Request for Proposal

Design, Supply, Testing, Installation, Commissioning, Operation and Maintenance of 20 MW/ 40 MWh Battery Energy Storage Systems (BESS) in Delhi under Tariff-Based Competitive Bidding

Ref:TERI/MAT/2023-24/014

Tender publishing date: 01 Sep 2023

Last Date for Submission of Bids: 22 Sep 2023

Vol I: Scope of Work and Technical specifications

Contents

Introduction and Background of the project

The power sector in India today is experiencing major technological disruptions, with the biggest being addition of RE generation alongside the thermal based generation. India's National Electricity Plan has projected nearly 600 GW of renewable electricity capacity by 2031-32, including 365 GW solar and 122 GW of wind energy[1]. Renewable Energy (RE) has also become the most affordable and cheapest source for meeting the energy requirements. India had a total renewable energy capacity of 169 GW as on 28th February 2023. While initial RE capacities have been successfully integrated to the grids so far, further capacity addition is expected to face integration challenges due to variability and supply-demand mismatch. As of March 2023, India's modern renewable energy share (solar and wind) of gross generation stood at ~12%, which is expected to increase to ~35% by 2031-32[1].

The increasing share of renewable energy generations in the grid has impacted the traditional approach of grid balancing. The renewable energy sources are intermittent in nature due to dependence on external climactic conditions, such as sunshine or wind. Therefore, the variability of renewable generation must be considered while adjusting output of load following generating stations for the purpose of balancing.

Large penetration of Renewable energy sources and Distributed Energy Resources (DERs), such as rooftop solar into the Distribution Network (DN), fast changing demand patterns and the electrification of transportation through electric vehicles pose technical challenges to existing power distribution networks. Technical/operational challenges in terms of loss of load, deviations in power flow, fault/congestion in electricity distribution network and power quality distortions are expected to affect the performance of distribution utilities. This will impact the overall power system stability and dynamic behaviour of the system.

The National Electricity Plan (NEP)[1] identifies Pumped Hydro Storage System (PSP) and Battery Energy Storage Systems (BESS) as the commercially deployable solutions for providing requisite storage capacity. CEA's modelling for the NEP projects BESS requirement of 8.68 GW/ 34.72 GWh by the year 2027-28 and 47.24 GW/ 236.22 GWh by 2031-32. BESS can thus be an effective solution to address issues of RE integration; it provides capabilities for shifting generation, regulating dispatch of electricity, maintaining flow control in transmission system, and strengthening reliability of the power system without adding new capacity.

Therefore, **BSES Rajdhani Power Limited (BRPL)** has envisaged to deploy a **20 MW/ 40 MWh BESS** within their licensed area, which is a timely and much needed step toward mitigating challenges arising from RE integration. BRPL has appointed **The Energy and Resources Institute (TERI)** to invite

[1] National Electricity Plan 2022-32 (Access here)

bids from prospective bidders through tendering for **site survey, planning, design, engineering, and transportation to site, insurance, supply at site, un-loading, handling, installation, integration, testing, commissioning & demonstration, operation, and maintenance of BESS**, as per the details given in these tender documents. The Delhi Electricity Regulatory Commission (DERC) has provided an in-principal approval for the project.

This Request for Proposal is meant to invite applications from interested Bidder(s) capable of delivering the BESS described herein. The content of this RFP has been documented as a set of three volumes explained below:

Volume I: Scope of Work and Technical Specifications

Volume I of this RFP contains details regarding the scope of work and technical specifications of the BESS that Buying Utility deems necessary. The information set out in this volume includes the detailed technical specifications of the BESS which is to be installed and operated.

Volume II: Instructions to Bidders and Evaluation Criteria

Volume II contains instructions for bidders when responding to this RFP. It also contains the eligibility conditions and the evaluation criteria for selecting of successful bidder.

Volume III: General Conditions of contract

Volume III explains the draft contractual terms that Buying Utility wishes to specify at this stage. Prospective bidders must follow the respective terms and conditions in each agreement.

It is envisioned that the following agreement will be signed with the selected bidder.

Type of agreement and Scope	Involved parties	Estimated Period of Performance
Battery Energy Storage Service Agreement (BESSA)	Buying Utility and Winning Bidder (BESS Developer (BESSD))	From signing of BESSA until 12 years post Commercial Operation Date (COD) of BESS

This document is Volume I.

Definitions of Terms

Following terms used in the documents will carry the meaning and interpretations as described below:

1. **"ACT" or "ELECTRICITY ACT, 2003"** shall mean the Electricity Act, 2003 and include any modifications, amendments, and substitution from time to time.

2. **"ADJUSTED EQUITY"** of a company shall mean the capital, surplus and retained earnings accounts less all intangible assets

3. **"AFFILIATE"** in relation to a Company shall mean a person who controls, is controlled by, or is under the common control with such Company.

4. **"APPROPRIATE COMMISSION"** or **"DERC"** shall refer to the Honourable Delhi Electricity Regulatory Commission.

5. **"AVAILABILITY"** shall be as defined in the RFP.

6. **"BATTERY ENERGY STORAGE SYSTEMS"** or **"BESS"** shall mean the system(s)/ projects utilizing methods and technologies such as electrochemical batteries (Li-ion, solid state batteries, flow batteries, etc.) or others, providing a facility that can store chemical energy and deliver the stored energy in the form of electricity, including ancillary facilities.

7. **"BATTERY ENERGY STORAGE SYSTEM DEVELOPER"** or **"BESSD"** or **"DEVELOPER"** shall mean the entity owning/operating the BESS facility for supply of power

8. **"BATTERY ENERGY STORAGE SERVICE AGREEMENT"** or **"BESSA"** shall mean the agreement signed between the Selected Bidder/ BESSD and Buying Utility according for procurement of capacity from the BESS. A draft for the BESSA is enclosed with Volume 3 this RFP.

9. **"BID"** or **"PROPOSAL"** shall mean the documents submitted by the Bidder towards meeting the techno-commercial and financial qualifying requirements, along with the price bid submitted by the Bidder as part of its response to the RFP issued by Bid Manager.

10. **"BIDDER"** shall mean Bidding Company (including a foreign company) or a Bidding Consortium submitting the Bid. Any reference to the Bidder includes Bidding Company/ Bidding Consortium, Member of a Bidding Consortium including its successors, executors and permitted assigns and Lead Member of the Bidding Consortium jointly and severally, as the context may require; foreign companies participating in the bidding process shall be registered as companies as per the rules of their country of origin.

11. **"BIDDING CONSORTIUM"** or **"CONSORTIUM"** shall refer to a group of Companies that collectively submit the response in accordance with the provisions of this RFP under a Consortium Agreement.

12. **"BID CAPACITY"** shall mean aggregate project capacity of the Battery Energy Storage System(s) as proposed by the Bidder.

13. **"BRPL"** or **"BUYING UTILITY"** shall mean BSES Rajdhani Power Limited, which utilizes the BESS for meeting its power on demand requirements.

14. **"CERC"** shall mean Central Electricity Regulatory Commission

15. **"CHARTERED ACCOUNTANT"** shall mean a person practicing in India or a firm whereof all the partners practicing in India as a Chartered Accountant(s) within the meaning of the Chartered Accountants Act, 1949.

    For bidders incorporated in countries other than India, "Chartered Accountant" shall mean a person or a firm practicing in the respective country and designated/ registered under the corresponding Statutes/ laws of the respective country.

16. **"COMPANY"** shall mean a body corporate incorporated in India under the Companies Act, 2013 or any law in India prior thereto relating to Companies, as applicable.

17. **"COMMERCIAL OPERATION DATE (COD)"** shall be the date on which the commissioning certificate is issued by the Commissioning Committee upon successful commissioning of project. The Commissioning Committee shall include members from Buying Utility and third-parties nominated by the Buying Utility. The conditions for commissioning are defined in Volume 3 of this RFP

18. **"CONTRACTED CAPACITY"** shall mean the capacity of 20 MW for 2 hours (40 MWh) contracted with Buying Utility for providing Energy storage facility for charging and discharging the system on "on-demand" basis, based on which the BESSA is executed between BESSD and Buying Utility.

19. **"CONTRACT YEAR"** shall mean the period beginning from the Effective Date of the BESSA and ending on the immediately succeeding 31st March and thereafter each period of 12 months beginning on 1st April and ending on 31st March provided that:
    a. in the financial year in which the Scheduled Commissioning Date would occur, the Contract Year shall end on the date immediately before the Scheduled Commissioning Date and a new Contract Year shall commence once again from the Scheduled Commissioning Date and end on the immediately succeeding 31st March, and thereafter each period of 12 (Twelve) Months commencing on 1st April and ending on 31st March, and

b. provided further that the last Contract Year of this Agreement shall end on the last day of the Term of this Agreement.

20. **"CONTROL"** shall mean the ownership, directly or indirectly, of more than 50% (fifty percent) of the voting shares of such Company or right to appoint majority Directors.

21. **"CONTROLLING SHAREHOLDING"** shall mean more than 50% of the voting rights and paid-up share capital in the Company/ Consortium.

22. **"CENTRAL TRANSMISSION UTILITY (CTU)"** shall mean the Central Transmission Utility as defined in sub-section (10) of section 2 of the Electricity Act 2003.

23. **"DAY"** shall mean calendar day.

24. **"EFFECTIVE DATE"** shall mean the actual date of signing of BESSA by both the parties.

25. **"EQUITY"** shall mean Net Worth as defined in Companies Act, 2013.

26. **"EXPIRY DATE"** shall mean the date of transfer of the BESS project from the BESSD to the Buying Utility at the end of the contract period of 12 years

27. **"FINANCIAL CLOSURE"** or **"PROJECT FINANCING ARRANGEMENTS"** means arrangement of necessary funds by the BESSD towards 100% Project Cost either by way of commitment of funds by the Company from its internal resources and/or tie up of funds through a bank/ financial institution by way of sanction of a loan or letter agreeing to finance;

28. **"GUIDELINES"** shall mean "Guidelines for Procurement and Utilization of Battery Energy Storage Systems as part of Generation, Transmission and Distribution assets, along with Ancillary Services" issued by Ministry of Power vide Gazette Resolution dated 10.03.2022, including subsequent amendments and clarification thereof, if any, issued until the last date of bid submission of this RFP.

29. **"INTERCONNECTION/ DELIVERY/ METERING POINT"** shall mean the point at 11kV/ 33kV Kilokari Grid Substation or 11kV/ 66kV C-Block Vasant Kunj Grid Substation where the power from the Battery Energy Storage System is injected into the BRPL's substation (including the Power Evacuation facilities from PCS output to 11kV panels). Metering shall be done at this interconnection point where the power is injected into. For interconnection with grid and metering, the BESSDs shall abide by the relevant CERC/ DERC Regulations, Grid Code and Central Electricity Authority (Installation and Operation of Meters) Regulations, 2006 as amended and revised from time to time.

    All charges and losses related to Transmission of power from project up to Delivery Point as notified by the competent authority / regulator shall be borne by the BESSD and beyond

the Delivery Point all charges and losses (including but not limited to Demand and Usage Charges, open access, transmission, Cross Subsidy, wheeling, SLDC Charges etc.) as notified by the competent authority / regulator from time to time shall be borne by Buying Utility.

30. **"INTERCONNECTION FACILITIES"** shall mean the facilities on BESSD's side of the Delivery Point for sending and metering the electrical output in accordance with this Agreement and, subject to Article 4, the Metering System required for supply of power

31. **"JOINT CONTROL"** shall mean a situation where a company has multiple promoters (but none of the shareholders has more than 50% of voting rights and paid-up share capital).

32. **"LEAD MEMBER OF THE BIDDING CONSORTIUM"** or **"LEAD MEMBER"**: There shall be only one Lead Member, having the shareholding of not less 51% in the Bidding Consortium.

    Note: The shareholding of the Lead member in the Project Company (Special Purpose Vehicle) cannot be changed till 01 (one) year after the Commercial Operation Date (COD) of the Project.

33. **"LETTER OF AWARD"** or **"LoA"** shall mean the letter issued by the Bid Manager to the selected Bidder for award of the Project.

34. **"LIMITED LIABILITY PARTNERSHIP"** or **"LLP"** shall mean a Company governed by Limited Liability Partnership Act 2008 or as amended.

35. **"LLC"** shall mean Limited Liability Company as defined under the Companies Act, 2013

36. **"MEMBER IN A BIDDING CONSORTIUM"** or **"MEMBER"** shall mean each Company in a Bidding Consortium. In case of a Technology Partner being a member in the Consortium, it has to be a Company.

37. **"MONTH"** shall mean calendar month.

38. **"NET-WORTH"** shall mean the Net-Worth as defined section 2 of the Companies Act, 2013.

39. **"PAID-UP SHARE CAPITAL"** shall mean the paid-up share capital as defined in Section 2 of the Companies Act, 2013.

40. **"PGCIL"** or **"POWERGRID"** shall mean Powergrid Corporation of India Limited

41. **"POSOCO"** or **"GCI"** or **"NLDC"** shall mean Grid Controller of India Limited (formerly known as Power System Operation Corporation Limited)

42. **"PROJECT"** shall mean the Battery Energy Storage System set up by the BESSD for supply of Power an "on Demand" basis, having single point of injection into the grid at

Interconnection/ Delivery/ Metering Point, or in case of sharing of transmission lines, by separate injection at Pooling Point and having separate control systems and metering. The Project shall also comprise auxiliaries and associated facilities, bay(s) for transmission system in the their switchyard, dedicated transmission line up to the injection point and all the other assets, buildings/structures, equipment, plant and machinery (pertaining to the BESS), facilities and related assets required for the efficient and economic operation of the power supply facility, whether completed or at any stage of development and construction or intended to be developed and constructed for the purpose of supply of power to Buying Utility. It is clarified that BESS charged using a source other than RE power would not qualify as RE power.

43. **"PROJECT CAPACITY"** shall mean the maximum AC capacity at the delivery point that can be scheduled from the Project.

44. **"PROJECT COMMISSIONING"**: The Project will be considered as commissioned in line with the Commissioning procedure defined in the RFP/BESSA.

45. **"PROJECT LOCATION"** shall mean the area identified by Buying Utility where the Project is being implemented. This will be the 11kV/ 33kV Kilokari Grid Substation or 11kV/ 66kV C-Block Vasant Kunj Grid Substation in Delhi

46. **"POWER ON DEMAND"** shall mean the requirement of the Buying Entity to charge and discharge the BESS based on its requirements during the time of day, subject to provisions of the RFP and BESSA.

47. **"RENEWABLE ENERGY (RE) POWER"** shall mean power from a RE Power generation facility.

48. **"RFP"** or **"RFP DOCUMENT"** or **"BIDDING DOCUMENT(S)"** or **"TENDER DOCUMENTS"** shall mean the "Request for Proposal" document issued by Bid Manager including standard Contracts, along with subsequent clarifications and amendments thereof, vide RFP No. TERI/MAT/2023-24/014 dated 01.09.2023.

49. **"SCHEDULED COMMISSIONING DATE"** or **"SCD"** shall be the date as indicated in Volume 3 of RFP/ BESSA.

50. **"SCOPE OF WORK"** or **"SOW"** shall be the Scope of Work as indicated in Volume 1 of this RFP

51. **"SELECTED BIDDER"** or **"SUCCESSFUL BIDDER"** shall mean the Bidder selected pursuant to this RFP to set up the Project and who has signed up to supply electrical output as per the terms of BESSA.

52. **"STATE TRANSMISSION UTILITY"** or **"STU"** shall mean the Board, or the Government Company notified by the respective State Government under Sub-Section I of Section 39 of the Electricity Act, 2003.

53. **"STATE LOAD DISPATCH CENTRE"** or **"SLDC"** shall mean the State Load Despatch Center, Delhi.

54. **"TERI"** or **"BID MANAGER"** shall mean The Energy and Resources Institute, which will be the Bid Manager for this RFP.

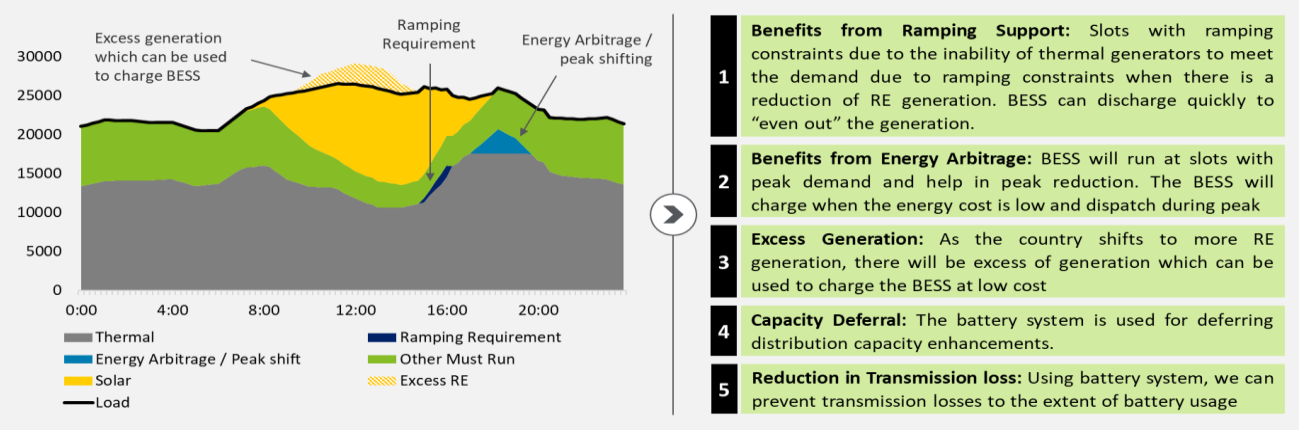
55. **"TOE"** shall mean Tender Opening Event.

56. **"WEEK"** shall mean calendar week;

Project Context

As illustrated, a single BESS can provide ramping support, energy arbitrage benefits, CAPEX deferral and minimize energy loss for a distribution utility. While each of these individual use cases may not provide adequate revenue streams to justify investment in BESS, the benefits together can demonstrate the commercial viability of BESS adoption.

Figure 1: The value stacking of benefits for a distribution utility from the same energy storage asset



Objective: The primary applications envisaged for the BESS is Energy time-shift (arbitrage) and ramping support. However, for increasing the utilization of the BESS and improving the economic viability, BESS will be utilized for other use cases, such as frequency support (ancillary services), capacity upgrade deferral, resource adequacy, and backup supply to critical loads (e.g., black start).

The key site conditions where the BESS is to be installed are described below:

S No.	Particulars	Details
1	Maximum Ambient Temperature	50 °C
2	Maximum Daily average ambient temp	40 °C
3	Minimum Ambient Temp	0 °C
4	Humidity range	10% to 95%
5	Maximum annual rainfall	750 mm
6	Average Rainy days per year	60
7	Rainy months	June to October
8	Altitude	300 m
9	Seismic zone	IV
10	Wind speed maximum	170 km/ hr
11	Location	33/11 kV Grid Substation – Kilokari, or 66/11 kV C-Block Vasant Kunj Grid Substation
12	Site area (Square meter)	2000 sq.meter (approx.)
13	Address	BTC Kilokari, 33/11 kV Grid Complex, BSES Rajdhani Power Limited, Kilokari, Opposite

		Jiwan hospital New Delhi, OR 66/11 kV C-Block Vasant Kunj Grid Substation
14	Site location (indoor / outdoor)	Outdoor

Scope of Work:

Under this RFP, the BESSD shall be required to set up, operate, and maintain a Battery Energy Storage System (BESS), with the primary objective of making the energy storage facility available to Buying Utility for charging/ discharging of the BESS, on an "on demand" basis. The scope of work is detailed in the following sections of this Volume 1, and the criteria for performance are elaborated in Volume 3 of the RFP.

BRPL has shortlisted two project locations within their licensed area in Delhi, and will select one of these for the final project. The primary application envisaged is Energy Arbitrage/Peak Shaving and secondary application is frequency support as ancillary services.

Setting up of the BESS, interconnection of the BESS with the distribution grid at the Project Location, and operations and maintenance of the BESS will be under the scope of the BESSD. For the capacity under contract, charging and discharging of the system will be carried out by the Developer as per requirements of the Buying Utility. After the expiry of the Term of the BESSA, the Project will be transferred to Buying Utility in working condition with defined energy throughput at the end of the term on a "as is where is" basis, in line with the provisions of the BESSA.

It is anticipated that the Selected Bidder(s) shall perform the following tasks as part of the Scope of Work, in relation to installation of BESS.

1. **Erection and Commissioning**

A. Site survey, planning, design, engineering, transportation to site, insurance, supply at site, un-loading, handling, storage, required site area grading, construction and civil work, installation, integration, testing, commissioning & demonstration for acceptance of all equipment/ materials and miscellaneous item required to complete the BESS installation, which includes, but is not limited to the following:

a) Battery packs, Power conditioning system, Air conditioning (AC) system, UPS, system hardware, measurement & control device, and other associated items necessary for trouble free operation and maintenance of whole system.

b) Energy Management System compatible for integration with existing BRPL's EMS and with SCADA (IEC 104) and all associated hardware and software including internet connectivity upto the monitoring and control system which will be placed in BRPL Control room/ building. The control/ monitoring system shall be cyber security compliant as it will be connected to BRPL SCADA system.

c) Containers, structures, earthing design, and battery modules inter-connection.

d) Power Conditioning Units (PCU) with monitoring & control related equipment such as actuators, sensors, transducers etc.

e) Appropriate protection and safety features.

f) Mandatory spares, maintenance tools and tackles

g) Interconnection with the grid

h) Project Management including adherence to all requisite safety practices.

i) Automated Fire and Smoke detection and Fire suppression system for all deliverables under the scope of work including but not limited to Battery container, PCS, and Transformers

j) Factory acceptance test (FAT) and site acceptance test (SAT)

k) CCTV video surveillance with 360-degree night vision with live feed output on mobile app and EMS screen and archival in DVR including any other required hardware, software, and internet connectivity

An analysis of the functional and performance requirements of this specification and / or site surveys, design and engineering may lead the bidders to conclude that additional items are required that are not specifically mentioned in this specification. The bid/ proposal should include all equipment, services and associated costs required to ultimately commission a viable and fully functional BESS that meets or exceeds the capacity and performance requirements specified. Such materials shall be considered to be within the scope of the contract.

The offered items shall be designed to operate as per the site conditions. Adequate measures meeting the relevant standards shall be taken to provide protection against contaminants, pollutants, water & moisture, lightning & short circuit, vibration & electro-magnetic interference, etc.

The bidders are advised to visit sites (at their own expense), prior to the submission of the bid, and make surveys and assessments as deemed necessary for proposal submission.

B. Installation and Commissioning of BESS that includes:

a) Special care to be taken while designing the system to cater to heavy rainfall, strong winds, temperature variations, and earthquakes that may be prevalent in the area.

b) The Selected Bidder shall provide all related drawings, documents, and reports to relevant IS/ IEC/UL/IEEE/NFPA standards.

c) Documentation and Training to Buying Utility's officials.

d) Undertake Pre-commissioning and Commissioning tests of all supplied equipment.

1.1. Test running of the grid-connected BESS facility including battery operation trials at Site, prior to handover.

1.2. Installation of appropriate measurement and control devices at required location, with submission of drawings - approved prior to commencement of work on Site.

1.3. Commissioning certificate from relevant authorities for the facility.

C. General Instructions

a) Security and safety of all materials at sites shall be the responsibility of the Selected Bidder.

b) Expenses for any other works, supply of material, and providing services including re-testing of any equipment/component during FAT required for the successful commissioning and operation of the plant, but not specifically mentioned in this document shall be borne by selected bidder.

c) Safety has to be strictly complied with by the Selected Bidder(s) throughout implementation activity.

d) All local labour, employment, and other issues shall be handled independently by the Selected Bidder.

e) The entire responsibility and risk relating towards the manpower working at the Site, and compliance of different statutory regulations (like Workman Compensation Act, Employees State Insurance Corporation (ESIC), Factory Act. 1948, Contract Labour Regulation, and Abolition Act 1970, Shop and Establishment Act. 1948, and other Statutory regulatory bodies, etc.) shall solely lie with the Selected Bidder. The Selected Bidder shall also be solely responsible for payment of wages, provident fund, bonus, retrenchment compensation leave, etc. applicable as per various statutory regulations to their entire workforce and keep the Buying Utility indemnified in this regard against any Claim.

D. Delivery, installation, and Commercial Operation Date (COD)

Delivery of materials, installation, testing, and commissioning of the project should be completed within twenty-four (24) weeks from the Effective Date of BESSA. This shall be the Scheduled Commissioning Date (SCD). Transit insurance and storage insurance till the handing over of all materials will be within the scope of work. The systems will be deemed commissioned only after successful trial run of the system for seven (7) days from the date of commissioning and submission of relevant test reports. **The Commissioning Committee shall then issue the commissioning certificate, and this date will be regarded as the Commercial Operation Date (COD).**

2. Operation and Maintenance

a) The operation & maintenance of the BESS would include operating the BESS as per control logic mentioned by Buying Utility and separate module needs to be integrated with EMS for optimal despatch, wear& tear, overhauling, insurance, and replacement of defective cells, invertors, PCUs, spares, consumables & other parts for a services period of twelve years.

b) The primary use cases for which the BESS would be operated are energy time-shift (arbitrage) and provision of ancillary services to the market by the utility. The bidder is expected to operate the BESS in a manner that meets the requirements of Buying Utility, as informed through the schedules developed by the bidder, and approved by Buying Utility.

c) The BESS system shall include energy management system (EMS), battery management system (BMS) and dashboard to display key operational parameters such as voltage, current, battery SoC, frequency etc. Final list of parameters will be decided during detailed engineering.

d) Monitoring of BESS performance as per IEC 62933-3 and parameters decided during detailed engineering and supply of all technical, production/operation data and information and making it available as and when required would be the responsibility of the BESSD.

e) The BESSD shall be responsible to carry out routine and preventive maintenance and replacement of each and every component / equipment of the BESS in case of any failure and bidder shall provide all labour, material, consumables etc. for routine and preventive maintenance at their own cost. BESSD shall be responsible to keep consumables and spares at their own store.

f) The BESSD shall carry out preventive maintenance of each and every component of the BESS and shall provide the required manpower, materials, consumables, components, or equipment etc. at regular intervals as per the discretion of Buying Utility.

g) The BESSD shall carry out maintenance activities as a result of sudden failure/breakdown of any particular component or equipment. Bidder / BESSD shall be responsible to carry out breakdown maintenance of each and every component of the BESS and shall provide the required manpower, materials, consumables, components, or equipment etc. for

breakdown maintenance at his own cost irrespective of the reasons of the breakdown/failure.

h) The BESSD shall make himself available to undertake a visit to the site on call basis to provide maintenance services within 12 hours of lodging of complaint by the Buying utility through Telephone/ E-mail or, any form of written communication. The BESSD shall provide dedicated trained contact/ personnel for troubleshooting and complaint lodging

i) An Operation, Instruction and Maintenance Manual in English or Hindi language as per the requirement should be issued enclosing the following aspects:

1. Basic principles of BESS operation.
2. A small site-specific write-up (with a block diagram) on the BESS – its components, battery packs, inverter, junction boxes and expected performance shall be provided.
3. Type of battery technology finalized, Make & Model number, Voltage & capacity of inverter and cells, used in the BESS.
4. Technical characteristics of the entire component.
5. Clear instructions on regular maintenance and trouble shooting.
6. Contact details of relevant official of the Bidder / BESSD

j) Bidder shall maintain stock of mandatory spares required for warranty and AMC period for any emergency troubleshooting. In any case system should be in running condition within 12 hours of break-down.

k) Sub-Contracting: No sub-contracting of work in full or in part is allowed unless approved by the Buying utility in writing.

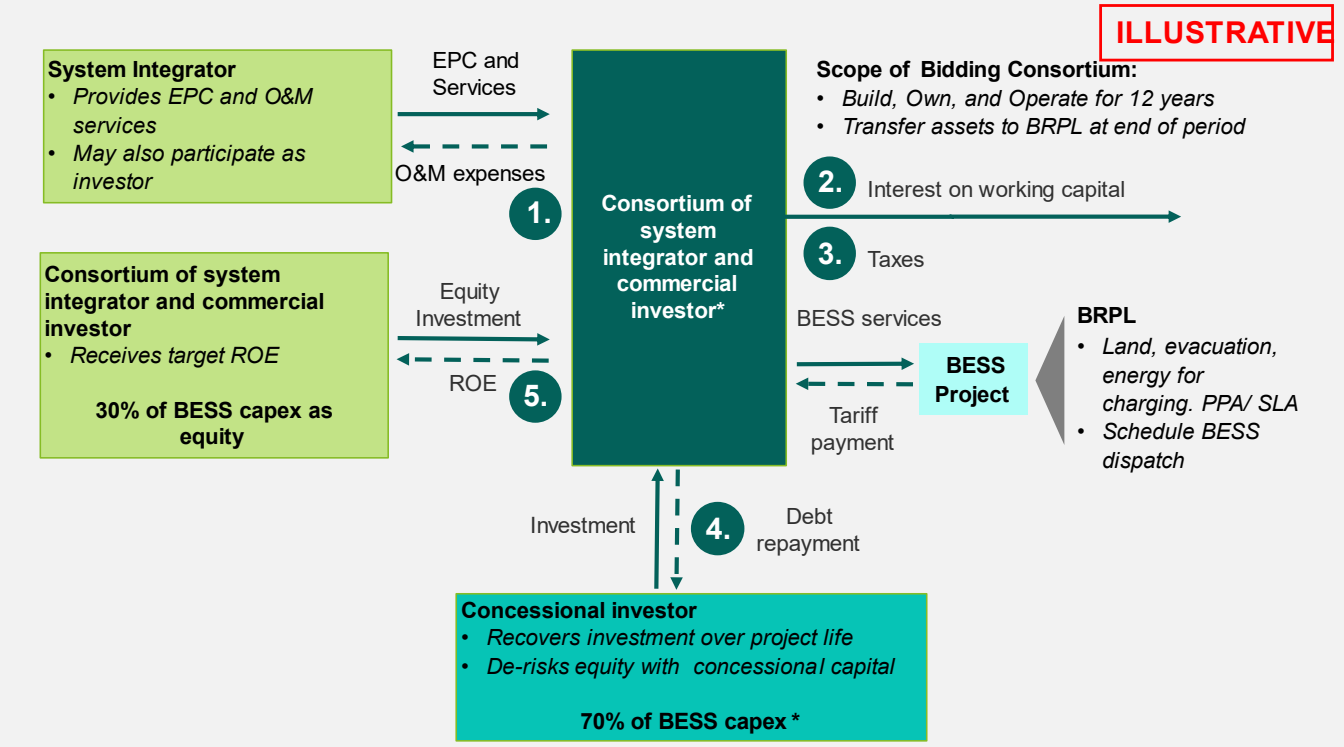
An analysis of the functional and performance requirements of this specification and / or site surveys, design and engineering may lead the bidders to conclude that additional items are required that are not specifically mentioned in this specification. The bid/ proposal should include all costs required to ultimately commission a viable and fully functional BESS that meets or exceeds the capacity and performance requirements specified. Such materials shall be considered to be within the scope of the contract. To the extent possible, the bidders shall identify and include all such items in their proposal.

3. <u>Equity investment</u>

The BESSD/ bidder shall commit 30 percent of the total capital investment of the project as equity investment. The BESS developer may tie-up with suitable commercial investors in order to bring in

the investment. For the purpose of this bid, the bidder must assume concessional financing at 1% cost of capital for the remaining 70 percent of capital investment.

Tentative business model for the BESS project



* *RE companies typically create a Special Purpose Vehicle (SPV) to separate firm cash flows from project cash flows. However, the bidder or bidding consortium may choose to own the project directly.*

The priority of cash outflows from the BESS project after receipt of BESS tariff is indicated by the numbers.

Technical Parameters of BESS, BESS Characterization and Performance Parameters

An analysis of the functional and performance requirements of this specification and / or site surveys, design and engineering may lead the bidders to conclude that additional items are required that are not specifically mentioned in this specification. The bid/ proposal should include all costs required to ultimately commission a viable and fully functional BESS that meets or exceeds the capacity and performance requirements specified. Such materials shall be considered to be within the scope of the contract. To the extent possible, the bidders shall identify and include all such items in their proposal.

1. Technical Parameters of BESS

1.1 Battery Sub System

Lithium-ion battery cells shall be used in the energy storage system. It should not require any memory /scheduled cycling for effective operation. Different chemistries are allowed so far as the following technical specifications for rated useful capacity of BESS are provided as in the table.

S. No.	Parameters	Unit	Details
1	Useful capacity output at delivery point	MWh	40
2	Peak power output at delivery point	MW	20
3	Life cycles	Nos	2 daily cycles, for at least 12 years from date of commissioning
4	Round trip efficiency (RTE) (AC-to-AC, including auxiliary consumption)	%	>85%
5	Service life	Years	At least 12 years from date of commissioning
6	PCS efficiency with Isolation Transformer as per BESSD design	%	**>95%**
7	System availability at PCS level	%	**>95%**

Taking into consideration capacity degradation, the minimum dispatchable energy to be made available by the BESS developer at the end of a given year shall be as follows:

Year	Min. Dispatchable Capacity at the end of Year (as a % of 40 MWh)
1	97.5%
2	95.0%
3	92.5%
4	90.0%
5	87.5%
6	85.0%

7	82.5%
8	80.0%
9	77.5%
10	75.0%
11	72.5%
12	70.0%

1.2 Battery Sub System

The cells shall be supplied as group of cells combined into modules and inter-connection of cells, and the modules should be designed properly to prevent the damage during transportation. The cells & modules should be able to absorb the anticipated vibration/shock associated with the transportation and shall resist deterioration due to vibrations. External connections to the cells, including inter-cells or inter-module connections shall also be designed to prevent failure during transportation. Protective covers / insulation shall be provided at battery terminals to prevent accidental contact with live electrical connections.

1.3 Battery Energy Management System (EMS)

The BESS will be primarily designed for energy time shift (arbitrage) and provision of ancillary services. In this application, BESS shall draw power from BRPL's distribution grid and discharge as informed through the schedules developed by the Buying Utility.

Details	Particulars
Application (main)	Energy time-shift (arbitrage), ramping support, ancillary services
No of cycles per day	2
Charging/ Discharging condition	Informed by the Buying Utility as per operating protocol
Response time	Less than 1 second

The Battery Energy Management System (EMS) architecture shall comply with following requirements. However, an analysis of the functional and performance requirements of this specification and / or site surveys, design and engineering may lead the bidders to conclude that additional items are required that are not specifically mentioned in this specification. The bid/ proposal should include all costs required to ultimately commission a viable and fully functional BESS that meets or exceeds the capacity and performance requirements specified:

i. Energy management system shall comprise of hardware and software including internet connectivity for managing the power/ energy flow through BESS for specific application.

ii. Energy Management System proposed should have experience in working with Distribution connected Energy Storage systems along with integration with Distribution SCADAs for remote optimisation and control

iii. EMS shall have the capability to tune BESS for Energy time shift/arbitrage, Peak shaving, Frequency support (ancillary services), Ramping support, Reactive power support.

iv. System should have capability to take and accept analog / digital data from other BESS of similar / different size and with different technology. The EMS may also be a cloud-based service, on the cloud approved by MEITY, and interoperable and integrable with utility's existing EMS/ DERMS and SCADA over IEC-104 / OPC-UA / Rest APIs / Modbus TCP / IEC 61850.

v. BESS should have the capability to monitor and control the operational parameters (Grid V & I, P, Q, f, battery V & I, SoC, relay/actuator command etc.) remotely in SCADA system through communication interface. In-addition, BESS operation shall be controlled either through EMS frontend or utility's SCADA screen.

vi. The EMS shall include monitoring, data acquisition and control system to provide continuous visualization or display of key operational parameters, as well as permanent archival of all measured parameters at the Buying Utility's SCADA control centre at Balaji. The archived data shall be readily and made available at any point throughout the term of the BESSA as per the Buying Utility's requirement. For monitoring & control, sensors, transducers, wiring, signal isolation, conditioning circuitry and data acquisition and analysis hardware and software shall be installed. The system shall record values of all operational parameters Including, but not limited to, cell level voltages, string / rack level currents and soc, cell / module level temperatures, AC side current, voltage, frequency, power and energy parameters, auxiliary power data, HVAC, fire activation and suppression of all components , CCTV live feed parameters. It shall be capable of making all monitored data and events available and shall allow the display of current values and recent historical trend (such as past 24 hours).

vii. The sampling time for measurement/monitoring of key electrical parameters shall be adjustable up to 1 second. The real time analogue data such as grid voltage and current, battery voltage and current, SoC, frequency etc. at 10 second intervals and digital data such as alarm, events will be stored for 30 days.

viii. Human machine interface (HMI) shall display the single line diagram of whole system with colour display and alarms & events shall be displayed in the form of list. The operation of HMI should be user friendly.

ix. It should have feature to control the BESS operation both in automatic and manual mode (set/reference point can also be defined manually as well).

x. Cell-level, Module-level, Rack level and Block level battery management system shall be provided to take care of battery module's, racks and block parameters (voltage, SoC and temperature) within specified range as per the applicable technical and industry standards of battery technology.

xi. The control features in Energy Management System (EMS) shall be customizable and shall have feature to update the algorithm and control philosophies from time to time till tenure of BESSA. -The updates should be over the air (OTA) and without system downtime.

xii. EMS of BESS shall be designed in such a way that it could be interfaced with existing SCADA system of the utility. The field status of key operational parameters must be communicated to SCADA system of the distribution utility through Modbus communication, and it shall have feature to control the system from SCADA centre. In addition, the bidder shall also create local control station to monitor & control the system operation locally from an industrial computer/ PC as well as through a smart phone application based on android or IOS.

xiii. EMS shall be extendable in case additional battery storage systems get installed in future at other locations or existing battery energy storage system gets replaced with a newer technology and/or of different size. EMS shall be interoperable and scalable with any other EMS or Distributed Energy Resources Management System (DERMS) and with SCADA through IEC 60870-5-104 protocol. The EMS so supplied should be supporting open protocols capable of integrating multiple battery energy storage systems at different locations in future as well. The communication between the EMS (which is to be located at the Buying utility's Central SCADA Control Centre at Balaji) and the location of BESS needs to be established by the bidder through suitable communication channels covering hardware, software and including internet connection.

xiv. BESS operation should be controlled by one operator at a time, positioned either locally at site or remotely at SCADA centre, Balaji and thus it must have suitable interlock features. However, BESSD's operator shall be available at SCADA centre, Balaji for operation of BESS for 24x7 hours till tenure of BESSA. Monitoring & control system shall be accessible through web-based interface for remote monitoring. Utility should be able to set threshold values for changing operating conditions. Required infrastructure for operator like computer system desktop PC.

xv. BESSD shall provide a module as part of EMS for uploading the schedule by buying utility, basis which charging and discharging of BESS shall be carried by BESSD. In addition, a forecasting module of day-ahead and real-time market prices shall be developed and shall be integrated in EMS for optimal charging and discharging for the purpose of envisaged application of Energy Arbitrage and/or participation in Ancillary market, with an over-riding facility to the operator after due approval from buying utility.

xvi. Software interlocking should be provided to ensure that inadvertent incorrect operation of switchgear causing damage and accidents in case of false operation does not take place.

xvii. A restricted access to monitor the operating parameters through web/ online portal as well as mobile app shall be provided to the Buying utility.

xviii. Change management to be approved by Buying Utility.

xix. Secure integration to be deployed such as SSL VPN Secure ports.

xx. Deployment architecture for Network connectivity shall be submitted to Buying Utility for its approval. BESSD to provide list of Inventory as part of documentation and update from time to time and provide to Buying Utility.

xxi. BESSD shall not procure any components/connected devices of OR involve any consultant from countries sharing boundaries with India viz (Pakistan, China, etc) as per the MoP/CEA Guidelines.

xxii. BESSD shall be solely responsible for patch management of IT & OT devices. Security testing must be conducted by certified Buying Utility's empanelled vendor

Following parameters are to be displayed at the control centre:

Monitoring

i. Operating Mode:
   a. Grid connected/ Standalone mode
   b. Automatic/ Manual mode
   c. Charge/discharge
ii. Application mode (as described above for different category)
iii. Measurements (V, I, P, Q, SoC, charge/discharge rate freq., energy export/import)
iv. Events and alarms
v. Breaker position/operation
vi. Status: Health of each battery, Air-conditioning system, Fire protection system
vii. Charge / Discharge: No of cycles, State of charge, estimated time for charging, estimated discharge time at ongoing discharge, etc.
viii. Any other parameter as mutually agreed during detailed engineering

Control

i. Operation: Open / close breakers, change of operating modes, change control logic for applications, charging control, change of local / remote control
ii. Protection: Protection relay parameter setting, battery over / under voltage alarm / tripping, battery over current alarm / tripping, temperature rise alarm / tripping, Temperature delta / voltage delta alarms. Rate of change of temperature alarm

System Hardware Requirements

Monitoring & control centre shall include workstation, keyboard, mouse, LAN cable and all associated items. Local LCD display shall be provided to monitor various functions and parameters locally viz. Charge, discharge, current, voltage, power, alarms etc.

The system shall preferably be based on computer technology with a Linux operating system. Other system architectures are acceptable, but regardless of system architecture, the system shall, at a minimum, provide remote data inquiry from personal computer-based platform and data file export capabilities in ASCII format or, independent media (such as universal serial bus drive) that are readable on personal computer-based systems.

The system shall comply with all relevant cyber security regulations and guidelines issued by relevant authorities from time to time.

The system shall provide unsolicited message capability for reporting critical alarms and indication locally and remotely to the Buying utility's SCADA system.

Processor, RAM, and storage should be selected in such a way that it should not use more than 50% of the disk space.

There should be CCTV surveillances for installations at each site with real-time recordings.

1.4 Battery Management System (BMS) & Power Conversion System (PCS)

Power Conversion system (PCS) shall supply rated power to the grid / battery for rated duration without violating the temperature rise limits. PCS shall consist of solid-state devices compatible to specified battery technology and shall be equipped with Isolation Transformer (Isolation transformer can be provided separately). PCS shall have at AC and DC side CB control and SPD (Type 1+2). Modular type pcs will be an added advantage. PCS shall have control of active and reactive power separately and should be able to provide power in all quadrants. It should have operational capability for both standalone and grid-connected mode. It should have capability to provide black-start support. It shall contain adequate inbuilt filter bank, harmonic filters, etc. for its operation. It shall contain adequate inbuilt filter bank, harmonic filters, etc. for its operation without deteriorating the quality of power in terms of power factor, harmonics, transients, flicker, etc. Power quality parameters of PCS shall comply with relevant IEC/IEEE standards. It shall have following additional features:

S. No.	Feature	Details
1	**Monitoring**	BMS and EMS shall monitor utility side parameters such as voltage, charge/discharge current, power quality parameters, protection system readings / status or any other parameter essential for monitoring health of battery. It shall also monitor parameters like charging / discharging current, power quality parameters, voltage, and protection system, etc. on the utility side of PCS.
2	**Charge control**	BMS shall monitor voltage, temperature and charging status of each cell of BESS. It shall be able to control charging of cells based upon these information and power / energy requirements. It should charge the module in CCCV mode as per requirement of battery sub-system design. PCS shall regulate the float / boost voltage in case of prescribed temperature rise of battery as per manufacturer's recommendation to avoid thermal runaway. The minimum C-rate for charging 0.5C and discharging 0.5C.

3	**Active / Reactive power control**	PCS shall have the capability to provide active / reactive power as per the requirement limited to rated/contracted capacity of the system. PCS shall have 4-quadrant operation and complied to IEEE 1547 and IEEE 519. Similarly, change in charging current of batteries shall also be smoothly controllable. PCS shall be able to provide 0.8 lead to 0.8 lag reactive power support without curtailing the active power.
4	**Operation Mode**	PCS shall be connected with the distribution grid and operate in grid connected mode. The grid connected mode shall be the default mode and shall be capable for standalone mode as well. Beyond the voltage limits, PCS shall disconnect itself from grid automatically. After normalization of voltage condition, it shall be able to restart / reconnect automatically.
5	**Auxiliary power supply**	Auxiliary loads of BESS shall be supplied power through a separate connection with metering. Auxiliary consumption has to be mentioned under technical bid for the proposed battery technology and same needs to be considered for calculation of round-trip efficiency.
6	**Enclosure**	PCS should be placed in waterproof and dustproof enclosure rated to minimum IP-54 protection with provision to prevent moisture condensation, airborne dust rodents etc., and compliant to IEC-60529 and NFPA 855. It shall be kept indoor (inside container/enclosure of BESS) floor-mounted, self-supporting sheet metal enclosed cubicle type. The BESS shall provide all associated items such as base frames, removable gland plates, copper lugs anchor bolts and hardware. Cubicle door should be earthed properly.

2. Design and Construction Requirements

Following are the design and constructional requirements which are expected by the Buying Utility. An analysis of the requirements of this specification and / or site surveys, design and engineering may lead the bidders to conclude that additional design and construction items are required that are not specifically mentioned in this specification. The bid/ proposal should include all costs required to ultimately commission a viable and fully functional BESS that meets or exceeds the capacity and performance requirements specified:

1. **Battery container / cabinet:** The whole system (battery, PCS, auxiliary source, PMS, firefighting system etc.), shall be enclosed in a container or cabinet with IP-54 class of protection or as per national/ international standards (IEC-60529) and NFPA 855. The system must be placed in a container, and it should have feature for heat load management. The system's container shall meet all standard safety requirements. Further, the battery container material should have electro-chemical compatibility and resistant to acid & alkaline material. The container should be insulated, fire retardant, and it shall be able to withstand the tensile stress due to internal

pressure of the cells or electrolyte in the worst operating condition. Cell / battery shall not show any deformity or bulge under all working conditions. Each Battery container should have early detection of thermal runaway system to protect the system against fire due to thermal runaway.

2. **Cell covers:** The cell covers should be permanently fixed with the battery container and shall be capable to withstand internal pressure without bulging / cracking. It shall also be fire retardant. Fixing of pressure regulation valve (if provided) & terminal posts in the cover shall be such that seepage of electrolyte, gas escape, and entry of electrostatic spark are prevented.

3. **Separator:** The separators used in manufacturing of battery cells, shall be of suitable material with large porosity, low acid / alkaline solubility and good insulating properties depending on the type of technology used for battery. The design of separators shall ensure that there is no misalignment during normal operation and handling.

4. **Pressure Regulation valve:** Each cell should be provided with pressure regulated valve (if required as per battery technology). The valve should be self-re sealable and fire resistant. The valve unit shall be such that it cannot be opened without a proper tool. The valve shall be capable to withstand the internal cell pressure specified by the manufacturer.

5. **Terminals:** Both the positive and negative terminals of the cells shall be capable of proper termination and shall ensure its consistency with the life of the battery. The surface of the terminal post extending above the cell cover including bolt hole shall be coated with an acid / alkaline resistant and corrosion retarding material. Terminal posts or any other metal part which is in contact with the electrolyte shall be made of the same alloy as that of the plates or of a proven material that does not have any harmful effect on cell performance. Both positive and negative posts shall be clearly and unambiguously identifiable. Terminal post seals shall not transmit stresses between the cover or container and posts.

6. **Connectors, Nuts and bolts, Heat Shrinkable sleeves:** Where it is not possible to bolt the cell terminals directly to assemble a battery, separate non-corroding lead or copper connectors of suitable size shall be provided to enable connection of the cells. Copper connections shall be suitably coated to withstand corrosion due to acid / base at a very high rate of charge or discharge. Nuts and bolts for connecting the cells shall be made of copper, brass, or stainless steel, which shall be effectively coated to prevent corrosion. All inter cell connectors shall be protected with heat shrinkable silicon sleeves for reducing the environmental impact including a corrosive environment.

7. **Mounting:** All the batteries shall be mounted in a metallic stand/frame. The suitable isolation should be provided between base of frame and ground to avoid the grounding of frame

8. **Battery Bank stand:** All batteries shall be mounted in a suitable metallic stand / frame. The frame shall be properly painted with the acid / base resistant paint. The battery stands shall be designed to withstand the wind speed and seismic design considerations.

9. All sensors, transducers, circuit boards, and test points in the System shall be easily and safely accessible for calibration and maintenance.

10. The additional items such as enclosures, junction boxes, grounding, instrumentation, wiring etc. required for fully functional system as per specification shall be provided / installed by BESSD.

11. External connection to the cells, including inter-cells or inter-module connections (such as cables/ straps etc.) shall also be designed to prevent failure during transportation.

12. BESS shall be provided with air conditioning system to manage the heat load of the system and rating of AC should be defined accordingly. It should be rugged, reliable and maintenance free and designed for long life time. It shall be designed for continuous operation. The system should be equipped with changeover feature to keep system healthy. Appropriate redundancy should also be provided such that operation is unaffected.

13. Energy meter of 0.5 class accuracy (as per IS-14697) shall be provided for recording export/import energy from/to BESS. CTs and PTs used in the energy meter will be under scope of BESSD.

3. General specifications

1. **Identification and Traceability:** Cells/Racks/Packs Assembly shall meet seismic requirement for the plant location of the BESS. Labelling of cells/batteries shall include manufacturer's name, cell type, name-plate rating, date of manufacture and date of expiry of parts and labour warranty

2. **Other Sub-systems/Components:** Other subsystems/components used in the BESS must also conform to the relevant international/national Standards for Electrical Safety besides that for Quality required for ensuring Expected Service Life and Weather Resistance.

3. **Fire Protection:** Adequate fire protection should be provided to tackle any fire incident likely to arise in battery energy storage system as per the international standard IEC 62897 (for Li-ion) or NFPA 72.A or NFPA 855. The BESSD shall design and install a fire protection system that conforms to national and local codes, as applicable. The fire protection system design and associated alarms shall take into account that the BESS will be unattended at most times. For high energy density technologies, the BESSD shall also obtain thermal runaway characterization of the battery storage systems.

4. **Authorized Test Centres:** Batteries/ Power Conditioning Units deployed in the power plants must have valid test certificates for their qualification as per above specified IEC/ BIS Standards by one of the ILAC member signatory accredited laboratories. In case of module types/ BESS/equipment for which such Test facilities may not exist in India at present, test certificates from reputed ILAC Member body accredited Labs abroad will be acceptable.

5. **Warranty:** BESSD shall procure performance guarantees to ensure minimum performance levels as per the terms of the RFP for 12 years from the Commercial Operation Date (COD). The Warranty shall clearly indicate life expectancy given discharge profiles provided for the application.

6. **Safe Disposal of unit Batteries from the BESS:** The BESSD will comply with the requirements under Hazardous & other Waste (Management and Transboundary Movement) Rules, 2016, as amended from time to time, as applicable. The BESSD shall ensure that all Unit Battery modules from the plant after their 'end of life' (when they become defective/ non-operational/ non-repairable) are disposed in accordance with the "e-waste (Management and Handling) Rules, 2022" and Battery Waste Management Rules, 2022 as notified by the Government of India and as revised and amended from time to time.

4. BESS Safety Standards

1. Safety of Li-Ion cell shall be ensured as per IEC-62281 and UL 1642 or UL 1973, Appendix E (cell) or IEC 62619 (cell) + IEC 63056 (cell), UL 9540 and UL 9540A. The container should have IP-54 class of protection.

2. The safety for whole BESS system shall also be ensured as per UL-9540 or IEC/TS 62933-5-1 + IEC/TS 62933-5-2).

3. Suitable earthing system should be designed and provided for BESS.

4. PCS shall have adequate safety features for complete isolation from grid in case of any malfunctioning (Separate isolation transformer may be connected between grid and BESS, if required). In addition, there should be a provision for manual as well as automatic disconnection of BESS from distribution system.

5. Provision should be provided for AC/DC protection (over/under voltage, over/under current, earth fault protection, over/under frequency for AC, transient/surge protection, breaker failure protection etc.).

6. Emergency alarm system should be provided for any malfunctioning of BESS operation.

In addition to above mentioned safety requirements, the BESS shall comply with the following Codes and Standards or equivalent Indian Standards, as applicable:

4.1 National/ International Standards for Battery Energy Storage System

Standard/ Code (or equivalent Indian Standards)	Description	Certification Requirements

UL 1642 or UL 1973, Appendix E (cell) or IEC 62619 (cell) + IEC 63056 (cell)	Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications	Required for Cell
UL 1973 (battery) or (IEC 62619 (battery) + IEC 63056 (battery))	Batteries for Use in Stationary, Vehicle Auxiliary Power and Light Electric Rail (LER) Applications / Secondary cells and batteries containing alkaline or other non-acid electrolytes - Safety requirements for secondary lithium cells and batteries, for use in industrial applications	Either UL 1642 or UL1973 or (IEC 62619 + IEC 63056) for the Battery level
IEC 62281 / UN 38.3	Safety of primary and secondary lithium cells and batteries during transport: Applicable for storage systems using Lithium-Ion chemistries	Required for both Battery and Cell.
IEC 61850/ DNP3	Communications networks and management systems. (BESS control system communication)	Required
IEC 61508	Functional Safety of Electrical/ Electronic/ Programmable Electronic Safety-related Systems: Applicable for all Battery Energy Storage Systems	Required for EMS/ OS and BMS
UL 9540 + UL 9540A and (IEC TS 62933-5-1 + IEC 62933-5-2) IS 17092	Electrical energy storage (EES) systems – Part 5-1: Safety considerations for grid-integrated EES systems – General specification / Standard for Energy Storage Systems and Equipment Part 5-2: Safety requirements for grid-integrated EES systems - Electrochemical-based systems IS 17092: Electrical Energy Storage System Safety Requirements	Either UL 9540 + UL 9540A and (IEC 62933-5-1 + IEC 62933-5-2) are required for BESS system level
IEC 62933-5-4	Safety test methods and Procedure for grid integrated ESS system-LI Ion based system	Required
UL 9540A	Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy	Required
IEC 61508	Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems: Applicable for all Battery Energy Storage Systems	Required for EMS/ OS and BMS

IEC 62933-2-1	Electrical energy storage (EES) systems - Part 21: Unit Parameters and testing methods - General Specification	Tests for Class B applications: Duty Cycle Round Trip Efficiency Test Equipment and Basic Function test Available Energy test Insulation test
IEC 62933-3	Planning and performance assessment of electrical energy storage systems - Additional requirements for power intensive and renewable energy sources integration related applications	Required
IEC/TS 62933-4	EES Systems - Electrical energy storage (EES) systems - Part 4-1: Guidance on environmental issues - General specification	Required
IEC/TS 62933-5	Electrical energy storage (EES) systems - Part 5-2: Safety requirements for grid-integrated EES systems - Electrochemical-based systems	Required
IEEE 2030.2.1-2019	IEEE Guide for Design, Operation, and Maintenance of Battery Energy Storage Systems	Required
IS 17387	General Safety and Performance Requirement of Battery Management System	Required
NFPA 855	Standard for the Installation of Stationary Energy Storage Systems	Required
IEC-60529	Ingress Protection Testing for Enclosures	Required

*4.2 National/ International Standards for Power Conditioning System / Power Conditioning Unit **

Power Conditioning Unit Standards for BESS	
IEEE 519-1992/2003	Power Quality Parameters
IEEE 1547	Standard for interconnecting distributed resources with electrical power systems
IEC 62909-1	Bi-directional grid connected power converters - Part 1: General requirements
IEC 62909-2 (if applicable)	Bi-directional grid-connected power converters - Part 2: Interface of GCPC and distributed energy resources

IEC 61683 Ed.1	Photovoltaic systems - Power conditioners - Procedure for measuring efficiency
IEC 61000-6-2 Ed. 2	Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments
IEC 61000-6-4 Ed. 2.1	Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments
IEC 62116 Ed. 2	Utility-interconnected photovoltaic inverters - Test procedure of islanding prevention measures
IEC 60068-2-1:2007	Environmental testing - Part 2-1: Tests - Test A: Cold
IEC 60068-2-2:2007	Environmental testing - Part 2-2: Tests - Test B: Dry heat
IEC 60068-2-14:2009	Environmental testing - Part 2-14: Tests - Test N: Change of temperature
IEC 60068-2-30:2005	Environmental testing - Part 2-30: Tests - Test Db: Damp heat, cyclic (12 h + 12 h cycle)
IEEE 519	Standard for Harmonica Control in Electric Power Systems
IEEE 1547	Standards for Interconnecting Distributed Resources with Electric Power Systems
IEC 60076-1	Power Transformer
IEC 61439	Low Voltage Switchgear and Control Assemblies
UL 1741	Standard for Static Inverters and Charge Controllers

Certification/test reports required for abovementioned standards for PCS/PCU

4.3 Protection System

Protection system must be capable of monitoring all the operating parameters and sensing all abnormal conditions to isolate the faulty circuit or component without damaging other parts of the system. Adequate indications/ alarms should also be provided locally as well as at remote control system for identification of faults and taking preventive / corrective actions.

The protection system shall work on following principles:

I. The fault should be identified as internal / external fault. The internal fault is associated with battery system whereas external fault is for distribution system. In the external fault, the system shall recover automatically from fault condition when healthy condition detected.

II. The protective device closest to fault location shall clear the fault without damaging other part of the system.

III. Lightning arrestor shall be installed to protect the whole system from damaging effect of lightning.

IV. Adequate fire protection system should be provided for whole system (cells, modules, PCS etc.).

V. Temperature rise protection system should be provided for battery and PCS.

VI. Emergency shutdown: Provision shall be given for automatic as well as manual disconnection of the BESS from distribution system if:

a. Protection system fail is detected during self-diagnostic, control healthy check

b. Breaker trip coil or interruptive device fails

c. DC supply is lost

Protection system supplied by BESSD shall include all the required components such as relay, contactor, and switches, for operation of BESS, which may not be specified in this tender specification.

The requirements of AC/DC protection system are listed in table below:

AC protection	DC protection
AC under/over voltage	DC under/over voltage
Over/ Under current protection	DC over current relay
Earth fault protection	Ground fault protection
Breaker failure protection	Breaker failure protection
Transient/surge protection	Transient/surge protection
Synchronization check for relay	Synchronization check for relay if any
Loss in phase difference	

4.3.1 Protection for PCS

The PCS shall be protected against thermal overload, over-current and over-voltage. Insulating monitoring ground fault detection shall be provided. The following protective functions shall be provided:

- DC over-voltage
- DC under-voltage
- DC over-current
- AC over-voltage
- AC under-voltage
- AC over-current

- Anti-Islanding
- Battery protection
- Internal fault (over temperature, logic failure, etc.)
- The electrical shield cable shall be adopted for the signal and control cable. The surge absorber shall be connected on both sides.
- EMC requirement shall meet IEC 61000 or equivalent standard.
- Neutral point high resister grounding type (DC side) for ground fault alarm shall be provided

4.3.2 Protection for Battery

The following protections shall be provided:

- Over/Under-charge protection
- Over-discharge protection
- Over/Under-temperature protection
- Over/Under-current protection
- Over/Under Voltage protection
- Ground-fault detection
- Internal battery fault detection
- Cell balancing
- Protective devices should include for DC-side protection:
- Battery fuse for each battery cell and module (preferred)
- DC contactor for each battery rack
- Grounding over current

4.3.3 Protection for Temperature Rise

The BESSD shall design a protection system for temperature rise in the battery modules/cells, PCS, or any other component of the BESS, due to short circuit in any part of the system, failure in temperature controller or sensors or any other internal/ external fault.

4.3.4 Emergency Stop

A manual disconnection of the BESS is to be provided. The system should also automatically disconnect the BESS from distribution system if and not limited to following conditions:

- Protection system failure is detected
- Breaker trip coils or interrupting device fails
- DC supply is lost

4.4 Transportation and Storage at site

The BESSD shall be responsible to survey, select and verify the route, mode of transportation and make all necessary arrangements with the appropriate authorities for the transportation of the equipment. It shall be the responsibility of the BESSD to coordinate the arrangement for transportation of the BESS for all the stages from the manufacturer's work to the site and ensure transit insurance and storage insurance for materials within the scope of work.

The BESSD shall dispatch the battery system in a way so as to avoid any accident either due to road conditions, environmental conditions and any other conditions which may arise due to transportation.

BESSD shall follow all the rules, regulations, and standards applicable for transport of batteries in India.

4.5 Civil and Structural Works

All civil works shall be carried out as per design / drawing / specifications as approved by the buying utility. The civil work includes levelling, area grading, site clearing (Tree and stump removal as per applicable law, clearing and grubbing, along with demolition of any obstructions or facilities), soil investigation and design as per site conditions. All materials used for construction should be of superior quality confirming to relevant Standards and Codes. The BESSD shall make necessary provisions for construction of foundation, cable trenches, excavation, etc. All materials including cement, reinforcement steel and structural steel, etc. shall be arranged by the BESSD and will be in the scope of BESSD.

The BESSD shall fully apprise themselves of the prevailing conditions at the proposed sites. Climatic conditions including monsoon patterns, local conditions and site-specific parameters, soil parameters, availability of construction material, etc. shall be taken care of by BESSD which may not have been explicitly mentioned in the RFP.

5. System Testing, Commissioning, and Operations

All testing including but not limited to Type Tests, Factory Acceptance Test (FAT) and Site Acceptance Test (SAT) must be conducted as per the specifications and the BESS Safety Standards listed above and approved by the Buying Utility. The BESSD shall submit final formats to be approved by Buying Utility. The project shall then be commissioned as per commissioning criteria and procedures specified by the CEA, if any.

5.1 Factory Acceptance Test

BESSD shall submit a comprehensive plan for factory acceptance test (FAT) to Buying Utility for approvals. and shall carry out FAT at sub system and module level as per the FAT plan approved by Buying Utility. it shall include for all components to the extent possible. The BESSD shall carry out FAT in presence of Buying Utility representatives.

It shall include, as a minimum, the following tests:

- Visual Inspection of equipment including dimension and overall design
- Verification of sensors, metering, and alarms
- Verification of all control function including remote control, monitoring and communication interface
- Verification of system performance at full/ partial Energy/ Power ratings
- Verification of maintenance and replacement features for unit batteries and other components

During the FAT, system shall be operated as specified and designed in all the operating states, use cases and duty cycles. It shall meet power / energy requirements and shall be demonstrated to meet the safety requirements.

Operation of all control, protective relaying and instrumentation circuits shall be demonstrated by direct tests, if feasible, or by simulating operating states for all parameters that cannot be directly tested. Automatic, local, and remote operation of the controls shall be demonstrated.

BESS shall be verified for operation at temperature extremes defined in specification. For this, if it is not possible for the full system, then independent laboratory certification of operation of critical components and subsystems shall be submitted at the time of FAT.

During FAT, if there is some malfunction, then FAT shall be suspended and resumed after rectification of the problem. The system shall not be accepted for shipment until all FATs have been successfully completed.

5.2 Site Acceptance Test

BESSD shall submit a comprehensive plan for site acceptance test to Buying Utility for approval. SAT plan shall include procedures to test correct system responses to system disturbances and operating scenarios described in the specification.

The test shall include, as a minimum, the following procedures:

- Verification of sensors, metering, and alarms
- Verification of all control functions including automatic, local, and remote control
- Verification of the performance criteria
- Demonstration of all the intended applications
- Demonstration of grid interface protection & control system
- Verification of power quality parameters

5.3 Training

BESSD shall provide training in India to manpower identified by the Buying utility. Training shall cover all aspects of BESS needed for proper operation & maintenance of the system. The BESSD shall be responsible for determination of content & duration of training sessions.

5.4 Documentation

To ensure that the proposed system conforms to the specific provisions and general intent of the specification, the BESSD shall submit a comprehensive list of the documents applicable for the offered system to the Buying utility for review and approval before the commissioning of the project. The flow of documents for approval from Buying Utility shall strictly meet the time schedule and project schedule shared by BESSD. Further, the BESSD shall also submit the drawings / documents for all the hardware & software required for site installation, testing and commissioning and thereafter the operation of the system.

The BESSD shall submit three hard copies and one soft copy with each submission. The documentation shall be in English. Review and acceptance of the documents does not encumber the utility with responsibility for the adequacy and safety of the BESSD's design. At a minimum, the documentation shall cover but not limited to:

- System description document (overview)
- Functional description document
- System configuration document
- Construction and installation drawings including civil layout, electrical layout, communication architecture, EMS hardware configuration (PLC layout)
- Equipment drawings and specifications
- Equipment drawings and specifications
- Wiring diagrams including electrical and communication
- Conduit diagrams
- Bill of material
- Assembly drawing
- O&M manual
- Maintenance schedule
- Project implementation schedule
- Master test plan & procedures
- Quality Assurance manual
- Software documentation
- Test reports
- FAT reports
- SAT procedure/ document

- Relay & control settings
- Progress reports
- Training manuals
- As-built drawings
- List of connected devices – EMS and entire system
- Troubleshooting manual
- Asset Register covering Make, Model No., Description, Country of Origin and Type of Device (Passive or Active)

6. Performance monitoring

As part of the performance monitoring, the following shall be carried out:

6.1 The BESSD must install necessary equipment to continuously measure BESS operating parameters (including but not limited to voltage, current, ambient conditions etc.) as well as energy input into and energy output from the BESS along with Metering arrangement in accordance with extant regulations. They will be required to submit this data to the concerned authorities/organizations online and/or through a report on regular basis every month for the entire duration of contract.

6.2 The BESSD shall provide access to the concerned authorities/organisations or their authorized representatives for installing any additional monitoring equipment to facilitate on-line transfer of data.

6.3 All data shall be made available as mentioned above for the entire duration of the Contract.

6.4 The plant SCADA should be OPC version 2.0a (or a later version including OPC UA) compliant and implement appropriate OPC-DA server as per the specification of OPC Foundation. All data should be accessible through this OPC server for providing real time online data (BESS parameters) to the concerned authorities/organisations. This time series data shall be available from the Project SCADA system to facilitate monitoring and should include among others as stated before, parameters to facilitate daily, monthly, and annual report for performance monitoring.

6.5 Web-based monitoring should be available, which should not be machine dependent. The web-based monitoring should provide the same screens as available in the plant. Also, it should be possible to download reports from a remote web-client in PDF or Excel format.

6.6 BESSD shall provide weekly, fortnightly, monthly, and annual reports as per the requirements on the performance parameters as per IEC 62933-3 and parameters approved by Buying Utility. BESSD shall submit monitoring report to Buying Utility briefly assessing the overall performance of the BESS and its associated components along-side the technical performance of battery cells/modules promised at the time of bidding for the term of the

agreement. For example, throughput consumed & throughput remaining, C-rate assessment (maximum, minimum and average), degradation curve, down-time assessment, depth of discharge assessment (maximum, minimum and average), auxiliary consumption assessment, round-trip efficiency, PCS efficiency, battery module-wise health parameters, etc.

7. Service Level Agreement (SLA)

Service Level Agreements (SLAs) reflect the measurements to be used to track and report overall progress, system performance and performance of BESSD's services on a regular basis. Detailed SLAs are defined in Volume 3 of this RFP. These shall operate as a legally binding services agreement specifying terms which apply to the parties and to the provision of the services by the BESSD to Buying Utility under the Battery Energy Storage Service Agreement (BESSA).