2.0 Technical Specifications for Battery Energy Storage System(BESS)

The bidder shall be able to provide the components of the BESS as per following technical specifications described below in this section.

2.1 Battery Sub-system

The cells shall be supplied as group of cells combined into modules and inter-connection of cells; 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.

2.2 Battery Technology

Definitions of various terminologies related to battery energy storage system should comply with IEC 60050-482 (International electro-technical vocabulary for cells/ batteries) if otherwise not specified. Li-ion LFP ($LiFePo_4$) shall be used in the battery energy storage system for application under category-A. Technical specification shall be provided for aforementioned Lithium-ion battery technologies for rated useful capacity of BESS as mentioned below in the table 2.

Table 2: Technical characteristics of BESS for Category A

Sr. No.	Parameters	Unit	Value
1	Useful capacity at output of power conversion system at rated DoD as per battery design	kWh	230 (Category A)
2	Peak power requirement	kW	125 (Category A)
3	Depth of Discharge	%	> 80 (Li-ion)
4	Throughput	kWh	At-least 9,20,000 kWh of total throughput for Li-Ion at rated DoD
5	Round Trip Efficiency (DC-DC)	%	> 90 (Li-ion)
6	Service Life	Years	At-least 6 years or, total throughput mentioned whichever is less
7	Charging time	Hours	Maximum 4 hrs. from rated DoD to full capacity
8	**Annual throughput (±10% permissible range)	kWh	2,000 kWh

** It indicates the annual energy required from BESS for category A as per current load pattern of distribution transformer. Annual throughput has been mentioned just to estimate the annual degradation of battery useful capacity. In-addition, BESS will not be

utilizing for more than one cycle in a day for specified application under category A. However, warranty & AMC shall be provided on the basis of total throughput of BESS.

2.21 Lithium-ion battery (LFP) shall be also used in the energy storage system for applications under category B & C as applicable. Technical specification shall be provided for aforementioned Lithium-ion battery technologies for rated useful capacity of BESS as mentioned below in the table 3.

Table 3: Technical characteristics of BESS for Category B & Category C

Sr. No.	Parameters	Unit	Value
1	Useful capacity at output of power conversion system at rated DoD as per battery design	kWh	120 (Category B) 50 (Category C)
2	Peak power requirement	kW	240 (Category B) 50 (Category C)
3	Depth of Discharge	%	> 85 (Li-ion)
4	Throughput	kWh	4,80,000 kWh of total throughput for LFP at rated DOD
5	Round Trip Efficiency (DC-DC)	%	> 90
6	Service Life (for category B)	Years	At least 6 years or 4,80,000 kWh of total throughput for LFP. whichever is less at rated DOD
7	Service Life (for category C)	Years	At least 6 years or 2, 00,000 kWh of total throughput for LFP at rated DOD.
8	Charging time	Hours	Maximum 4 hrs. from rated DoD to full capacity
9	***Annual throughput (±10% permissible range)	kWh	3,600 kWh for category B and 9,000 kWh for category C

*** It indicates the annual energy required from BESS for category B & C. Annual throughput has been mentioned just to estimate the annual degradation of battery useful capacity. In-addition, BESS will not be utilizing for more than one cycle in a day for specified application under category B & C. However, warranty & AMC shall be provided on the basis of total throughput of BESS.

2.3 Battery Energy Management System

Category A

Battery storage shall discharge based on battery capacity and real-time loading of DT. Reference for discharge current shall be evaluated as per equation (4) expressed in annexure-I. The reference value shall be updated periodically (interval time will be decided in consultation with system integrator) depending upon the electrical parameter measurement. The charging shall be performed in constant current constant voltage (CCCV) mode. However, change of operating mode from CC to CV during charging shall be determined on the basis of bidder recommendations.

Category B

BESS shall supply the power to common/critical load during power outage event. The system shall monitor the grid parameters (voltage, current, frequency, power factor etc.) and total load demand during power outages. The system shall be able to discharge with 2C rate and it shall also be synchronized with DG set in such a manner that it should not back feed the power to DG. When the BESS is discharged completely during power outages then the power to the load shall be supplied through the DG set for remaining duration. The charging of battery storage system shall be performed through grid power supply. Grid power, common/critical load demand and battery capacity will be monitored continuously and whenever power failure occurs, BESS shall supply the power to load as per equation (5) and (6) expressed in annexure-II. In-addition, BESS must have feature to supply the power to the load in grid-connected mode when utility observes the peak demand. Therefore, bidder must install a hybrid system (PCS) which can be operated in both off grid as well as grid connected mode. Although, the aforementioned application of grid-connected operation of BESS is not a primary application as of now however it can be implemented in future.

Category C

The battery storage shall discharge during pre-defined peak hours with constant C-rate as per equation expressed in annexure-III. The charging of BESS shall be performed through grid in off-peak hours. Battery SoC shall be monitored periodically to evaluate the remaining capacity at start of discharge operation and accordingly a constant rate of discharge will be defined. Further, an additional feature shall be provided to change/edit the discharge duration and rate of discharge whenever required.

***Note**: Control Algorithm mentioned in Annexure-I, II and III can be improvised, if required, in discretion with TERI & BRPL considering proper functioning of BESS.*

2.4 The Battery Energy Management System (EMS) architecture shall comply with following requirements:

a. Energy management system shall comprise of hardware & software for managing the power/energy flow through BESS for specific application.

b. BESS should have the capability to monitor the operational parameters of grid and BESS (Grid V & I, P, Q, f, battery V & I, State of Charge, relay/actuator command etc.) remotely in SCADA system through communication interface.

In-addition, BESS operation shall be controlled through utility's SCADA center.

c. The EMS shall include monitoring, data acquisition and control to provide continuous visualization or display of key operational parameters (such as Grid voltage & current, Input/output power, battery voltage & current, state of charge, energy throughput remaining, SoC, sampling rate, mode of operation, cell level voltage and temperature, etc.), as well as permanent archival of all measured parameters. The system shall record values of all operational parameters in fix and removable non-volatile memory. It shall be capable of making all monitored data and events available through the Distributed Network Protocol (DNP3) communication interface and shall allow the display of current values and recent historical trend (such as past 24 hours).

d. The sampling time for measurement/monitoring of key electrical parameters shall be adjustable up to 100 ms. The real time analogue data such as grid voltage & current, battery voltage & current, SoC, frequency etc. at 10 second interval and digital data such as alarm, events will be stored for 30 days. Human machine interface (HMI) shall display the single line diagram of whole system with color display and alarms & events shall be displayed in the form of list. The operation of HMI should be user friendly.

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). There should be provision to change some of the set point values such as loading threshold of various distribution system components like transformers, sampling rate (as a decision parameter) and this should be provided through the user interface.

e. The control features in Energy Management System (EMS) shall be customizable and shall have feature to update the algorithm time to time as per requirement. There should be provision to change the program/code of EMS software depending upon the TERI demand. The procedure to request the change in program/code of EMS should be provided by the Contractor.
It shall have capability to store 30 days back up data at local EMS platform, and can be extracted on user/TERI demand.
The EMS portal should display input/output power, operating state (charge/discharge/idle), charge/discharge mode (CC, CV, CP), DoD Vs cycle count histogram and module-wise temperature heat-maps.

f. Module-level battery management system shall be provided to take care of battery module's parameters (voltage, SoC and temperature) within specified range as per the requirement of battery technology. Additionally, BMS must have feature to monitor the cell level parameters as well.

g. Local EMS portal should be password protected with different level of security such as operator, supervisory and admin level. Also, the recorded & monitored data should be encrypted to ensure secure operation of BESS.

The operator and supervisory level access should be provided to TERI/BRPL while the Contractor will hold the access of admin level password.

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 a centralized control station of the distribution utility through Modbus communication and it shall have feature to control the system from centralize control station. In addition, the contractor 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. Also, the EMS portal shall have a provision to monitor the real-time status of Distributed Energy Resources (DERs) located nearby the BESS installation site through a seamless integration method. However, the communication methodologies such as GPS, GPRS, etc. may be decided mutually between TERI and the Contractor, later during the engineering design stage based on the options available for accessing the external data repositories corresponding to the respective DERs.

h. EMS shall link all three (3) sites which are to be installed in the current tender. However, 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. The contractor shall share the open Application Program Interface (APIs) of the EMS with customizable data structure for integration of any future battery energy storage system of any make at multiple locations. EMS shall be interoperable with any other EMS or Distributed Energy Resources Management System (DERMS) having the same protocol and with SACDA through IEC 60870-5-104 protocol. It is reemphasized that 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 BRPL's Central SCADA Control Center at 33kV Balaji Grid Station, Kalkaji) and different locations of BESS needs to be established by the contractor through suitable communication channels.

i. BESS operation should be controlled by one operator at a time, positioned either locally or remotely and thus it must have suitable interlock features. Local control should be highly placed in control hierarchy. Real-time analogue & digital inputs & outputs should be visible on the display screen both locally and remotely and logical command shall also be displayed in Control Centre. An integrity scan shall also be made periodically and any discrepancy occurs between field status and command, shall be intimated through alarm.

j. 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.

k. A restricted access to monitor the operating parameters through web/ online portal as well as mobile app shall be provided to TERI and BRPL.

Following parameters to be displayed at the control center:

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. Parameters of PCS such as active power, reactive power, power factor, operating DC voltage etc.
VII. Fault information
VIII. Status of air conditioning and fire protection system
IX. Smoke/fire alarm and container opening alarm

2.5 System Hardware Requirements

Monitoring & control centre shall include workstation, keyboard, mouse, LAN cable and all associated items. Local L E D - 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 Latest hardware and software of personal computer technology with a Microsoft Windows 10 or later 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 provide unsolicited message capability for reporting critical alarms and indication locally and remotely to the BRPL's SCADA system.

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

An additional remote monitoring unit (42'') displaying required features shall also be provided at TERI HQ with suitable configurations.

There should be CCTV surveillances for installations at each site with real-time recordings.(IP based CCTV camera with DVR system for recording)

3.0 Battery Management System (BMS) Functionality Requirement & Monitoring:

BMS shall monitor battery system parameters such as string voltage & current, SoC, cumulative number of cycles and throughput along with DoD. It shall also monitor utility side parameters such as voltage, charge/discharge current and protection system readings/status.

3.1 Charge control:

EMS shall control the charging state of each module based on monitoring of parameters and power/energy requirements. It should charge the module in float/boost mode and/or Constant Current Constant Voltage (CC-CV) mode as per requirements of battery sub system. Further, it should regulate the voltage to limit the temperature rise in the cell.

4.0 Power Conditioning System (PCS) Functionality Requirements &Monitoring:

4.1 Power Control:

PCS shall able to supply rated power to grid/battery for specified duration (as per requirement) as required without violating the temperature rise limits. Additionally, it shall control the active and reactive power separately. Though, the primary requirement of the project is to supply only active power (power factor must be greater than 0.98 from BESS but there should be provision to supply reactive power as well if required. Power quality parameters of PCS shall comply with relevant IEC/IEEE standards.

4.2 Operation Mode:

The output of the PCS (voltage and frequency) needs to be synchronized with secondary side output of Distribution Transformer (DT) when the battery energy storage system is operating in synchronized mode of DT. In other cases, PCS output voltage shall remain within 1% of the set value i.e. 433V. PCS must have isolation transformer (inbuilt shall be preferred) to disconnect the system from grid in case of any hazardous situation. It shall operate in inverter mode during discharging and rectifier mode during charging of battery system.

4.3 Auxiliary power supply:

Auxiliary loads of BESS shall be supplied power either from AC bus of PCS or else a separate connection shall be established from control room. Useful capacity at output of power conversion system at rated DoD as mentioned in tables above are after consideration of Auxiliary power consumption the BESS. It is re-emphasized that the useful capacity at output of power conversion system as mentioned in above tables is after consideration of round-tip efficiency, rated DoD, auxiliary power consumption, (which should preferably be less than 2%) etc. Auxiliary consumption has to be mentioned under technical bid for proposed battery technology and same has to be included in technical datasheet as well.

4.4 Enclosure:

PCS should be placed in waterproof and dustproof enclosure rated to minimum IP-42 protection with provision to prevent moisture condensation, airborne dust rodents etc. It shall be kept indoor (inside container/enclosure of BESS) floor-mounted, self-supporting sheet metal enclosed cubicle type. The contractor shall provide all associated items such as base frames, removable gland plates, copper lugs anchor bolts and hardware. Cubicle door should be earthed properly.

Table 4: Detailed description of PCS/ PCU

Sr. No.	Parameters	Unit	Value
1	Maximum power rating	kVA	140 (Category A) 270 (Category B) 56 (Category C)
	Power rating	kW	125 (Category A) 240 (Category B) 50 (Category C)
2	Power factor	Cos Φ	0.9 (leading to lagging)
3	Efficiency	%	> 97
4	Voltage withstand capabilities	Volts	+15/-20% of rated voltage on both AC & DC side
5	Frequency	Hz	50±3 %
6	Power quality parameters	As per IEC/IEEE standards (IEEE 519-1992/2003)	
7	Communication interface with SCADA system	Modbus (Port: RS-485) / IEC 60870-5-104 protocol	

5.0 Design and Construction Requirements

a. BESS system will be inter-connected with grid at secondary terminal of distribution transformer i.e. three-phase four-wire, 433 Volts (L-L) at point of common coupling (PCC). The above mentioned inter-connection point is suggested for category-A & category-C application. However, probable inter-connection point of BESS for category-B will be at 3-phase output of DG set. However, it may further change slightly after the site visit to installation site. The single line diagram (SLD) of all the three categories is given in annexure IV, V & VI. In-addition, the appropriate location for BESS inter-connection shall be proposed by the bidders and further it shall be approved by TERI/BRPL.

b. 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). The system must be placed in a container and it should have feature for heat load management. The standard containerized solution including both Battery modules and PCS shall be preferred. The system's container shall meet all standard safety requirements. For BESS Container sizing ,Bidders to consider actual space availability at sites . A site survey report is attached for reference(Annexure VII). Further, the battery container material should have electro-chemical compatibility and resistant to acid &

alkaline material. The container should be fire retardant and it shall able to withstand the tensile stress due to internal pressure of the cells or electrolyte in the worst operating condition.

c. 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.

d. The terminals of the cells shall be coated with corrosion resistant materials and it should be non- reactive to acid and alkaline. It shall also be covered with insulating material to prevent any accidental contact with live electrical connections.

e. All the batteries shall be mounted in a metallic stand/frame. The frame should be painted with acid/base resistant paint. The suitable isolation should be provided between base of frame and ground to avoid the grounding of frame

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

g. 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 contractor.

h. 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.

i. The modules can be interconnected in series or parallel configuration to achieve the specified energy and power requirements.

j. 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.

k. Reputed make 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 contractor.

6.0 Safety Requirements

6.1 System Safety

a. Safety of Li-Ion cell shall be ensured as per IEC-62281 and container should have IP-54 class of protection.

b. Each cell shall be equipped with a flame arrestor to defuse any flammable gas escaped during charge and discharge. In addition to the fire suppression system, the flame arrester is required to prevent the fire from one cell to the adjacent cells and needs to be provided from the perspective of safety as per relevant standards.

c. The safety for whole BESS system shall be ensured as per UL-9540.

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

e. Suitable Earthing system should be designed and provided for BESS.

f. PCS shall have adequate safety feature 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.

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

h. 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.).

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

In addition to above mentioned safety requirements, manufacturer will be responsible to carry out following test (described in table below) required for safety and performance standards:

Table 5: National/ International Standards for Battery Energy Storage System

Requirements	**Standards**
Safety requirements	IEC-62133 or IEC 62620:2014 or UL-1642 or UL-1973 UL-9540 (for every components of BESS)
Performance tests, designations, markings, dimensions and other requirements	IEC 62619/62620
Test methods and requirements to ensure safety during transport other than for recycling or disposal	IEC 62281 or, UL-1973
Tests and requirements for verifying the mechanical behavior	IEC-61959/ IEC-62897
Protection of Stationary Battery Systems	IEEE 1375
Design, Operation & Maintenance of BESS	IEEE 2030.2.1-2019 or equivalent
Planning & Installation of Electrical Energy Storage System	IEC-62935
Guide for Selection and Use of BMS in Stationary Applications	IEEE 1491

Table 6 : National/ International Standards related to operation & safety of PCS/ PCU, testing procedures and protection devices

Requirements	**Standards**
General and safety requirements	IEC 62040-1 or IEC 62477-1 or Equivalent
Interconnecting distributed resources with electrical power system	IEEE 1547 IEC 61850(communication standard) UL 1741 (testing)
Power conditioners - Procedure for measuring efficiency	IEC 61683 or, Equivalent

Environmental testing	IEC 60068-2 (1,2,14,30)
Switches / Breakers / Connectors	IEC 60947 (1, 2, 3)
Power metering & monitoring devices	IEC 61557-12
Power quality parameters	IEEE 519-2003 or IEC 61000-4 series

6.2 Fire Fighting System:

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. Different types of fire extinguishers (Sinorix N2, Hepta Flouro Propane or equivalent for electrical safety) shall be installed to take care of fires which are likely to happen and protection from such incident shall be ensured as per International fire code (IFC-ICC).

6.3 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 is described as internal and external fault. The internal fault is associated with battery system where as 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.

Protection system supplied by contractor 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 7 below:

Table 7: Requirements of AC/DC Protection System

AC Protection	DC Protection
AC under/over voltage	DC under/over voltage
Over 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 of phase	------
Over/under current frequency	------

6.4 Protection for Temperature Rise

The contractor 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.

6.5 Protection for Spillage

Protection shall be provided for electrolyte spills that are related with the type of electrolyte used. It shall have feature to prevent the discharging of electrolyte to nearby installation site.

6.6 Emergency Stop

There should be provision of manual and automatic disconnection of the BESS from distribution system if;

1. Protection system failure is detected during self-diagnosis, healthy check.
2. Breaker trip coils or interrupting device.
3. DC supply lost.

7.0 Disposal/ Battery Recycling Plan

Once battery / system completes its life the contractor will be responsible for dismantling of system and remove the item from the site and handover clear site to owner of the property / site.

a) The supplies of battery cells/modules/pack shall be supported by an extended producer responsibility certificate as and when available, authorization from the battery manufacturer. 'Extended Producer Responsibility' (EPR) means responsibility of any producer of batteries for their products beyond manufacturing until environmentally sound management of their end-of-life products; for channelization of waste batteries to ensure environmentally sound management of such waste. Extended Producer Responsibility may comprise of implementing take back system or setting up of collection centres or both and having agreed arrangements with registered recycler either individually or collectively through a Producer Responsibility Organization recognized by producer or producers in their Extended Producer Responsibility.

b) All batteries that have completed the useful life (battery waste) at the location installed shall be managed in an environmentally sound manner. 'Environmentally sound management of battery waste' means taking all steps required to ensure that batteries are managed in a manner which shall protect health and environment against any adverse effects, which may result from hazardous substance contained in such wastes;

7.1 Dismantling:

At the end of the life of batteries, final dismantling, removing and recycling batteries from the site is the complete responsibility of vendor. Under Category-B, BESS is to be placed into a premises of residential society. The inter-connection of the said system will be behind-the-meter, and hence it is outside of control area of TERI/ BRPL. Thus, in view of public interest, a premature removal of BESS from the site may be required even within the contract duration. In such unforeseen circumstances, TERI/ BRPL will provide another site within licensee area of BRPL with similar operating conditions in NCT of Delhi. The shifting and re-installation of BESS will be performed by TERI/ BRPL (within a stipulated time-frame) at their own cost and risk under the supervision of vendor. The commissioning of the BESS at the new site will be performed by vendor with the support from TERI/

BRPL. The charges for vendor's services for 'shifting & re-installation supervision' and 'commissioning of the BESS at the new site' are to be paid to vendor by BHEL as per the per man-day rates prevailing at that time. The man-day rates shall include to-and-fro transportation, food and lodging. The charges shall be prior mutually discussed and finalized as and when required. At the time of shifting & re-installation, the CAMC clauses of purchase order in particular and any clauses related to non-availability during the relocation period in general will remain suspended till the BESS is completely installed and ready to use condition in new site. Post commissioning, those clauses will be applicable as per the purchase order.

7.2 Recycling

Once batteries have reached the end of its useful life (even after six years of contract duration), It is the complete responsibility of Contractor to remove batteries from each site and recycle the batteries. Batteries should be in completely discharged condition prior to their disposal and disposed as per the brief plan presented at the time of quality assurance program (refer clause 13). The DC connection terminals of the batteries must be insulated with electric tape to prevent accidental contacts. Incineration must be performed by an approved and permitted waste treatment facility that handles lithium ion batteries.

It shall be the responsibility of Contractor to;

1. ensure that used batteries collected are sent to the registered recycling agencies or for disposal;
2. ensure that necessary arrangements are made for safe transportation from site to the premises of recyclers or for disposal;
3. ensure that no damage to the environment occurs during transportation;
4. ensure that batteries are recycled according to relevant guidelines prevailing at the time of disposal.

A detailed report on recycling has to be submitted once the process is complete duly signed by registered recycling agency.

8.0 System Testing

8.1 Factory Test

The contractor shall carry out factory acceptance test (FAT) at sub system and module level and it shall include for all component to the extent possible. The contractor shall submit FAT document to approving authority. It shall include following test:

- 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 something mal-operates 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.

8.2 Site test

The contractor shall submit a comprehensive plan for site acceptance test to approving authority 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, following procedure:

- 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

9.0 Special Tools and Mandatory Spares

The bidder shall ensure the deployment of all special tools and tackles, required for installation, testing & commissioning and maintenance of BESS. Additionally, the contractor shall also furnish list of special tools and tackles for the system (such as switches, measurement & sensing device, transducers etc.), referred by employer during the operation of the system. Further, bidder shall provide the mandatory spares along with the list of mandatory spares for the system and no such spares to be used during commissioning of equipment or warranty period. Any spares required for commissioning / warranty shall be arranged by the Contractor.

In-addition, battery modules of capacity 5 kWh of lithium-ion (LFP) shall also be provided as spare items, 3 kWh under category B and 2 kWh of category C for the technology as mentioned in bid. The same will be used for research purpose and placed in TERI's Smart Control Laboratory at TERI Gram, Gual Pahari, Gurugram, Haryana.

10.0 AMC & WARRANTY

Supplier shall offer one year warranty as per tender document and comprehensive AMC charges for 5 years after warranty expires for maintenance of the BESS systems for all sites.

The Supplier shall warrant as per standards for quality that anything to be furnished shall be new, free from all defects and faults in material, workmanship and manufacture, shall be of the highest grade and consistent with established and generally accepted standards for material of the type ordered, shall be in full conformity with the specifications, drawing or samples, if any and shall if operable, operate properly.

10.1 Scope of AMC

Warranty period is followed by comprehensive AMC period. The Scope of AMC contract starts after one year of receiving signed completion certificate from TERI.

i) The Contractor shall perform standard annual maintenance and augment the system as needed to meet performance guarantee in all aspects**.**

ii) The Contractor shall perform standard annual maintenance of BESS that would include wear, tear, overhauling, insurance, and replacement of defective cells, PCUs, spares, consumables and other parts including sensors and data acquisition equipment installed to communicate parameters to EMS and between EMS and SCADA.

iii) Monitoring of BESS performance and supply of all technical, production/operation data and information and making it available as and when required.

iv) Responsible to carry out routine and preventive maintenance and replacement of component/equipment of BESS in case of failure and Contractor shall provide all labor, material, consumables etc. for routine and preventive maintenance at regular intervals. This will also include scheduled software maintenance, HVAC cleaning, battery container cleaning, low voltage side circuit breaker maintenance, fire suppression system maintenance etc.

v) Carryout maintenance activities as a result of sudden failure/breakdown of any particular component or equipment. Contractor shall be responsible to carry out breakdown maintenance of each and every component of BESS.

vi) Visit to onsite on call basis to provide maintenance services within 12 hours of raising the complaint.

vii) Emergency trouble shooting calls - within 12 Hrs including spare arrangements.

viii) On site repairing/component replacement - within 2 working days, however, system has to be in service utilizing the spares (if available on site/ or at nearby service center of the Contractor) within 12 hours of the breakdown.

ix) The Contractor 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.

x) Contractor shall keep one technically skilled person employed dedicatedly to three sites as mentioned in the tender. The technically skilled person has to remain in New Delhi and in case of absence of the person due to any unavoidable circumstances; a back-up skilled person must be employed by contractor.

xi) Payment of AMC charges shall be linked with uptime (availability) of BESS. BESS is more significant during peak times of BRPL, thus weightage of penalty will be higher during peak time slots as per the latest tariff orders of BRPL, as shown

below:

Time Slot	Weightage
00:00 Hours to 02:00 Hours	1
02:00 Hours to 14:00 Hours	0.5
14:00 Hours to 00:00 Hours	1

The penalty on the account of non-availability of the BESS shall be calculated as under:

System Availability Factor (SAF) %		Penalty (%)	% of Quoted AMC*
0	95	100	0
95	96	80	20
96	97	60	40
97	98	40	60
98	99	20	80
99	100	0	100

Time Slot	BESS unavailable hours in a month (UAH)	Weightage(W)
TS1- 00:00 Hours to 02:00 Hours	2	1
TS2-02:00 Hours to 14:00 Hours	2	0.5
TS3-14:00 Hours to 00:00 Hours	8	1

SAF= 1-[{(TS1 UAH*W+TS2 UAH*W+TS3 UAH*W)}/ (Number of days in the month * 24)]
SAF= 1-[{(2*1+2*0.5+8*1)}/ (Number of days in the month * 24)]
SAF=98.47% (considering 30 days month)

Assumed AMC charges: 1000 units

Actual charges paid: 80% of 1000 = 800 units

xii) The penalty on account of non-availability of the BESS shall be calculated on monthly basis. The net balance (AMC contract annual price – penalty) will be released half-yearly to the contractor.

xiii) Sub-Contracting: No sub-contracting of work in full or in part is allowed unless approved by TERI in writing.

xiv) The Contractor shall submit category wise monitoring report to TERI and BRPL.

xv) The Contractor shall continue to provide spare parts during warranty and AMC period at their own cost to keep the systems in good operating conditions. After

the expiry of AMC period, the Contractor shall continue to provide spare parts at the users cost till the product life. If the Contractor fails to continue to supply spare parts and services to users, 'BHEL' shall take appropriate action against the contractor.

10.2 Performance of Equipment

10.21 In addition to the warranty as already provided, the Contractor/ Bidder shall guarantee satisfactory performance of the equipment and shall be responsible for the period specified in Clause 10.23 hereof after the equipment has been accepted by 'TERI' to the extent for any defects that may develop such defects shall be removed at his own cost when called upon to do so by 'TERI'.

During AMC contract period, as per the listed conditions of tender, the total responsibility of the BESS at all the three sites lies with the Contractor and all the repairs and replacements have to be made without any additional cost to TERI and BRPL. Also, the contractor shall be responsible for any defects that may occur due to faulty materials, design or workmanship during the AMC contract period. If it becomes necessary for the contractor to replace or repair any defective portion of the system, the contractor shall make such replacement or renewal within 2 working days of intimation and without any extra cost to BHEL/TERI/ BRPL.

10.22 The Contractor shall warrant as per standards for quality that anything to be furnished shall be new, free from all defects and faults in material, workmanship and manufacture, shall be of the highest grade and consistent with established and generally accepted standards for material of the type ordered, shall be in full conformity with the specifications, drawing or samples, if any and shall if operable, operate properly. The bidder to Guarantee the materials / items supplied against any defect of failure, which arise due to faulty materials, workmanship or design for the entire defects liability period. The Defect liability period shall be 12 months and warranty of 12 months from the date of commissioning followed by the comprehensive AMC period of be 5 (five) years for complete system including battery after 12 months from the date of commissioning and handing over of the system or total throughput mentioned in the bid whichever is first. If during the defects liability period any materials / items are found to be defective, these shall be replaced or rectified by the bidder at his own cost within 30 days from the date of receipt of intimation. BHEL may also invoke performance/security bank guarantee if any identified defects are not replaced or rectified by the bidder at his own cost within 30 days from the date of receipt of intimation. After completion of 5 years of installation due to ageing, available capacity shall not go below 95% of available capacity specified at the time of bidding. Annual expected throughputs with ± 10% permissible range are as mentioned in Table-2 and Table-3. Bidders are requested to propose degradation against estimated annual throughput in the technical bid.

The Contractor shall submit category wise monitoring report to TERI and BRPL twice in a year briefly assessing the overall performance of the BESS and its associated components alongside the technical performance of battery cells/modules promised at the time of

bidding for all six years 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.

10.23 The Warranty period shall be 1 (one) year for complete system including battery from the date of commissioning and handing over of the system. During warranty period, as per the listed conditions of NIT terms, the total responsibility of the BESS at all the three sites lies with contractor and all the repairs and replacements have to be made without any additional cost to BHEL.

For warranty period, after system installation, the contractor shall be responsible for any defects that may occur due to faulty materials, design or workmanship. If it becomes necessary for the contractor to replace or repair any defective portion of the system, the contractor shall address all the issues within 2 working days and any replacements or renewals can be completed within 10 working days of intimation and without any extra cost to BHEL. However, the system must be in running condition within 2 working days of intimation to the contractor.

10.24 Since the maintenance of the system may also be taken up by the Contractor/Bidder after expiry of one year of warranty period if the end user/'TERI'/'BRPL' so desires, the Contractor/ Bidder shall take up annual maintenance of the installed system. Bidder has to provide the year-wise quote for the period of five years after expiry of warranty years.

10.25 The Contractor/ Bidder shall maintain the system under periodic maintenance contract with the end-user. The preparation of maintenance schedule is sole responsibility of the contractor/bidder. Additionally, a checklist shall be prepared to check/validate the critical operating parameters during maintenance. The checklist will be prepared by the bidder with all mandatory details.

10.3 On-site Warranty:

a. Contractor / Bidder will create provision for receiving and recording all complaints, attending the complaints, stocking essential spares, provisioning trained service personnel, recording monthly logs of all activities, etc.

b. During the 1 (one) year period, the repair works will have to be carried out at the premise except in exceptional circumstances where the equipment or any component may be required to be taken out for repair, for which specific written permission should be obtained from TERI. In such cases, standby arrangements are required to be made by Contractor / Bidder so that the BESS remains in functional state. All products have valid product warranty and hence on-site repair and maintenance service needs to be provided after getting replenishment of spares from respective product manufacturer.

c. If the Contractor/ Bidder fail to attend the complaint within 2 working days, every time, a reasonable penalty will be applied as per NIT commercial terms.

d. The work shall be carried out by the Contractor/ Bidder as per design and drawings approved by BHEL/TERI/BRPL, wherever, necessary, the contractor/ bidder submit relevant designs and drawings for approval of employer, well in advance.

The scope of work for on-site warranty services will further include the following:
a) The Contractor will create provision for receiving and recording all complaints, attending the complaints, stocking essential spares, provisioning trained service personnel, recording monthly logs of all activities, etc.

b) During the 1 (one) year period, the repair works will have to be carried out at the premise except in exceptional circumstances where the equipment or any component may be required to be taken out for repair, for which specific written permission should be obtained from TERI. In such cases, standby arrangements are required to be made by Contractor so that the BESS remains in functional state. All products have valid product warranty and hence on-site repair and maintenance service needs to be provided after getting replenishment of spares from respective product manufacturer.

c) The contractor will be responsible for complete on-site warranty of the installed systems for period of one year. It is mandatory for the Contractor to have an authorized service center at Delhi-NCR.

d) All preventive & breakdown maintenance and repair activities associated with Battery Energy Storage System.

e) The Contractor shall provide to its service station all normal tools and testing equipment needed for maintenance of the station at its own cost.

f) Contractor shall keep one technically skilled person employed dedicatedly to three sites as mentioned in the tender. The technically skilled person has to remain in New Delhi and in case of absence of the person due to any unavoidable circumstances; a back-up skilled person must be employed by contractor.

11 SCOPE OF SUPPLY

Scope of supply shall be as per **BoM Table 10** .

12 GROUNDING / EARTHING

All metal enclosures, conduits, junction/pull boxes shall be grounded in compliance with I.E. rules. Separate ground Earthing shall be provided for the BESS system.

13 QUALITY Assurance & Implementation Plan

The Contractor shall establish, document and maintain an effective quality assurance program (A detailed quality plan related to different products such as batteries, BMS, EMS, etc. will be submitted after vendors has been finalized).
The Quality Assurance Program should be comprehensive and must include all aspects from battery design parameters, layout of all three sites with actual measurement, manufacturing to commissioning details/ and plans to trial run plan of systems with all technical specifications of the battery and associated equipment, Inspection Test Plan (ITP) or Factory Acceptance Test (FAT) details and disposal plan. The actual ITP and FAT specific details reports and battery disposal plan can be submitted within 10 working days of their execution.
Also the detailed battery disposable plan has to be submitted to TERI after vendor finalization and before delivery of the material at the site. In case, TERI allows sub-contracting to the contractor, technical specs, warranty and guarantee associated aspects and conditions must be shared with TERI as a part of quality assurance program. Approved quality assurance programme will form the basis of

all future inspections/ audits undertaken by TERI after the supply of materials and within the warranty coverage. TERI reserves the right to conduct the random quality check for the materials associated with BESS through third party intervention; however the cost shall be borne by TERI to conduct such test.

In-addition, validation test shall be performed after each routine/preventive maintenance in-order to ensure the proper functioning of the system and component replaced during maintenance, if any. Accordingly, validation certificate shall be signed by contractor and approved by TERI. In case of any deviations in quality or technical characteristics of battery and associated equipment from the conditions stated in the Specifications, the contractor shall re-ensure that all the deviations stand null within stipulated mutually agreed time period between TERI and contractor.

13.1 Inspection

a) The 'TERI', 'BRPL' or their representative shall have the right to anytime inspect and/or to test the goods to confirm their conformity to the Agreement. The special conditions of contract and/or the Technical specifications shall specify what inspections and test the 'TERI' required.

b) The 'TERI', 'BRPL' or their duly authorized representative shall have at all reasonable times access to the contractor premises or works and shall have the power at all reasonable time to inspect and examine the materials and workmanship of the works during its manufacturing or assembling stage.

c) The contractor shall give the 'TERI', 15 days prior written notice of any material being ready for testing. It shall be mandatory that such notice should reach 'TERI' within 120 days of placement of work order. Such tests shall be on the contractor's accounts/ expenses except for the expenses of the inspector. 'TERI' reserves the full rights, to waive off inspection of material.

d) The contractor is required to get the entire lot of the ordered material inspected , before the supply of the materials.

e) All arrangements for the inspection of materials will be done by contractor.

f) The inspection by 'TERI' and issue of dispatch instruction thereof shall in no way limit the liabilities and responsibilities of the contractor in respect of the agreed quality assurance programme forming a part of the contract

13.2 Replacement of rejected material:

Any material supplied against order placed on basis of this tender and found to be defective at any time during the project life on inspection or differing from approved samples or make or specifications will be replaced by the Contractor free of cost or full refund made for the amount paid by BHEL. The contractor must replace or repair any defective portion of the system; the contractor shall make such repair within 2 working days. of intimation and without any extra cost to TERI/ BRPL. The contractor shall address the issues within 2 working days and any replacements or renewals/replacements can be completed within 10 working days of intimation to the contractor.

13.3 Materials –Quality & Workmanship

i. Immediately on award of contract, the contractor shall submit a detailed project report along with valid external ISO audit report of the company and Implementation plan report within 20 working days having planning and testing strategy with provisions for quality check performance at various stages of the project. The report shall also furnish details of method of checking and inspection and acceptance standards / values.