

TECHNICAL REPORT

**Distributed energy resources connection with the grid -
Part 102: CAES connection to the grid**

iteh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC TR 62786-102:2025](https://standards.iteh.ai/catalog/standards/iec/ba27792c-15cf-4560-9611-7cd794293b8d/iec-tr-62786-102-2025)

<https://standards.iteh.ai/catalog/standards/iec/ba27792c-15cf-4560-9611-7cd794293b8d/iec-tr-62786-102-2025>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2025 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat
3, rue de Varembe
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 It also gives information on projects, replaced and withdrawn publications.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 62786-102:2025](https://standards.iteh.ai/catalog/standards/iec/ba27792c-15cf-4560-9611-7cd794293b8d/iec-tr-62786-102-2025)

<https://standards.iteh.ai/catalog/standards/iec/ba27792c-15cf-4560-9611-7cd794293b8d/iec-tr-62786-102-2025>

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

CONTENTS

FOREWORD	4
1 Scope	6
2 Normative references	6
3 Terms and definitions and abbreviated terms	6
3.1 Terms and definitions	6
3.2 Abbreviated terms	7
4 Introduction to CAES system	8
4.1 Basic principle of CAES system	8
4.2 The energy conversion process of CAES system	9
4.2.1 General	9
4.2.2 The energy conversion process during charging state	9
4.2.3 The energy conversion process during discharging state	11
5 Grid-connected method	11
5.1 General	11
5.2 Grid-connected process and needs	12
5.3 Charging state	12
5.3.1 Grid-connected startup process	12
5.3.2 Shutdown process	13
5.4 Discharging state	13
5.4.1 Grid-connected startup process	13
5.4.2 Shutdown process	13
6 Grid-connected operating characteristics	13
6.1 General needs	13
6.2 Response characteristics and curves in charging state	14
6.2.1 General	14
6.2.2 Response characteristics of active power to frequency	14
6.2.3 Response characteristics of active power to current	15
6.2.4 Response characteristics of active power to injecting mass flow	15
6.2.5 Response characteristics of active power to pressure	17
6.3 Response characteristics and curves in discharging state	17
6.3.1 General	17
6.3.2 Response characteristics of active power to frequency	17
6.3.3 Response characteristics of reactive power to voltage	19
6.3.4 Response characteristics of active power to injecting mass flow	20
6.3.5 Response characteristics of active power to pressure	21
6.4 State transition process	22
7 Other grid-connected needs	23
7.1 Selection of the POC	23
7.2 EMC and power quality	23
7.3 Communication and automation	23
7.4 Monitoring and protection	23
7.5 Immunity to disturbances	23
8 Grid-connected testing needs	24
8.1 General needs	24
8.2 Response test of voltage and reactive power	24
8.3 Test of power-generation control	24

8.4	Test of charging and discharging time.....	24
8.5	Test of rated energy.....	24
8.6	Efficiency test of energy conversion.....	24
Annex A	(informative) Types of CAES system.....	25
A.1	Supplementary combustion CAES system.....	25
A.1.1	Supplementary combustion CAES system I	25
A.1.2	Supplementary combustion CAES system II	25
A.1.3	Supplementary combustion CAES system III	26
A.2	Non-supplementary combustion CAES system.....	26
A.2.1	Non-supplementary combustion CAES system I.....	26
A.2.2	Non-supplementary combustion CAES system II	27
Annex B	(informative) Cycle efficiency of energy conversion.....	28
Annex C	(informative) Introduction to the subsystems of CAES system.....	30
C.1	Compressor	30
C.1.1	General	30
C.1.2	Piston compressor	30
C.1.3	Centrifugal compressor.....	30
C.1.4	Axial compressor	30
C.1.5	Rotary compressor	30
C.2	Heat exchanger	30
C.2.1	General	30
C.2.2	Fixed tube-plate heat exchanger.....	31
C.2.3	U-shaped tube heat exchanger.....	31
C.2.4	Cross flow heat exchanger	31
C.2.5	Hairpin heat exchanger.....	31
C.3	Turbine	31
C.3.1	General	31
C.3.2	Piston turbine	31
C.3.3	Radial turbine	32
C.3.4	Axial flow turbine	32
C.4	Air storage device.....	32
C.4.1	General	32
C.4.2	Salt cavern	32
C.4.3	Artificial chamber.....	32
C.4.4	Abandoned mine.....	32
C.4.5	Pipeline steel.....	32
C.5	Heat storage medium.....	33
C.5.1	General	33
C.5.2	Water	33
C.5.3	Organic heat carrier.....	33
C.5.4	Molten salt.....	33
Annex D	(informative) Cases of CAES system	34
D.1	Case 1	34
D.2	Case 2	35
D.3	Case 3	36
Bibliography	38
Figure 1	– Schematic diagram of supplementary combustion CAES system.....	8

Figure 2 – Schematic diagram of non-supplementary combustion CAES system	8
Figure 3 – The schematic diagram of the CAES system connected to a network	12
Figure 4 - The grid-connected process of the CAES system in charging state	14
Figure 5 - Response curve of active power to injecting mass flow in charging state	16
Figure 6 – Response curve of active power in charging state with changes in final-level pressure	17
Figure 7 – Response curve of active power in discharging state	18
Figure 8 – Typical active power and frequency response curve	19
Figure 9 – Response curve of active power to injecting mass flow in discharging state	21
Figure 10 – Response curve of active power to pressure in discharging state	22
Figure A.1 – Architecture of supplementary combustion CAES system I.....	25
Figure A.2 – Architecture of Supplementary Combustion CAES System II.....	26
Figure A.3 – Architecture of supplementary combustion CAES system III.....	26
Figure A.4 – Architecture of non-complementary combustion CAES system I.....	27
Figure A.5 – Architecture of non-complementary combustion CAES system II.....	27
Figure D.1 – Panoramic view of Case 1	34
Figure D.2 – Panoramic view of Case 2	35
Figure D.3 – Panoramic view of Case 3	36
Table 1 – Active power in charging state of the CAES system.....	15
Table 2 – Active power and injecting mass flow of the CAES system in stable charging state	16
Table 3 – The final-level pressure and charging active power during the stable charging stage	17
Table 4 – Operating frequency needs of the CAES system	18
Table 5 – Active power of the CAES system in discharging state	18
Table 6 – Response needs of reactive power to voltage.....	20
Table 7 – The outlet pressure and active power in discharging state of the CAES system	22

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**Distributed energy resources connection with the grid -
Part 102: CAES connection to the grid**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch>. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TR 62786-102 has been prepared by IEC Technical Committee 8: System aspects of electrical energy supply. It is a Technical Report.

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

Draft	Report on voting
8/1745/DTR	8/1749/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.