into the secondary use system.