



भारत सरकार

Government of India

विद्युत मंत्रालय

Ministry of Power

केन्द्रीय विद्युत प्राधिकरण

Central Electricity Authority

विद्युत प्रणाली योजना एवं मूल्यांकन-I प्रभाग

Power System Planning & Appraisal-I Division

सेवा में / To,

1. Chief Operating Officer (CTUIL), 16, Institutional Area, Sector 32, Gurugram, Haryana 122001
2. Director (Operations), GRID-INDIA, B-9, Qutab Institutional Area, Katwaria Sarai, New Delhi - 11001
3. All Principal Secretary/ Secretary to State/UT Energy Departments
4. MDs of All State Transmission Utilities

विषय / Subject: Advisory for implementation of 100% Grid Forming Invertors (GFMs) in all upcoming BESS projects- regarding

महोदय / Sir,

The All India generation installed capacity as on 31.05.2026 is 542GW, which includes 157 GW of Solar and 57 GW of Wind Capacity. As per the Resource Adequacy studies, the projected generation installed capacity by the end of 2035-36 is 1121 GW, which includes 509 GW Solar, 155 GW Wind along with the energy storage installed capacity of 174 GW/888 GWh (BESS of 80 GW/321 GWh and PSP of 94 GW/ 567 GWh).

Presently, it has been observed that grid following inverters are being installed in the solar and BESS capacity. While these inverters operate effectively in strong grids, the large-scale integration of inverter-based renewable energy sources has introduced significant operational challenges, including low Short Circuit Ratio (SCR), power system oscillations, and inadequate system strength. Further addition of inverter-based RE generation and BESS without adequate grid-support capabilities is likely to result in a further decline in SCR, thereby aggravating oscillatory behaviour, reducing system strength, and posing challenges to overall grid stability and reliable system operation.

The above issues have been deliberated with stakeholders at various national forums including NCT and RPCs. It was suggested that Grid-forming Inverters will not only help in

reducing the stability issues in RE complexes by enhancing system strength and improving grid stability, but also provide black start support as they act as a voltage source. In view of the above, it is advised to implement 100% Grid-forming Invertors in all the upcoming Battery Energy Storage System (BESS) projects.

The detailed technical requirements for Grid Forming (GFM) inverters to be installed in the BESS projects is attached at **Annexure-I**

This issues with the approval of Chairperson, CEA.

भवदीय / Yours faithfully,

Digitally signed by
Bhanwar Singh Meena
Date: 10-07-2026
10:24:59

(भंवर सिंह मीना /Bhanwar Singh Meena)

निदेशक/ Director

Copy for information:

1. Joint Secretary (Trans), MoP
2. SA to Chairperson, CEA
3. SA to Member (PS), CEA
4. SA to Member (Planning), CEA
5. PPS to Chief Engineer (PSPA-I), CEA
6. PS to Chief Engineer (PSPA-II), CEA
7. PS to Chief Engineer (ESS), CEA

Annexure I

Requirements for Battery Energy Storage Systems (BESS) with Grid Forming Control (GFM).

This document consolidates the essential requirements for Battery Energy Storage Systems (BESS) with Grid Forming Control (GFM). Unless specifically stated otherwise, these requirements shall apply in addition to the applicable Grid Following Control (GFL) requirements, as per the relevant clauses of CEA Technical Standards for Connectivity to Grid. Where there is any conflict, the requirement in this memorandum shall prevail.

General Requirement

1. The GFM BESS shall comply with all applicable requirements specified for Grid Following Control Inverters and all other applicable clauses in this section.

Where any requirement specified herein conflicts with the corresponding requirement applicable to Grid Following Control Inverters, the requirement specified herein shall prevail to the extent of such conflict.

2. The GFM BESS shall be capable of maintaining stable operation over a wide range of system strengths, including weak grid conditions corresponding to a Short Circuit Ratio (SCR) of 2.0 or lower at the Point of Interconnection
3. The GFM BESS shall provide autonomous and near-instantaneous frequency and voltage support. The primary control objective shall be to maintain the voltage phasor of the internal voltage source—established through control strategies—as constant during the sub-transient time frame, utilizing the converter's full short-term overloading capability.
4. Grid-forming control features:
 - (a) must be operational whenever the energy storage system is connected to the network. In addition, the operating mode must not change in the event of changes or disturbances in the network.
 - (b) must operate in a coordinated manner at the converters' current limits so that any need to restrict the current does not result in discontinuity of the grid-forming controller function or otherwise jeopardize the stable operation of the energy storage station. The current limits set for the control shall correspond to the installation's actual performance and take advantage of the short-term overloading capability of the equipment.
 - (c) must operate in a coordinated manner with the other controls affecting the short-term overloading capability's active and reactive power and other top-level controls (e.g., plant level controls in case

of GFL-GFM hybrid power-generating/storage facility) so that no adverse interactions arise between the controls.

5. It is desirable to have short-term current overload capability of at least 1.5 p.u. for a minimum duration of 200 ms to effectively utilize the grid-forming control features.
6. The GFM BESS's response to frequency and voltage oscillations in the electricity network must not amplify such oscillations. The facility shall also have the capability of damping oscillations in the system at least within the 0.1-20 Hz frequency range.
Where the inherent characteristics of the energy storage system are insufficient to satisfy this requirement, the facility shall be equipped with an appropriate supplementary damping control function to ensure adequate oscillation damping performance over the specified frequency range.
7. Considering the evolving nature of grid-forming technology, the necessary requirements issued subsequently, in addition to the above requirements, from time to time shall also be followed.
8. The GFM BESS developer shall ensure installation of Phasor Measurement Units (PMUs) within its premises and make the corresponding PMU data available to the appropriate Load Despatch Centre based on the CEA guidelines on Unified Philosophy for Placement of Phasor Measurement Unit (PMU) in Indian Grid. The PMU data shall be provided with a time resolution of at least 20 ms.

Active Power and Frequency Control

9. The GFM BESS shall be capable of operating in all active power control modes, such as constant power control and frequency control modes.
10. The GFM BESS shall be equipped with the facility to control active power injection/absorption in accordance with a set point, capable of being revised based on directions of the State Load Despatch Centre or Regional Load Despatch Centre, as the case may be;
11. The GFM BESS shall have active power-frequency droop capability to regulate active power output in response to frequency deviation, support frequency stability and load sharing among inverters. Besides local P-f droop control, each converter shall have a provision of receiving P-f command from PPC as well.
12. The plant-level control functions shall be suitably coordinated with the grid-forming capabilities of the converters to prevent adverse control interactions and ensure stable plant operation.
13. The GFM BESS must have the capability to provide active power support to resist RoCoF within the facility's limits for short-term maximum current capability.
Provided that the facility shall be capable of responding to rate-of-change-of-frequency (RoCoF) conditions in such a manner that the resulting change in active power at the point of connection, calculated

under nominal voltage conditions, is equivalent to an inertia constant (H in sec) within the specified range (0 to 25), in accordance with the following relationship:

$$\Delta P_{pu} = \Delta f / \Delta t \times 2H / f_n$$

The GFM BESS facility's inertia constant/settings shall be coordinated in consultation with the appropriate Load Despatch Centre.

The GFM BESS facility must be designed and operated such that it always has sufficient energy storage capability to maintain the required change in active power for a minimum of 5 seconds.

14. The GFM BESS must achieve a response time of a maximum of 5 ms after the start of the change of RoCoF.

Reactive Power Control

15. The GFM BESS facility shall have reactive power-voltage droop control capability to regulate reactive power output in response to voltage deviation, support voltage stability and reactive power sharing. Besides local Q-V droop control, each converter shall have a provision for receiving Q-V command from PPC as well.
16. The GFM BESS facility shall be capable of operating in all reactive power control modes, such as constant voltage control, constant reactive power control, and constant power factor control.
17. The plant-level control functions shall be suitably coordinated with the grid-forming capabilities of the converters to prevent adverse control interactions and ensure stable plant operation.

Voltage Disturbance Ride Through

18. The GFM BESS facility must have the capability to respond with current injections or absorptions to any balanced or unbalanced voltage disturbance, which must withstand the changes in voltage magnitude at the Pol, including that:

Provided that the facility shall respond to both small variations / disturbances within the normal operating range and large disturbances, including faults, resulting in undervoltage or overvoltage incidents.

19. The GFM BESS shall remain connected to the grid for the duration and voltage profile specified in the corresponding LVRT and HVRT requirement applicable to the grid following type of facility as mentioned in the relevant clauses of CEA Technical Standards for Connectivity to Grid
20. The GFM BESS shall contribute incremental positive sequence reactive current during symmetrical disturbances according to the provisions specified below:
 - (i) if there is an increase in Pol's positive sequence voltage, the facility must absorb positive sequence reactive current from the system
 - (ii) if there is a decrease in Pol's positive sequence voltage, the facility must inject positive sequence reactive current into system

21. The GFM BESS must be able to contribute negative sequence current (to dissipate external negative sequence voltage) under unbalanced voltage conditions at the Pol.
22. The GFM BESS shall demonstrate a reactive power reaction time not exceeding 5 ms from the occurrence of the voltage change, and a response time not exceeding 30 ms from the occurrence of the voltage change.
23. The GFM BESS shall be capable of operating steadily up to, and at, its stated short-term maximum current limit. The developer shall specify the current capability limit and the short-term maximum current at the IBR unit terminal, expressed with reference to the nominal current in per unit (pu). The specification shall state:
 - a) the maximum permissible duration for operation above nominal current;
 - b) the duration for which the short-term maximum current may be sustained;
 - c) the maximum number of permissible occurrences; and
 - d) the recovery conditions required for resumption of continuous operation.
24. Upon reaching the current capability limit, current clipping by means of a protective function based on instantaneous sub-cycle values shall be permitted, solely for protection of the equipment, before limiting the current to the short-term maximum current. Upon reaching the stated short-term maximum current, the facility shall maintain stable operation at that level for the specified duration.
25. Current limitation shall apply only to the magnitude of the output current vector. The internal voltage angle of the units in the facility shall evolve naturally in accordance with their synchronisation mechanism and shall not be manipulated for the purpose of altering the phase orientation of the output current.

The GFM BESS shall not implement any fixed or predefined prioritisation between active and reactive current components (I_d/I_q) or between positive-sequence and negative-sequence currents, including but not limited to:

- a) enforcing a constant power factor;
- b) prioritising I_d or I_q irrespective of system conditions;
- c) preferring one sequence component over another.

Upon reaching current limitation, the resulting current shall represent a proportionally scaled-down vector sum of all ideal, unconstrained current components, including active and reactive, and positive- and negative-sequence components, so that the total magnitude remains within the applicable current limit.

Voltage Phase Angle Change Ride Through:

26. The GFM BESS shall be capable of withstanding a momentary voltage phase jump of up to ± 60 degrees at the Pol without disconnecting from the grid and without interruption of facility operation, including unintended stops, pauses, or material deviations in power delivery or control.
27. The GFM BESS shall be capable of contributing active current to counteract transient voltage phase angle displacement in both positive and negative directions at Pol, within the facility's short-term maximum current limit.
28. The GFM BESS shall demonstrate an active power reaction time not exceeding 5 ms from the start of the phase jump, and a response time not exceeding 30 ms from the start of the phase jump.

Islanding and Black-start

29. The GFM BESS shall be capable of seamless transition to and from islanded operation, ensuring stable reconnection to the main grid.
30. The GFM BESS of aggregate capacity of 50 MW and above shall be capable of providing Black Start support. This capability shall be utilized by appropriate Load Despatch Centre based on system requirements.
31. The black start functionality shall be demonstrated during commissioning and verified periodically through testing in accordance with these standards and other requirements as specified by the appropriate LDC.

BESS AGC Requirements

32. Experience of the AGC pilot project on AGC of Renewable Energy Generating Stations (REGS), BESS, and Pumped Storage Plants (PSP) has been documented in the Consultation Paper available at https://webcdn.grid-india.in/files/grdw/2026/01/Consultation%20Paper%20on%20AGC%20of%20RE_BESS_PSP_31122025_215.pdf
33. BESS shall be capable of participating in AGC on a continuous 24x7 basis
34. The BESS shall be capable of seamless bidirectional power operation and frequent charge-discharge reversals within its rated operating limits.
35. No cooling period shall be required between charging and discharging operations and between cycles
36. The BESS, including Battery System, Battery Management System (BMS), Power Conversion System (PCS), Energy Management System (EMS), thermal management system, and associated control systems, shall be designed to support frequent and continuous transitions between charging and discharging modes in response to AGC commands issued by the LDC AGC controller.

37. The BESS shall be designed for an expected operational profile of approximately one to two equivalent full charge-discharge cycles per day under normal system conditions. However, the BESS shall have the flexibility to undertake additional full or partial charge-discharge cycles as required for grid operation, ancillary services, reliability support, congestion management, or emergency system conditions. Actual utilization shall be driven by operational requirements and shall not be constrained by any specified daily cycling expectation. The developer shall ensure that the BESS cycle life capability, energy throughput capability, and performance warranty are adequate to support the anticipated utilization over the design life of the project.
38. When daily energy limits, cycle limits, or any other safety related operational constraints are reached, the BESS control systems shall automatically implement suitable control logic to limit, suspend, or modify AGC participation in a controlled manner.
39. The BESS shall continuously communicate to the LDC AGC/SCADA system the required signals as per the signal list including State of Charge (SOC), Cycle Count including partial cycles, and State of Health (SOH).
40. The control systems, inverter parameters, and damping functions of the BESS shall be appropriately designed and tuned to ensure stable operation under all credible system conditions. The BESS shall not introduce or exacerbate sustained oscillatory behaviour in the power system following active power setpoint changes by Automatic Generation Control (AGC), ancillary service activation, or other dispatch instructions. Compliance shall be demonstrated through appropriate RMS and EMT studies, and closed loop testing.



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1. All Principal Secretary/ Secretary to State/UT Energy Departments
2. MDs of All State Transmission Utilities
3. Chief Operating Officer (CTUIL), 16, Institutional Area, Sector 32, Gurugram, Haryana
4. Director (Operations), GRID-INDIA, B-9, QIB, Katwaria Sarai, New Delhi

विषय / Subject: Clarification on CEA's Advisory dated 10.07.2026 for implementation of 100% Grid Forming Invertors (GFMs) in all upcoming BESS projects-regarding

महोदय / Sir,

An advisory for implementation of 100% Grid Forming Invertors (GFMs) in all upcoming BESS projects was issued vide CEA's letter dated 10.07.2026 (copy attached) to which some clarifications were sought from various stakeholders. These have been examined and the clarifications with respect to the advisory dated 10.07.2026 are as under:

- i) The advisory would be applicable from the date of issuance of advisory i.e. 10.07.2026. However, the projects whose bids would be concluded by 10.08.2026 or the BESS projects whose purchase order was placed before 10.07.2026 would be exempted from the compliance of the CEA's advisory dated 10.07.2026.
- ii) The advisory would be applicable on all upcoming BESS projects having Capacity of 50 MW and above.
- iii) The testing, certification and compliance verification framework would be in coherence with **The Central Electricity Authority (Technical Standards for Connectivity to the Grid) Regulations, 2026** which provide the compliance framework for Grid-Forming and Black-Start capability, comprising EMT study submission at the design stage, demonstration during commissioning, and periodic re-verification as specified by the appropriate Load Despatch Centre.

This issues with the approval of Chairperson, CEA.

भवदीय / Yours faithfully,

Digitally signed by
Bhanwar Singh Meena
Date: 30-07-2026
19:07:40

(भंवर सिंह मीना /Bhanwar Singh Meena)

निदेशक/ Director

Copy to (for information):

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2. SA to Chairperson, CEA
3. SA to Member (PS), CEA
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