बिड संख्या/Bid Number: GEM/2026/B/8215251
दिनांक /Dated: 06-11-2026

बिड दस्तावेज़ / Bid Document

बिड विवरण/Bid Details	
बिड बंद होने की तारीख/समय /Bid End Date/Time	27-11-2026 15:00:00
बिड खुलने की तारीख/समय /Bid Opening Date/Time	28-11-2026 15:00:00
बिड पेशकश वैधता (बंद होने की तारीख से)/Bid Offer Validity (From End Date)	180 (Days)
मंत्रालय/राज्य का नाम/Ministry/State Name	Ministry Of Railways
विभाग का नाम/Department Name	Railways Autonomous
संगठन का नाम/Organisation Name	Gati Shakti Vishwavidyalaya
कार्यालय का नाम/Office Name	Gati Shakti Vishwavidyalaya
शिकायत निवारण के संपर्क विवरण/ Contact details of Grievance redressal	HOD Email id :jitesh.thakkar@gov.in Buyer Email id: ar.purchase@gsv.ac.in
कुल मात्रा/Total Quantity	3
वस्तु श्रेणी /Item Category	ENGINEERING INTELLIGENCE AND DIGITAL TWIN PLATFORM WITH AI AND CYBER SECURITY FOR MICROGRID , MODULAR BATTERY AND BMS DEVELOPMENT PLATFORM , SMART AND PROGRAMMABLE HYBRID AC/DC MICROGRID WITH DISTRIBUTED RENEWABLE ENERGY SOURCES
GeMARPTS में खोजी गई स्ट्रिंग्स / Searched Strings used in GeMARPTS	SMART AND PROGRAMMABLE HYBRID AC/DC MICROGRID WITH DISTRIBUTED RENEWABLE ENERGY SOURCES
GeMARPTS में खोजा गया परिणाम / Searched Result generated in GeMARPTS	Category not available on GeM for the text string uploaded by the buyer
अधिसूचना के लिए चयनित प्रासंगिक श्रेणियाँ / Relevant Categories selected for notification	• LT Spacer
पिछले 3 वित्तीय वर्षों का बिडर का न्यूनतम औसत वार्षिक वित्तीय टर्नओवर/Minimum Average Annual Turnover of the bidder (For the last 3 Financial Years)	156 Lakh (s)
उन्हीं/समान सेवा के लिए अपेक्षित विगत अनुभव के वर्ष/Years of Past Experience Required for same/similar service	3 Year (s)
टर्नओवर पात्रता मानदंड/Turnover eligibility criteria	GeM verified turnover

बिड विवरण/Bid Details	
वर्षों के अनुभव एवं टर्नओवर से एमएसई को छूट प्राप्त है / **MSE Relaxation for Years Of Experience and Turnover**	Yes | Complete
स्टार्टअप के लिए अनुभव के वर्षों और टर्नओवर से छूट प्रदान की गई है / **Startup Relaxation for Years Of Experience and Turnover**	Yes | Complete
विक्रेता से मांगे गए दस्तावेज़/**Document required from seller**	Experience Criteria,Past Performance,Bidder Turnover,Certificate (Requested in ATC),OEM Authorization Certificate,Additional Doc 1 (Requested in ATC) *In case any bidder is seeking exemption from Experience / Turnover Criteria, the supporting documents to prove his eligibility for exemption must be uploaded for evaluation by the buyer
क्या आप निविदाकारों द्वारा अपलोड किए गए दस्तावेज़ों को निविदा में भाग लेने वाले सभी निविदाकारों को दिखाना चाहते हैं? संदर्भ मेनू है/**Do you want to show documents uploaded by bidders to all bidders participated in bid?**	Yes (Documents submitted as part of a clarification or representation during the tender/bid process will also be displayed to other participated bidders after log in)
बिड लगाने की समय सीमा स्वतः नहीं बढ़ाने के लिए आवश्यक बिड की संख्या। / **Minimum number of bids required to disable automatic bid extension**	3
दिनों की संख्या, जिनके लिए बिड लगाने की समय-सीमा बढ़ाई जाएगी। / **Number of days for which Bid would be auto-extended**	7
ऑटो एक्सटेंशन अधिकतम कितनी बार किया जाना है। / **Number of Auto Extension count**	1
विगत प्रदर्शन /**Past Performance**	50 %
बिड से रिवर्स नीलामी सक्रिय किया/**Bid to RA enabled**	Yes
रिवर्स नीलामी योग्यता नियम/**RA Qualification Rule**	H1-Highest Priced Bid Elimination
बिड का प्रकार/**Type of Bid**	Two Packet Bid
प्राथमिक उत्पाद श्रेणी/**Primary product category**	ENGINEERING INTELLIGENCE AND DIGITAL TWIN PLATFORM WITH AI AND CYBER SECURITY FOR MICROGRID
तकनीकी मूल्यांकन के दौरान तकनीकी स्पष्टीकरण हेतु अनुमत समय /**Time allowed for Technical Clarifications during technical evaluation**	2 Days
निरीक्षण आवश्यक (सूचीबद्ध निरीक्षण प्राधिकरण /जेम के साथ पूर्व पंजीकृत एजेंसियों द्वारा)/**Inspection Required (By Empanelled Inspection Authority / Agencies pre-registered with GeM)**	No
मूल्यांकन पद्धति/**Evaluation Method**	Group wise evaluation
वित्तीय दस्तावेज की आवश्यकता है / **Financial Document Required**	Yes

बिड विवरण/Bid Details	
मध्यस्थता खंड/Arbitration Clause	No
सुलह खंड/Mediation Clause	No

ईएमडी विवरण/EMD Detail

एडवाईजरी बैंक/Advisory Bank	State Bank of India
Schedule 1 ईएमडी राशि/EMD Amount (In INR)	278800
Schedule 2 ईएमडी राशि/EMD Amount (In INR)	110900

ईपीबीजी विवरण /ePBG Detail

एडवाइजरी बैंक/Advisory Bank	State Bank of India
ईपीबीजी प्रतिशत (%)/ePBG Percentage(%)	5.00
ईपीबीजी की आवश्यक अवधि (माह) /Duration of ePBG required (Months).	38

(a). जेम की शर्तों के अनुसार ईएमडी छूट के इच्छुक बिडर को संबंधित केटेगरी के लिए बिड के साथ वैध समर्थित दस्तावेज़ प्रस्तुत करने है। एमएसई केटेगरी के अंतर्गत केवल वस्तुओं के लिए विनिर्माता तथा सेवाओं के लिए सेवा प्रदाता ईएमडी से छूट के पात्र हैं। व्यापारियों को इस नीति के दायरे से बाहर रखा गया है।/EMD EXEMPTION: The bidder seeking EMD exemption, must submit the valid supporting document for the relevant category as per GeM GTC with the bid. Under MSE category, only manufacturers for goods and Service Providers for Services are eligible for exemption from EMD. Traders are excluded from the purview of this Policy.

(b). The EMD Amount will be applicable for each schedule/group selected during Bid creation.

(c).ईएमडी और संपादन जमानत राशि, जहां यह लागू होती है, लाभार्थी के पक्ष में होनी चाहिए। / EMD & Performance security should be in favour of Beneficiary, wherever it is applicable.

(d).ईएमडी और संपादन जमानत राशि लाभार्थी के पक्ष में होनी चाहिए। / Earnest Money Deposit (EMD) shall also be accepted by the buyer in the form of a surety bond.

लाभार्थी /Beneficiary :
VC
GATI SHAKTI VISHWAVIDYALAYA, Railways Autonomous, Gati Shakti Vishwavidyalaya, Ministry of Railways (Gati Shakti Vishwavidyalaya)

UIN Number NCTGC2415P

बोली विभाजन लागू नहीं किया गया/ Bid splitting not applied.

एमआईआई खरीद वरीयता / MII Purchase Preference

एमआईआई खरीद वरीयता / MII Purchase Preference	Yes

मेक इन इंडिया विक्रेताओं को खरीद में प्राथमिकता, यदि उनका मूल्य L1+X% तक की सीमा में है / Purchase Preference to MII sellers availabele upto price within L1+X%	20
मेक इन इंडिया खरीद में प्राथमिकता के लिए बिड की मात्रा का अधिकतम प्रतिशत / Maximum Percentage of Bid quantity for MII purchase preference	50
सार्वजनिक खरीद (मेक-इन-इंडिया को प्राथमिकता) आदेश 2017 के अनुसार केवल क्लास 1/क्लास 2 के स्थानीय आपूर्तिकर्ताओं को ही भागीदारी की अनुमति है दिनांक 16.09.2020 (समय-समय पर संशोधित एवं लागू) / Allow participation only from Class 1/Class 2 local suppliers as per the Public procurement(Preference to Make-in-india) order 2017 date 16.09.2020(as amended and applicable time to time)	Yes, in compliance with the MII ORDER : DPIIT Order(as amended and applicable time to time)

एमएसई खरीद वरीयता/MSE Purchase Preference

एमएसई खरीद वरीयता/MSE Purchase Preference	Yes
सूक्ष्म और लघु उद्यम मूल उपकरण निर्माताओं/सेवा प्रदाता को खरीद में प्राथमिकता, यदि उनका मूल्य L1+X% / Purchase Preference to MSE OEMs/ Service Provider available upto price within L1+X%	15
सूक्ष्म और लघु उद्यम मूल उपकरण निर्माता/सेवा प्रदाता को खरीद में प्राथमिकता के लिए बिड की मात्रा का अधिकतम प्रतिशत / Percentage of Bid quantity/amount for MSE OEMs/ Service Provider Purchase preference	25

1. If the bidder is a Micro or Small Enterprise as per latest orders issued by Ministry of MSME, the bidder shall be relaxed from the eligibility criteria of "Experience Criteria" as defined above subject to meeting of quality and technical specifications. The bidder seeking Relaxation from Experience Criteria, shall upload the supporting documents to prove his eligibility for Relaxation.
2. If the bidder is a Micro or Small Enterprise (MSE) as per latest orders issued by Ministry of MSME, the bidder shall be relaxed from the eligibility criteria of "Bidder Turnover" as defined above subject to meeting of quality and technical specifications. If the bidder itself is MSE OEM of the offered products, it would be relaxed from the "OEM Average Turnover" criteria also subject to meeting of quality and technical specifications. The bidder seeking Relaxation from Turnover, shall upload the supporting documents to prove his eligibility for Relaxation.
3. If the bidder is a DPIIT registered Startup, the bidder shall be relaxed from the the eligibility criteria of "Experience Criteria" as defined above subject to their meeting of quality and technical specifications. The bidder seeking Relaxation from Experience Criteria, shall upload the supporting documents to prove his eligibility for Relaxation.
4. If the bidder is a DPIIT registered Startup, the bidder shall be relaxed from the the eligibility criteria of "Bidder Turnover" as defined above subject to their meeting of quality and technical specifications. If the bidder is DPIIT Registered OEM of the offered products, it would be relaxed from the "OEM Average Turnover" criteria also subject to meeting of quality and technical specifications. The bidder seeking Relaxation from Turnover shall upload the supporting documents to prove his eligibility for Relaxation.
5. The minimum average annual financial turnover of the bidder during the last three financial years, ending on 31st March of the previous financial year, should be as indicated in the bid document. The turnover of the bidder shall be validated by the system based on the financial data available on the GeM portal. The average turnover shall be calculated based on the last three financial years where data is available; in case data is available for

only two of the last three financial years, the average shall be computed based on those two years. In case the date of constitution / incorporation of the bidder is less than three years old, the average turnover in respect of the completed financial years after the date of constitution / incorporation shall be taken into account for this criterion. No separate documentary evidence is required to be uploaded by the bidder for this criterion, as the system shall derive and validate the turnover figures from the data available on the GeM portal.
6. Experience Criteria: In respect of the filter applied for experience criteria, the Bidder or its OEM of the product offered in the bid {themselves or through reseller(s)} should have regularly, manufactured and supplied same or similar Category Products to any Central / State Govt Organization / PSU for number of Financial years as indicated above in the bid document before the bid opening date. Copies of relevant contracts and delivery acceptance certificates like CRAC to be submitted along with bid in support of having supplied some quantity during each of the Financial year. In case of bunch bids, the category of primary product having highest value should meet this criterion.
7. Preference to Make In India products (For bids < 200 Crore):Preference shall be given to Class 1 local supplier as defined in public procurement (Preference to Make in India), Order 2017 as amended from time to time and its subsequent Orders/Notifications issued by concerned Nodal Ministry for specific Goods/Products. The minimum local content to qualify as a Class 1 local supplier is denoted in the bid document. If the bidder wants to avail the Purchase preference, the bidder must upload a certificate from the OEM regarding the percentage of the local content and the details of locations at which the local value addition is made along with their bid, failing which no purchase preference shall be granted. In case the bid value is more than Rs 10 Crore, the declaration relating to percentage of local content shall be certified by the statutory auditor or cost auditor, if the OEM is a company and by a practicing cost accountant or a chartered accountant for OEMs other than companies as per the Public Procurement (preference to Make-in -India) order 2017 dated 04.06.2020. Only Class-I and Class-II Local suppliers as per MII order dated 4.6.2020 will be eligible to bid. Non - Local suppliers as per MII order dated 04.06.2020 are not eligible to participate. However, eligible micro and small enterprises will be allowed to participate .The buyers are advised to refer the OM No.F.1/4/2021-PPD dated 18.05.2023.
OM_No.1_4_2021_PPD_dated_18.05.2023 for compliance of Concurrent application of Public Procurement Policy for Micro and Small Enterprises Order, 2012 and Public Procurement (Preference to Make in India) Order, 2017 and its subsequent Orders/Notifications issued by concerned Ministry .Benefits of MSE will be allowed only if seller/service provider is validated on-line in GeM profile as well as validated and approved by Buyer after evaluation of documents submitted.

8. **Purchase preference to Micro and Small Enterprises (MSEs):** Purchase preference will be given to MSEs having valid Udyam Certificate and whose credentials are validated online through Udyam Registration portal as defined in Public Procurement Policy for Micro and Small Enterprises (MSEs) Order, 2012 dated 23.03.2012 issued by Ministry of Micro, Small and Medium Enterprises and its subsequent Orders/Notifications issued by concerned Ministry. If the bidder wants to avail themselves of the Purchase preference, the bidder must be the manufacturer / OEM of the offered product on GeM. In respect of bid for Services, the bidder must be the Service provider of the offered Service. Traders are excluded from the purview of Public Procurement Policy for Micro and Small Enterprises and hence resellers offering products manufactured by some other OEM are not eligible for any purchase preference. Relevant documentary evidence in this regard shall be uploaded along with the bid in respect of the offered product or service, and Buyer will decide eligibility for purchase preference based on documentary evidence submitted in case of product bids, whereas in case of services the eligibility is automatically validated. If L-1 is not an MSE and MSE Seller (s) has / have quoted price within L-1+ 15% (Selected by Buyer) of margin of purchase preference /price band defined in relevant policy, such MSE Seller shall be given opportunity to match L-1 price and contract will be awarded for 25% (selected by Buyer) percentage of total quantity. The buyers are advised to refer the OM_No.1_4_2021_PPD_dated_18.05.2023 for compliance of Concurrent application of Public Procurement Policy for Micro and Small Enterprises Order, 2012 and Public Procurement (Preference to Make in India) Order, 2017. Benefits of MSE will be allowed only if seller is validated on-line in GeM profile as well as validated and approved by Buyer after evaluation of documents submitted.
9. Estimated Bid Value indicated above is being declared solely for the purpose of guidance on EMD amount and for determining the Eligibility Criteria related to Turn Over, Past Performance and Project / Past Experience etc. This has no relevance or bearing on the price to be quoted by the bidders and is also not going to have any impact on bid participation. Also this is not going to be used as a criteria in determining reasonableness of quoted prices which would be determined by the buyer based on its own assessment of reasonableness and based on competitive prices received in Bid / RA process.
10. Past Performance: The Bidder or its OEM {themselves or through re-seller(s)} should have supplied same or similar Category Products for 50% of bid quantity, in at least one of the last three Financial years before the bid opening date to any Central / State Govt Organization / PSU. Copies of relevant contracts (proving supply of cumulative order quantity in any one financial year) to be submitted along with bid in support of quantity supplied in the relevant Financial year. In case of bunch bids, the category related to primary product having highest bid value should meet this criterion.

11. Reverse Auction would be conducted amongst all the technically qualified bidders except the Highest quoting bidder. The technically qualified Highest Quoting bidder will not be allowed to participate in RA. However, H-1

will also be allowed to participate in RA in following cases:

i. If number of technically qualified bidders are only 2 or 3.
ii. If Buyer has chosen to split the bid amongst N sellers, and H1 bid is coming within N.
iii. In case Primary product of only one OEM is left in contention for participation in RA on elimination of H-1.
iv. If L-1 is non-MSE and H-1 is eligible MSE and H-1 price is coming within price band of 15% of Non-MSE L-1
v. If L-1 is non-MII and H-1 is eligible MII and H-1 price is coming within price band of 20% of Non-MII L-1

एक्सेल में अपलोड किए जाने की आवश्यकता /Excel Upload Required :

Price Breakup (To be uploaded on Financial Bid only) - 1793341237.xlsx

Evaluation Method (Group Wise Evaluation Method)

Contract will be awarded schedulewise and the determination of L1 will be done separately for each schedule. The details of item-consignee combination covered under each schedule are as under:

Evaluation Schedules	Item/Category	Consignee/Reporting Officer	Consignee Address	Quantity
Schedule 1	Smart And Programmable Hybrid Ac/dc Microgrid With Distributed Renewable Energy Sources	Madeti Siva Rama Krishna	LAL BAUG, VADODARA 390004	1
	Engineering Intelligence And Digital Twin Platform With Ai And Cyber Security For Microgrid	Madeti Siva Rama Krishna	LAL BAUG, VADODARA 390004	1
Schedule 2	Modular Battery And Bms Development Platform	Madeti Siva Rama Krishna	LAL BAUG, VADODARA 390004	1

ENGINEERING INTELLIGENCE AND DIGITAL TWIN PLATFORM WITH AI AND CYBER SECURITY FOR MICROGRID (1 set)

(क्रमशः श्रेणी 1 और श्रेणी 2 के स्थानीय आपूर्तिकर्ता के रूप में अर्हता प्राप्त करने के लिए आवश्यक/Minimum 50% and 20% Local Content required for qualifying as Class 1 and Class 2 Local Supplier respectively)

तकनीकी विशिष्टियाँ /Technical Specifications

क्रेता विशिष्टि दस्तावेज़ /Buyer Specification Document	Download

परेषिती/रिपोर्टिंग अधिकारी तथा मात्रा/Consignees/Reporting Officer and Quantity

क्र.सं./S.No.	परेषिती/रिपोर्टिंग अधिकारी /Consignee Reporting/Officer	पता/Address	मात्रा /Quantity	डिलीवरी के दिन/Delivery Days
1	Madeti Siva Rama Krishna	390004,LAL BAUG, VADODARA	1	60

MODULAR BATTERY AND BMS DEVELOPMENT PLATFORM (1 set)

(क्रमशः श्रेणी 1 और श्रेणी 2 के स्थानीय आपूर्तिकर्ता के रूप में अर्हता प्राप्त करने के लिए आवश्यक/Minimum 50% and 20% Local Content required for qualifying as Class 1 and Class 2 Local Supplier respectively)

तकनीकी विशिष्टियाँ /Technical Specifications

क्रेता विशिष्टि दस्तावेज़ /Buyer Specification Document	Download

परेषिती/रिपोर्टिंग अधिकारी तथा मात्रा/Consignees/Reporting Officer and Quantity

क्र.सं./S.No.	परेषिती/रिपोर्टिंग अधिकारी /Consignee Reporting/Officer	पता/Address	मात्रा /Quantity	डिलीवरी के दिन/Delivery Days
1	Madeti Siva Rama Krishna	390004,LAL BAUG, VADODARA	1	60

SMART AND PROGRAMMABLE HYBRID AC/DC MICROGRID WITH DISTRIBUTED RENEWABLE ENERGY SOURCES (1 set)

(क्रमशः श्रेणी 1 और श्रेणी 2 के स्थानीय आपूर्तिकर्ता के रूप में अर्हता प्राप्त करने के लिए आवश्यक/Minimum 50% and 20% Local Content required for qualifying as Class 1 and Class 2 Local Supplier respectively)

तकनीकी विशिष्टियाँ /Technical Specifications

क्रेता विशिष्टि दस्तावेज़ /Buyer Specification Document	Download

परेषिती/रिपोर्टिंग अधिकारी तथा मात्रा/Consignees/Reporting Officer and Quantity

क्र.सं./S.No.	परेषिती/रिपोर्टिंग अधिकारी /Consignee Reporting/Officer	पता/Address	मात्रा /Quantity	डिलीवरी के दिन/Delivery Days
1	Madeti Siva Rama Krishna	390004,LAL BAUG, VADODARA	1	60

क्रेता द्वारा जोड़ी गई बिड की विशेष शर्तें/Buyer Added Bid Specific Terms and Conditions

1. **Generic**

   OPTION CLAUSE: The Purchaser reserves the right to increase or decrease the quantity to be ordered up to 25 percent of bid quantity at the time of placement of contract. The purchaser also reserves the right to

increase the ordered quantity up to 25% of the contracted quantity during the currency of the contract at the contracted rates. The delivery period of quantity shall commence from the last date of original delivery order and in cases where option clause is exercised during the extended delivery period the additional time shall commence from the last date of extended delivery period. The additional delivery time shall be (Increased quantity ÷ Original quantity) × Original delivery period (in days), subject to minimum of 30 days. If the original delivery period is less than 30 days, the additional time equals the original delivery period. The Purchaser may extend this calculated delivery duration up to the original delivery period while exercising the option clause. Bidders must comply with these terms.

2. **Generic**

   Actual delivery (and Installation & Commissioning (if covered in scope of supply)) is to be done at following address

   Gati Shakti Vishwavidyalaya
   Lalbaug
   Vadodara
   Gujarat
   Pincode - 390004
   .

3. **Generic**

   Bidder financial standing: The bidder should not be under liquidation, court receivership or similar proceedings, should not be bankrupt. Bidder to upload undertaking to this effect with bid.

4. **Generic**

   Manufacturer Authorization: Wherever Authorised Distributors/service providers are submitting the bid, Authorisation Form /Certificate with OEM/Original Service Provider details such as name, designation, address, e-mail Id and Phone No. required to be furnished along with the bid

5. **Generic**

   Data Sheet of the product(s) offered in the bid, are to be uploaded along with the bid documents. Buyers can match and verify the Data Sheet with the product specifications offered. In case of any unexplained mismatch of technical parameters, the bid is liable for rejection.

6. **Generic**

   1. The Seller shall not assign the Contract in whole or part without obtaining the prior written consent of buyer.
   2. The Seller shall not sub-contract the Contract in whole or part to any entity without obtaining the prior written consent of buyer.
   3. The Seller shall, notwithstanding the consent and assignment/sub-contract, remain jointly and severally liable and responsible to buyer together with the assignee/ sub-contractor, for and in respect of the due performance of the Contract and the Sellers obligations there under.

7. **Generic**

   Bidders are advised to check applicable GST on their own before quoting. Buyer will not take any responsibility in this regards. GST reimbursement will be as per actuals or as per applicable rates (whichever is lower), subject to the maximum of quoted GST %.

8. **Service & Support**

   Availability of Service Centres: Bidder/OEM must have a Functional Service Centre in the State of each Consignee's Location in case of carry-in warranty. (Not applicable in case of goods having on-site warranty). If service center is not already there at the time of bidding, successful bidder / OEM shall have to establish one within 30 days of award of contract. Payment shall be released only after submission of documentary evidence of having Functional Service Centre.

9. **Past Project Experience**

The Bidder / OEM {themselves or through reseller(s)}, should have executed project for supply and installation / commissioning of same or similar Category Products during preceding 3 financial years (i.e. current year and three previous financial years) as on opening of bid, as per following criteria:

(i) Single order of at least 35% of estimated bid value; or
(ii) Two orders of at least 20% each of estimated bid value; or
(iii) Three orders of at least 15% each of estimated bid value.
Satisfactory Performance certificate issued by respective Buyer Organization for the above Orders should be uploaded with bid. In case of bunch bids, the Category related to primary product having highest bid value should meet this criterion

10. **OEM**

IMPORTED PRODUCTS: In case of imported products, OEM or Authorized Seller of OEM should have a registered office in India to provide after sales service support in India. The certificate to this effect should be submitted.

11. **Warranty**

Warranty period of the supplied products shall be 3 years from the date of final acceptance of goods or after completion of installation, commissioning & testing of goods (if included in the scope of supply), at consignee location. OEM Warranty certificates must be submitted by Successful Bidder at the time of delivery of Goods. The seller should guarantee the rectification of goods in case of any break down during the guarantee period. Seller should have well established Installation, Commissioning, Training, Troubleshooting and Maintenance Service group in INDIA for attending the after sales service. Details of Service Centres near consignee destinations are to be uploaded along with the bid.

12. **Certificates**

Bidder's offer is liable to be rejected if they don't upload any of the certificates / documents sought in the Bid document, ATC and Corrigendum if any.

13. **Forms of EMD and PBG**

Bidders can also submit the EMD with Account Payee Demand Draft in favour of

Gati Shakti Vishwavidyalaya
payable at
Vadodara
.
Bidder has to upload scanned copy / proof of the DD along with bid and has to ensure delivery of hardcopy to the Buyer within 5 days of Bid End date / Bid Opening date.

14. **Forms of EMD and PBG**

Successful Bidder can submit the Performance Security in the form of Fixed Deposit Receipt also (besides PBG which is allowed as per GeM GTC). FDR should be made out or pledged in the name of

Gati Shakti Vishwavidyalaya
A/C (Name of the Seller). The bank should certify on it that the deposit can be withdrawn only on the demand or with the sanction of the pledgee. For release of Security Deposit, the FDR will be released in favour of bidder by the Buyer after making endorsement on the back of the FDR duly signed and stamped along with covering letter. Successful Bidder has to upload scanned copy of the FDR document in place of PBG and has to ensure delivery of hard copy of Original FDR to the Buyer within 15 days of award of contract.

15. **Buyer Added Bid Specific ATC**

Buyer Added text based ATC clauses

Additional Terms and Conditions

1) Purchase Orders of reputed Institutions to be submitted for similar products.

2) Client Contact List of similar products are to be submitted.

3) A satisfactory physical demonstration of the offered product at GSV, or an online demonstratio n of the same or a similar product, shall be provided to qualify for the Technical Bid evaluation.

4) Bidder should submit GST, PAN and Registration Certificate

5) Manufacturer Authorization Letter is required

6) Purchase Orders of OEM/Bidder of similar equipment along with installation report supplied in I ITs/NITS/CFTIs/Central University must be submitted.

7) Manufacturer/Bidder should have ISO Certification.

8) Original Catalogue of the equipment's are required otherwise quotation my not be considered.

9) Technical Compliance Sheet is required.

10) Bidder must submit a signed undertaking to provide an online/offline product demonstration a t GSV for technical evaluation.

11) Bidder/OEM shall provide service/maintenance/repair whenever required on GSV campus.

DECLARATION-CUM-UNDERTAKING
FOR ACCEPTANCE OF TENDER TERMS AND CONDITIONS

(To be submitted on the Letter Head along with the Technical Bid)

Tender/Bid No.: _____

Name of Bidder: _____

I/We hereby declare and undertake that:

a) I/We have carefully read and understood the complete Tender Document, including Scope of Work/Supp ly, ATC, specifications, terms & conditions, annexures, schedules and all other applicable documents.

b) I/We hereby unconditionally accept all the terms and conditions of the Tender Document, including ATC, Corrigenda/Addenda/Amendments, if any.

c) I/We confirm that all pages of the Tender Document, including ATC and applicable annexures, have bee n duly ink-signed and stamped by the Authorized Signatory and the same are submitted/uploaded along wi th the bid.

d) I/We confirm that no deviation, condition or reservation has been made against any term or condition of the tender and undertake to abide by all the tender conditions and the resultant contract, if awarded.

e) I/We undertake that the information furnished in this tender is true and correct in all respects, and I/We shall be responsible for the same.

f) I/We shall be responsible for rejection/cancellation of the contract if the services/end products supplied are not found satisfactory or are sub-standard or not in accordance with the required specifications/approv ed sample/pre-inspection. I/We shall also be liable for any civil/criminal proceedings arising therefrom, as applicable.

g) I/We confirm that the Technical Compliance Sheet has been duly filled in and submitted along with the T

echnical Bid, indicating compliance with the technical specifications/requirements of the Tender Document . I/We undertake that the goods/products/services offered shall strictly conform to the prescribed specificat ions, technical details and quality requirements. In case of any deviation or non-conformity, the Buyer shal l have the right to reject the same at any stage**.**

Signature of Authorized Signatory: _____

Name: _____

Designation: _____

Name of Firm/Company: _____

Date: _____

Place: _____

Seal of the Bidder

DECLARATION-CUM-UNDERTAKING FOR CLAIMING MSE BENEFITS
(To be submitted on the Letter Head along with the Technical Bid)

Tender/Bid No.: _____

Name of Bidder:_____

Name of the OEM:_____

Udyam Registration No.: _____

I/We hereby declare and undertake that:

a) I/We am/are a Micro or Small Enterprise (MSE) duly registered under Udyam Registration.

b) (i) In case of procurement of goods, I/We confirm that I/We am/are the manufacturer/producer/OEM of th e product(s) offered against this tender and am/are not merely acting as a dealer, distributor, reseller, trad er or agent of the OEM/Brand of the offered product(s).

(ii) In case of procurement of services, I/We confirm that I/We am/are the service provider of the services offered against this tender and am/are not merely acting as an agent/intermediary/trader for the offered s ervices.

c) The details of the product(s) offered/services provided by me/us are as under:

Sl. No .	**Make/Brand of Product Offe red / Details of Offered Ser vices**	**Model No. (if a pplicable)**	**Product Descriptio n / Details of Servi ces**	**Relevant NIC Co de(s)**
1.				
2.				
3.				

d) I/We confirm that the NIC Code(s) mentioned above are relevant and applicable to the product/service c ategory offered by me/us.

e) I/We understand that failure to submit the requisite product/service details and applicable NIC Code(s) s hall render me/us ineligible for MSE benefits, and no claim or clarification in this regard shall be entertaine d at any later stage.

f) I/We further undertake that the information and documents submitted in support of my/our claim for MS E benefits are true, correct and complete.

Signature of Authorized Signatory: _____

Name: _____

Designation: _____

Name of Firm/Company: _____

Date: _____

Place: _____

Seal of the Bidder

Annexure 2: Make-in-India Declaration Certificate

(In compliance to the Public Procurement (Preference to Make-in-India) Order 2017 issued by Department of Promotion of Industry and Internal Trade (Public Procurement Section), Ministry of Commerce and Indust ry, Government of India, dated 16.06.2020, 04.03.2021 & 19.07.2024 (as amended).

TO WHOMSOEVER IT MAY CONCERN

M/s.....certifies that the following component wise breakup indicated below is in line with the Make in India policy with respect to the value addition to the total price quoted by us against this GeM Bid No.....

M/s.....also solemnly declare that component wise breakup given below are true and correct and understand that “false declarations will be breach of Code of Integrity under Rule 175(1)(i)(h) of Gene ral Financial Rule (GFR) for which a bidder or its successors can be debarred for up to two years as per Rul e 151 (iii) of the General Financial Rules along with such other actions as may be permissible under law”.

M/s.....also solemnly declare and understand that incase the given “data does not meet the stipulated Local content requirement and the category of the supplier changes from Class 1 to Class 2/Non -Local or from Class 2 to Non-Local, a penalty up to 10% on the contract value may be imposed”.

Sl. No .	Name of the item	Name of the manufacturer	Country of origin	% value to th e total cost	Location(s) and address at which the local value addition is made
1.					
2.					
3.					

4.					
Total value (in %) to the total cost					

Note: Points to be noted while certifying the declaration:

i.For item(s) sold by Bidder as Re-seller, OEM Certificate for country of origin is to be submitted.

ii.Supply of Re-packaged/Re-furbished/Re-branded “IMPORTED” product should be treated as “Re-selling of imported products” and must not be included while calculation of Local content.

iii.Services such as Transportation, Insurance, Installation, Commissioning, Training and after sales service support like AMC/CMC, etc. must not be included as Local content.

iv. All item(s) under PLI Scheme shall be treated as deemed Class II Local supplier for that item(s) unless t hey have minimum local content equal to or higher than that notified for Class I Local supplier for that item .

v.In case of procurement value in excess of Rs 10 Cr, the supplier shall required to provide a certificate fro m the statutory auditor or cost auditor of the company (in the case of companies) or from a practicing cost accountant or practicing charter accountant (in respect of suppliers other than companies) giving the perc entage of Local content.

I/We hereby declare that all the details furnished above are true. If any information is found incorrect as pe r points mentioned above, then I agree to actions as per Rule of GFR mentioned above.

Date :

Place :

(Signature of authorized

signatory of the Bidder/

Supplier with stamp)

Annexure 3 GFR -144 (xi) Compliance Certificate (in the letterhead)

Tender No.:

GFR-144 (xi) compliance certificate as per the latest GOI.

I have read the clauses regarding restrictions under GFR 144(XI) on procurement from a bidder of a countr y which shares a land border with India.

I certify that ....., the vendor is not such a country is from a country and has been regist ered with a competent authority (attached evidence of valid registration)

(tick mark the above option whichever is applicable)

I hereby certify that we fulfill all requirement in this regard and is eligible to be considered for the procure ment on CPP portal / GeM.

Thanking you

Authorized Signatory with seal

Encl.: Copy of the proof documents.

Non-Blacklisting Declaration Certificate

(On company letterhead)

To
GSV

Sub.: Declaration regarding Non-Blacklisting/Debarring for taking part in the tender.

Dear Sir,

I/We_____Firm/Contractor/Manufacturer/Partner(s)/Authorized Distributor/agent hereby declare that the firm/company namely M/s._____has not been blacklisted or debarred by Union / State Government /Autonomous organizations/ universities from taking part in tenders in India.

I/We further declare that **M/s. _____** is not under liquidation, court receivership, or any similar proceedings and is not bankrupt.

In case the above information is found false I/we are fully aware that the tender/ contract will be rejected /canceled and EMD/ Performance Security shall be forfeited.

In addition to the above, GSV shall not be responsible to pay the bills for any completed / partially completed work.

[Name, Signature& Seal] for and on behalf of M/s. _____

Note: This letter of shall be on the letterhead of the company and shall be signed by a person competent and having the power of attorney to bind the company/firm.

Date :

Place : (Signature of authorized signatory of the Bidder/ Supplier with stamp)

General Terms & Conditions

Indemnity: The Contractor shall indemnify the University against any loss, damage, claim, liability, cost, or expense arising out of the performance of the contract/tender including

i. Damage to property;
ii. Injury to or death of any person; and
iii. Negligence, breach of contract, or statutory non-compliance by the Contractor, its personnel or subcontractors

Disclaimers and Rights of Buyer Department: The issue of the Tender/ Bid Document does not imply that the Buyer Department is bound to select any bid(s). The Buyer Department reserves the right without assigning any reason to:

i. Reject any or all bids, or
ii. Cancel the tender process; or
iii. Issue a fresh tender for the same or similar products.

Termination of Contract: GSV reserves the right to terminate the contract by written notice in the event of breach of contract/tender terms and conditions, persistent unsatisfactory performance, fraudulent activi ty by the contractor/seller.

Dispute Resolution: Disputes arising out of or in connection with the tender/contract shall be resolved in accordance with the applicable contractual dispute resolution procedure and the Arbitration and Conciliatio n Act, 1996, as amended. For GeM procurements, the applicable GeM dispute-resolution provisions shall b e followed. The seat and venue of the arbitration shall be Vadodara, Gujarat. All legal proceedings arising o ut of or in connection with the tender/contract shall be subject to the jurisdiction of the competent courts a t Vadodara, Gujarat, only.

Penalties & Liquidated Damages: In the event of delay in delivery, installation, commissioning, or com pletion of the work beyond the stipulated delivery/completion period, Liquidated Damages (LD) shall be levied at the rate of 0.5% of the contract value per week or part thereof, subject to a maximum ceiling of 1 0% of the total contract value, which shall be recovered without any notice from the pending bills. Even wh ere the delay is attributable to only a portion of the supply/work, including partial or part supply, installatio n, testing or commissioning, LD shall be calculated on the total contract value.

Statutory Compliance: The Contractor shall obtain, maintain, and comply with all statutory approvals, re gistrations, obligations and compliances, including but not limited to:

i. Labour license, Insurance, and compliance with applicable wage law, wherever required
ii. GST, EPF, and ESI registrations and statutory compliances, wherever applicable
iii. Approvals from local authorities, wherever required
iv. Fire Safety and other applicable health, safety and Environmental compliance certificates, wh erever required

Inspection and Acceptance: All materials, equipment, and components supplied or used shall be brand new, unused, and conform to the specifications and applicable standards prescribed in the tender. GSV res erves the right to inspect the goods, services or work at any stage. Final acceptance shall be subject to sat isfactory completion of delivery, installation, testing, and commissioning in accordance with the tender spe cifications.

No Conditional Offers: Conditional offers or quotations will not be accepted.

Subletting: Subletting or assignment of the contract, in whole or in part, shall not be permitted without pr ior written approval of GSV.

Service Through Third Party in Case of Delay: If the Seller fails to rectify the defect within the stipulated time after being notified, the Buyer shall have the right to get the repair or service carried out through a third party.

a) Any expenditure incurred by the Buyer for such third-party repair or service shall be entirely borne by the Seller, without affecting or limiting the Seller's warranty obligations.

b) The Seller shall reimburse the Buyer for such expenses within the time period specified by the Buyer.

Continuity of Warranty: Availing repair or service through a third party due to the Seller's failure or delay shall not result in cancellation, reduction, or invalidation of the warranty. The Seller shall remain fully responsible for all warranty obligations for the remaining warranty period.

Earnest Money Deposit (EMD)

The Bidder has to upload a scanned copy/proof of the EMD along with the bid and ensure delivery of the original hard copy to the Buyer within five days of the Bid End Date or the Bid Opening Date at the following address:

The Store and Purchase Section,

Room No. #11, Palace Building,

Gati Shakti Vishwavidyalaya,

Lalbaugh, Vadodara, Gujarat – 390004.

Performance Bank Guarantee (PBG)

The Successful Bidder has to upload a copy/proof of the PBG and ensure delivery of the original hard copy of the PBG to the Buyer within 15 days of the award of the contract at the following address:

The Store and Purchase Section,

Room No. #11, Palace Building,

Gati Shakti Vishwavidyalaya,

Lalbaugh, Vadodara, Gujarat – 390004.

It is hereby acknowledged that I have read and understood the entire tender document, including the terms and conditions mentioned therein, and agree to abide by them.

Date: **Signature of the Bidder with Name and Seal**

Place:

Note: Delivery, Installation and Commissioning: The scope of work shall include delivery, installation and commissioning of the product at the designated location. In case of delay in delivery, installation and/ or commissioning beyond the delivery schedule specified in the original Contract Order under the head **"D elivery To Be Completed By"**, LD shall be imposed, as per the terms of the tender/contract, until compl etion of delivery, installation and commissioning of the product in satisfactory condition.

.

16. **Buyer Added Bid Specific ATC**

    Buyer uploaded ATC document Click here to view the file.

17. **Generic**

    Buyer Organization specific Integrity Pact shall have to be complied by all bidders. Bidders shall have to upload scanned copy of signed integrity pact as per Buyer organizations policy along with bid. Click here to view the file

अस्वीकरण/Disclaimer

The Additional Terms and Conditions (ATC) have been incorporated by the Buyer after approval of their Competent Authority. The Buyer ,is solely responsible for the impact of these clauses on the bidding process, its outcome, and consequences thereof including any restriction arising in the bidding process due to these ATCs and including the modification of technical specifications and / or terms and conditions governing the bid.All representations / grievances pertaining to the ATC clauses shall be raised with the buyer organization directly and not with GeM.If any of the clause(s) is/are incorporated by the Buyer regarding the following, the bid & resultant contract shall be treated as null & void. Further, GeM reserves the right, at its sole discretion, to cancel the bid forthwith, without issuance of any prior notice or intimation :-

1. Publishing Custom / BOQ bids for items for which regular GeM categories are available (unless such Custom / BOQ item is bunched with the major regular product Category Item).
2. Mandating procurement of / from specific Brand / Make / Model / Manufacturer / Dealer except in case of Single Bid / Proprietary Article Certificate (PAC) Buying.
3. Inclusion of disqualification criteria related to suspension of seller / service provider, where such suspension period has already expired.
4. Mandating submission of documents (other than EMD and signed Integrity Pact - which can be submitted within 5 days of bid opening) in physical form as a pre-requisite to qualify bidders.
5. Publishing bids on GeM for procurement of works.
6. Procurement of Goods by creating a Service bid on GeM & vice-versa.
7. Seeking sample with bid or approval of samples during bid evaluation process. However, trial / sample, as the case may be, shall be permitted in cases where trial / sample are allowed as per approved and published procurement policy of the Buyers' controlling Ministry / Department / State / Public Sector Enterprises Headquarters. If there is any violation of trial / sample clause with regard to approved policy of the Buyers' Ministry / Department / State / Public Sector Enterprises Headquarters, then this is to be determined and redressed by the concerned Buyer Organisation only.
8. Seeking experience from specific organization / department / institute only or from foreign / export experience.
9. Creating bid for items from incorrect categories.
10. Reference of conditions published on any external site or reference to external documents/clauses.
11. Asking for any Tender fee / Bid Participation fee, as the case may be.
12. Buyer added ATC Clauses which are in contravention of clauses defined in bid detail section, including specifications, EMD Detail, ePBG Detail and MII and MSE Purchase Preference sections of the bid, unless otherwise allowed by the applicable GeM GTC.
13. Any ATC clause in contravention with GeM GTC Clause 4 (xiii) (h) will be invalid. In case of multiple L1 bidders against a service bid, the buyer shall place the Contract by selection of a bidder amongst the L-1

bidders through a Random Algorithm executed by GeM system.

14. In a category based bid, adding additional items, through buyer added, additional scope of work/ additional terms and conditions/or any other document. If buyer needs more items along with the main item, the same must be added through bunching category based items or by bunching custom catalogues or bunching a BoQ with the main category based item, the same must not be done through ATC or Scope of Work.

Further, if any seller has any objection/grievance against these additional clauses or otherwise on any aspect of this bid, they can raise their representation against the same by using the Representation window provided in the bid details field in Seller dashboard after logging in as a seller. Buyer is duty bound to reply to all such representations and would not be allowed to open bids if he fails to reply to such representations.

All GeM Sellers/Service Providers shall ensure full compliance with all applicable labour laws, including the provisions, rules, schemes and guidelines under the four Labour Codes i.e. the Code on Wages, 2019; the Industrial Relations Code, 2020; the Occupational Safety, Health and Working Conditions Code, 2020; and the Code on Social Security, 2020 as and when notified and brought into force by the Government of India.

For all provisions of the Labour Codes that are pending operationalisation through rules, schemes or notifications, the corresponding provisions of the pre-existing labour enactments (such as The Minimum Wages Act, 1948, The Payment of Wages Act, 1936, The Payment of Bonus Act, 1965, The Equal Remuneration Act, 1976, The Payment of Gratuity Act, 1972, etc. and relevant State Rules) shall continue to remain applicable.

The Seller/ Service Providers shall, therefore, be responsible for ensuring compliance under:

- **All notified and enforceable provisions of the new Labour Codes as mentioned hereinabove; and**
- **All operative provisions of the erstwhile Labour Laws until their complete substitution.**

All obligations relating to wages, social security, safety, working conditions, industrial relations etc. and any other statutory requirements shall be strictly met by the Seller/ Service Provider. Any non-compliance shall constitute a breach of the contract and shall entitle the Buyer to take appropriate action in accordance with the contract and applicable law.

This Bid is governed by the General Terms and Conditions, conditions stipulated in Bid and Service Level Agreement specific to the Service, as the case may be, as provided in the Marketplace.

However, in case of Service, if any condition specified in General Terms and Conditions is contradicted by the conditions stipulated in Service Level Agreement specific to said Service, then it will over-ride the conditions in the General Terms and Conditions.

यह बिड सामान्य शर्तों के अंतर्गत भी शासित है /This Bid is also governed by the General Terms and Conditions

जेम की सामान्य शर्तों के खंड 26 के संदर्भ में भारत के साथ भूमि सीमा साझा करने वाले देश के बिडर से खरीद पर प्रतिबंध के संबंध में भारत के साथ भूमि सीमा साझा करने वाले देश का कोई भी बिडर इस निविदा में बिड देने के लिए तभी पात्र होगा जब वह बिड देने वाला सक्षम प्राधिकारी के पास पंजीकृत हो।बिड में भाग लेते समय बिडर को इसका अनुपालन करना होगा और कोई भी गलत घोषणा किए जाने व इसका अनुपालन न करने पर अनुबंध को तत्काल समाप्त करने और कानून के अनुसार आगे की कानूनी कार्रवाई का आधार होगा।/In terms of GeM GTC clause 26 regarding Restrictions on procurement from a bidder of a country which shares a land border with India, any bidder from a country which shares a land border with India will be eligible to bid in this tender only if the bidder is registered with the Competent Authority. While participating in bid, Bidder has to undertake compliance of this and any false declaration and non-compliance of this would be a ground for immediate termination of the contract and further legal action in accordance with the laws.

---धन्यवाद/Thank You---

Price Breakup	
(To be uploaded on GeM in financial bid only)	
Description of Item	**Amount (in ₹) inclusive of GST**
1. SMART AND PROGRAMMABLE HYBRID AC/DC MICROGRID WITH DISTRIBUTED RENEWABLE ENERGY SOURCES	
Renewable Energy Microgrid	
WIND TURBINE EMULATOR -2 kW	
SOLAR PV EMULATOR – 2kW	
REGENERATIVE GRID SIMULATOR – 9KVA	
5KW FUEL CELL SIMULATOR	
LFP BATTERY BANK — DUAL-ROLE STORAGE & VOLTAGE REFERENCE	
GRID INTERFACE — THREE-PHASE VSI & TRANSFORMER	
PROGRAMMABLE LOADS	
EV Mobility Platform	
TRACTION BATTERY PACK	
TRACTION BATTERY BIDIRECTIONAL CONVERTER — G2V & V2G INTERFACE	
ULTRACAPACITOR & BIDIRECTIONAL CONVERTER — MOTOR TRANSIENT SUPPORT	
PMSM TRACTION MOTOR & MOTOR CONTROLLER	
PMDC LOADING MACHINE & INSTRUMENTATION	
ONBOARD CHARGER (OBC) & EVSE — AC SLOW CHARGING PATH	
DATA ACQUISITION & SOFTWARE	
Additional components and interconnection support	
Measurement Systems	Additional components and interconnection support for integrating all the above equipment into a smart, programmable hybrid AC/DC microgrid with distributed renewable energy sources (cost included in the above modules)
Control Systems	
Operator Console and Visualisation	
Research-Grade Architecture and Independent Operation	
DC Bus and DC/DC Converter	
Research Interface, Measurement and Communication	
Safety, Acceptance Test and Documentation	
2. ENGINEERING INTELLIGENCE AND DIGITAL TWIN PLATFORM WITH AI AND CYBERSECURITY FOR MICROGRID	
Total Amount inclusive of GST	

Price Breakup	
(To be uploaded on GeM in financial bid only)	
Description of Item	**Amount (in ₹) inclusive of GST**
Battery Cycler Integrated with Data Analytics	
Cell Voltage Manager	
Cell Sorting Manager	
Battery Cycler with Data Analytics	
BMS Development and Validation System	
Environmental Chamber with thermal camera	
Handheld Thermal Imaging Camera	
Environmental Chamber	
Additional components and interconnection support	
Central Controller and User Interface	Additional components and interconnection support for interconnecting Battery and BMS platform (cost included in the above battery modules)
Operator Control and Visualization	
Battery Testing Safety	
Fault Test Demonstration and Documentation	
Total Amount Inclusive of GST	

Technical Specification

1. ENGINEERING INTELLIGENCE AND DIGITAL TWIN PLATFORM WITH AI AND CYBERSECURITY FOR MICROGRID

The proposed system shall be a modular, open and research-oriented platform. Each major equipment/subsystem shall be capable of independent standalone operation using its dedicated local control, measurement, switching/isolation and protection system. The same equipment shall also be capable of integrated operation with the common microgrid/EMS/controller. In addition, suitable interfaces shall be provided for connection of external/user-developed controllers, algorithms and measurement systems. The central supervisory computer, LabVIEW software or communication network shall not constitute a single point of failure for the safe operation and protection of individual equipment. Critical electrical and safety protections shall remain functional independently of the supervisory software and communication network."

Vendor must also submit the following before supply:

1. Detailed electrical single-line diagram.
2. Control architecture/block diagram.
3. Individual equipment control architecture.
4. Protection architecture.
5. Switching/isolation architecture.
6. Communication architecture.
7. Complete I/O list.
8. External controller interface details.
9. List of all hardware protections.
10. List of all software protections.
11. Source-code access statement.
12. Compliance matrix against every specification.
13. FAT/SAT procedure.
14. Demonstration of standalone + integrated + external-controller operation of each major subsystem.

A. Specifications

S. No.	Item / Module	Minimum Technical Specification	Qty.

1	**System Overview**	The system shall be an Engineering Intelligence and Digital Twin Platform integrating • AI-assisted Energy Management, • Cybersecurity and • a physics-based Digital Twin • with a live cyber-physical energy/mobility platform. The three layers shall operate as an interconnected system.	1
2	**Control Platform**	NI sbRIO-based LabVIEW platform with Shared Variables	1
3	**AI-Assisted Energy Management System (AI-EMS)**	AI-EMS shall operate as an advisory layer alongside the rule-based EMS. It shall read the same Shared Variables and Modbus instrument data and display AI recommendations on the operator desktop while the rule-based EMS retains physical command authority with the following modules: • **AI Module 1:** One Class SVM Converter Health Monitoring • **AI Module 2:** Decision Tree – G2V Scheduling Recommender • **AI Module 3:** Adaptive MPPT Selector All three AI modules—One-Class SVM, Decision Tree and Adaptive MPPT Selector—shall be retrainable using locally acquired operating data.	1
4	**AI-EMS Safety & Model Development**	• AI-EMS remains an advisory/research layer • AI shall not bypass hardware protection, BMS protection, converter protection, grid protection or emergency shutdown • User can retrain and modify AI models using locally acquired data; One-Class SVM, Decision Tree and Adaptive MPPT modules provided with editable/retrainable models • Supports development of load forecasting, renewable forecasting, battery SoC/SoH prediction, fault diagnosis, MPPT optimisation, EV charging optimisation and energy scheduling	1
5	**Cybersecurity Architecture**	The cybersecurity module shall operate on the live Ethernet/Shared Variable network and shall allow students to study both cyber-attacks and their corresponding defence mechanisms using the actual operating platform. • **Attack Simulation Interface:** A LabVIEW Runtime-based Attack Simulation EXE shall be provided for the student laptop. It shall follow a read-first architecture, provide live Shared Variable observation, allow target/value selection and	1

		require an explicit Launch Attack action for each attack scenario.	
6	**Isolated Research Network**	• Dedicated isolated research network, separated from the university production network • Cyberattack experiments conducted only inside the isolated research environment • Cybersecurity experiments cannot bypass hardware protection or create an unsafe electrical condition	1
7	**Cybersecurity Attack Scenarios**	The system shall demonstrate five attack scenarios: (i) Eavesdropping, (ii) Stealthy False Data Injection, (iii) Aggressive Control Variable Attack, and (iv) Replay Attack, and (v) Denial-of-Service / Communication Failure (where safely applicable).	1
8	**Cybersecurity Defences**	The system shall provide four corresponding defence mechanisms: (i) Shared Variable Access Control, (ii) Cross-Validation, (iii) Rate-of-Change Limiter with Watchdog, and (iv) Timestamp Consistency Checking.	1
9	**Eavesdropping & Access Control**	• Students shall be able to observe Shared Variables and IEC 61850 GOOSE communication from the RET615 and implement • NI user-based access permissions to reject unauthorised connections/writes and log access-denied events.	1
10	**False Data Injection & Cross-Validation**	• Battery SoC shall be available from BMS Modbus, sbRIO Shared Variable and the Digital Twin physics-based reference. • A discrepancy between these sources shall be detected within one polling cycle.	1
11	**Control Attack & Defence**	• The system shall demonstrate an aggressive control-variable attack and provide a rate-of-change limiter and watchdog to reject implausible changes, generate an alarm and provide safe fallback behaviour.	1
12	**Replay Attack & Timestamp Defence**	• The system shall support recording and replay of Shared Variable time-series data and shall provide timestamp consistency checking to identify, reject and log replayed/old data beyond the defined tolerance.	1
13	**Cybersecurity Defence Demonstration**	• Authentication, access control and data validation • Rate-of-change limiting, watchdog and timestamp validation • Alarm generation, safe fallback and event logging	1

		• Shared Variable Access Control, Cross-Validation, Rate-of-Change Limiter/Watchdog and Timestamp Consistency Checking retained and made experimentally accessible to students	
14	**Digital Twin**	A physics-based Digital Twin shall be developed using the **LabVIEW Control Design and Simulation Module**, with dynamic models based on state-space, equivalent-circuit and transfer-function representations. • **Digital Twin Parameters:** The Twin shall include converter inductance, capacitance and switching characteristics; battery and ultracapacitor characterisation data; and PMSM parameters including Ld, Lq, Rs, flux linkage and inertia. • **PMSM Parameter Determination:** PMSM parameters shall be determined using no-load, DC resistance and back-EMF tests. The Digital Twin shall be pre-parameterised and pre-validated for operation from commissioning without client-side model identification. • **Digital Twin – Parallel Mode:** In parallel operation, the Digital Twin shall read live Shared Variables and predict DC-link voltage, battery SoC, PMSM torque and converter efficiency while operating alongside the physical system. • **Twin Validation & Diagnostics:** The system shall provide comparison of Digital Twin and hardware results using RMSE and maximum deviation, supporting diagnostic monitoring and cyber-physical cross-validation. • **Digital Twin – Standalone Mode:** The Twin shall operate independently using front-panel controls or CSV input and shall support accelerated simulation from 10× to 100× real time for EMS pre-testing, degradation studies and AI training-data generation. • **Component Degradation Simulation:** The Digital Twin shall allow component degradation studies, including changes in battery internal resistance and converter switching loss, with a defined degradation example such as a 30% increase in battery internal resistance.	1
15	**Digital Twin Operating Modes**	• **Mode 1 –** Standalone Simulation: no physical hardware required; user can modify parameters and run simulations; data import/export in open formats • **Mode 2 –** Hardware/Controller-in-the-Loop: Digital Twin interacts with an external controller; user-developed controller tested against the simulated plant	**1**

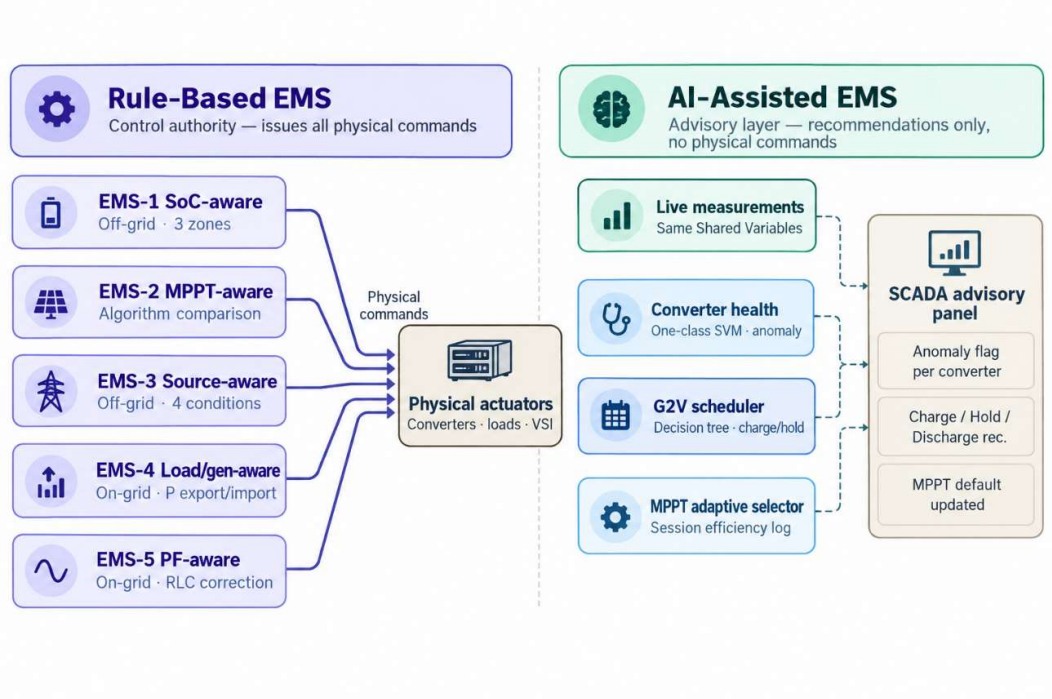
		• **Mode 3 –** Live Parallel Operation: Digital Twin receives real-time data from the physical microgrid; physical and simulated results compared • State-space, equivalent-circuit and transfer-function models retained	
16	**Digital Twin Parameter Modification**	• User-modifiable converter, battery, PMSM, load, grid and renewable-source parameters	1
17	**External Interface (HIL/CIL)**	• Feedback signal interfacing pins (voltage, current, temperature, speed and fault signals) brought out on an external interface panel • Optional access to gate-signal pins • Signal-level access allows the user to interface any external system, such as MATLAB/Simulink, Python, C/C++, LabVIEW, DSPs, microcontrollers, FPGAs, dSPACE/OPAL-RT or equivalent research controllers	1
18	**Real-Time Data Exchange & User Algorithms**	• Real-time data exchange through documented APIs/protocols • User can replace the vendor's control algorithm with a user-developed algorithm	1
19	**Synchronised Signals**	• Voltage, current, power, SoC, SoH, temperature, speed, torque, control commands and fault signals	1
20	**SCADA / Operator Interface**	The operator interface shall provide AI-EMS/rule-based decision information, cybersecurity attack/defence controls and a Digital Twin comparison panel within the research platform.	1
21	**Software & Source Code**	The system shall include a • 1-user LabVIEW license and the AI-EMS, cybersecurity and Digital Twin VIs. • All delivered LabVIEW source code shall be fully editable and provided without restriction. • Complete source code for the Digital Twin, AI algorithms, cybersecurity applications, communication interfaces, EMS and user interface (wherever vendor-developed)	1
22	**Data Access & Export**	• All important measurement and control variables available through documented APIs/protocols • No critical research variable locked exclusively inside proprietary software • Data export in open formats like CSV	1
23	**Documentation**	• Software architecture, network architecture, Digital Twin model, I/O list, communication map, API documentation, source code, user manuals and research/experiment manuals	1

24	**Network Hardware**	A managed industrial Ethernet switch shall be provided for connecting the student laptop to the sbRIO network when the cybersecurity module is active. • VLAN and network segmentation • Port mirroring, network monitoring and packet capture • Access control and firewall • IDS/IPS interface	1
25	**System Compatibility & Support**	The platform shall be compatible with the Hardware & Measurement System or other NI sbRIO/LabVIEW platforms using Shared Variables and shall include commissioning, training and after-sales support.	1
26	**Must have Features**	The Suite supports systematic research into machine-learning-assisted energy dispatch, industrial control-system security, and model-based validation of cyber-physical systems. **AI-Assisted Energy Management** ● One-class SVM boundary characterisation of converter normal-operating envelopes. ● Decision tree G2V dispatch comparison against rule-based thresholds under identical energy profiles. ● MPPT adaptive selector session-based learning and automatic default promotion. ● Quantified renewable-energy fraction and battery-cycling-stress comparison across dispatch strategies. **Cybersecurity** ● Eavesdropping detection via Shared Variable access-control logging. ● Stealthy false-data-injection detection via cross-validated measurement paths. ● Aggressive control-variable attack containment via rate-of-change limiting and watchdog monitoring. ● Replay-attack detection via timestamp consistency validation. **Digital Twin & System Validation** ● Real-time model-fidelity quantification via RMSE and maximum deviation against physical measurement. ● What-if component-degradation analysis without waiting for actual hardware degradation.	1

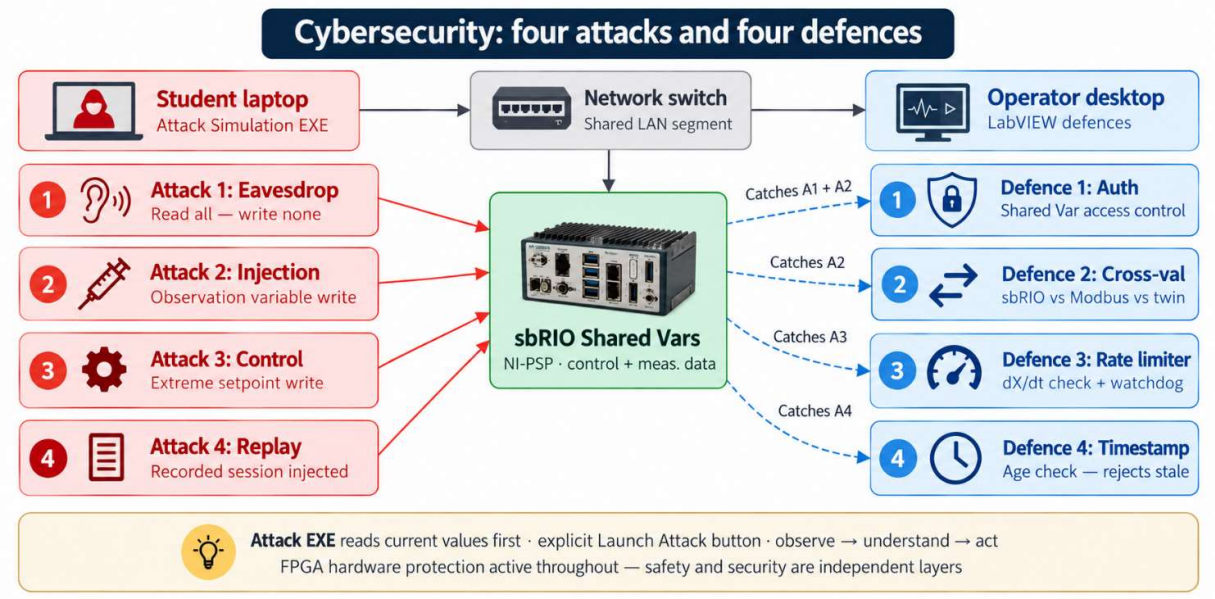
		• AI training-data generation through accelerated standalone simulation sessions. • Parallel-mode cross-validation of battery SoC, DC link voltage, and PMSM torque predictions against live measurement. **Process Control & Instrumentation** • Dedicated AI-EMS SCADA panel displaying rule-based and AI-recommended dispatch decisions side by side. • Explicit Launch Attack and defence-VI controls for structured, repeatable cybersecurity teaching sessions. • Twin comparison panel with live RMSE and maximum-deviation readouts alongside physical measurement traces. **Safety & System Validation** • Read-first, explicit-action attack workflow that prevents accidental disruption during teaching sessions. • Independent physics-based cross-validation reference that does not depend on the same sensors as the primary control loop. • Pre-validated Digital Twin parameters eliminate the need for client-side system identification before first use.	

B. Block Diagram

a) Block Diagram of AI Layer



b) Block Diagram of Cybersecurity layer



2. MODULAR BATTERY AND BMS DEVELOPMENT PLATFORM

The proposed system shall be a modular, open and research-oriented platform. Each major equipment/subsystem shall be capable of independent standalone operation using its dedicated local control, measurement, switching/isolation and protection system. The same equipment shall also be capable of integrated operation with the common microgrid/EMS/controller. In addition, suitable interfaces shall be provided for connection of external/user-developed controllers, algorithms and measurement systems. The central supervisory computer, LabVIEW software or communication network shall not constitute a single point of failure for the safe operation and protection of individual equipment. Critical electrical and safety protections shall remain functional independently of the supervisory software and communication network."

Vendor must also submit the following before supply:

15. Detailed electrical single-line diagram.
16. Control architecture/block diagram.
17. Individual equipment control architecture.
18. Protection architecture.
19. Switching/isolation architecture.
20. Communication architecture.
21. Complete I/O list.
22. External controller interface details.
23. List of all hardware protections.
24. List of all software protections.
25. Source-code access statement.
26. Compliance matrix against every specification.
27. FAT/SAT procedure.
28. Demonstration of standalone + integrated + external-controller operation of each major subsystem.

Specifications

System Overview

The system shall be a Modular Battery & BMS Development Platform comprising interconnected Cell Voltage Manager Unit, Cell Sorting Unit, BMS Development & Validation System, Battery Cycler with Data Analytics and Environmental Chamber Unit. The platform shall support battery cell preparation, cell matching, battery pack assembly, BMS development, testing and system-level validation.

The BMS and the battery cycler shall operate independently of the PC, LabVIEW, Ethernet and the central controller, with open access to data, firmware and communication interfaces for research.

A. Battery Cycler Integrated with Data Analytics

A1. Cell Voltage Manager: Qty-1

Parameter	Specification
Cell Connection Matrix	128 channels
Voltage Equalisation Range	0–5.000 V per channel
Calibration Resolution	1 mV
Equalisation Accuracy	±0.8% FS
Post-Equalisation Delta	Typically, <10 mV across all 115 cells
Charge/Discharge Current	0–6,000 mA programmable; resolution 2 mA
Current Ripple	<0.5% peak
Measurement ADC	16-bit
Data Update Rate	Configurable per channel
Max Power Consumption	3.5 kW (dynamic distribution based on channel load)
Fault Detection	Open-cell, reverse polarity, overtemperature (dual NTC per 16-channel block)

A2. Cell Sorting Manager: Qty-1

Parameter	Specification
Compatible Cell Formats	18650, 18700, 21700, 26650, 26700, 32650, 32700
Sorting Grades	4 pass grades + 1 reject channel
Throughput	3,000–3,600 cells/hour
Equipment Failure Rate	< 2%
Cell Loss Rate	< 0.1%
Noise	48 dB
Operating temperature range	20°C ± 5°C
Humidity	≤82%
Equipment Weight	≈ 160 kg
Power Supply	AC 220 V ±10%, 50 Hz; 800 W

A3. Battery Cycler with Data Analytics: Qty-1

Parameters	Specifications
Input AC	AC 220V ±10% / 50Hz

Input Power	2500 Watt.	
Input Impedance	≥1MΩ	
Voltage	Voltage Output Range	2.5-90V
	Min. Voltage	2.5 V
	Accuracy	± 0.1% of FS
	Voltage Tolerance	+/-1.0%
	Line Regulation	+/-0.5%
	Load Regulation	+/-0.5%
Current	Current Output Range	0~30A
	Min. Current	0 A
	Accuracy	± 0.1% of FS
	Voltage Tolerance	+/-1.0%
	Line Regulation	+/-0.5%
	Load Regulation	+/-0.5%
Power	Max. Output Power	2500 W
	Stability	± 0.2% of FS
Data Logging	Sampling Rate	Adjustable
	Max. Sampling Rate	3.6 Msps
	Export	CSV file and image file
Charge Condition	Charging Modes	Constant Current, Constant Voltage, Constant Power, C-Rate, Battery Cycler
Discharge Condition	Discharging Modes	Constant Current, Constant Power, C-Rate, Battery Cycler
Discharging Loads	Load Type	Resistive
	Rated Power	1500 Watt.
Voltage Sensor	Ipn	10 mA
	Vpn	10…..500V
	Conversion Ratio	2500:1000
	Supply Voltage	12-15V
Current Sensor	Ipn	25A
	Turns Ratio	1:1000
	Supply Voltage	12-15V
Test Programming	Charge/discharge cycling	

	Programmable profiles and user-defined test sequences
Local Operation	Independently operable through local control; can be operated without LabVIEW
External Control	External control through documented communication protocols (command set/register map supplied)

B. BMS Development and Validation System: Qty-1

Parameters	Specifications
System Overview	• **Supported Battery Configuration:** Up to 23S × 5P (BYOB) • Battery Chemistry: $LiFePO_4$ (standard). Cell voltage thresholds, protection limits and OCV-SoC tables are user-configurable in firmware for research on other Li-ion chemistries • **Max Pack Voltage:** 73.6V (for 23S) • **Max Pack Capacity:** Up to 30Ah (based on 6Ah cells in 5P)
Pack Configuration & Research Interface	• Configurable pack arrangements: 3S2P, 5S3P, 10SxP and up to 23S5P • Battery pack terminals brought out to a safe external research interface (shrouded safety terminals) • **Pack independently connectable to:** BMS, battery cycler, electronic load, external DC source, external converter, microgrid DC bus, user-developed controller/BMS
Sensor Interface	Voltage Measurement • **Channels:** 23 individual cell voltage measurement points • **Resolution:** 1 mV • **Accuracy:** ±0.2% FS • **Pack Voltage Monitoring:** 1 channel for total battery pack voltage
	Current Measurement • **Sensor Type:** Bidirectional Hall-effect sensor • **Range:** ±30A continuous • **Resolution:** 10 mA • **Accuracy:** ±1% FS
	Temperature Measurement

	• **Sensors Supported:** NTC thermistors / RTDs (user-selectable) • **Channels:** Multiple (min. 6) • **Temperature Range:** -20°C to +100°C • **Protection Thresholds:** User-configurable cutoffs
Protection	• Charging/Discharging Cut-off • Single Cell High Voltage Protection • Single Cell Low Voltage Protection • Pack High Voltage Protection • Pack Low Voltage Protection • Difference in Cell Voltage Protection • Charging Overcurrent Protection • Discharging Overcurrent Protection • Charging High Temperature Protection • Discharging High Temperature Protection • Charging Low Temperature Protection • Discharging Low Temperature Protection • SoC Range Protection • Short Circuit • Inrush Current • Passive Balancing Resistance overheat • Controller error
Hardware Protection (Independent of PC)	• Hardware-level protection in the local BMS (analog front-end protection with local microcontroller), not dependent on software running on the PC • Cell over-voltage and cell under-voltage • Pack over-voltage and pack under-voltage • Charge overcurrent and discharge overcurrent • Short circuit and inrush current • Over-temperature and under-temperature • Excessive cell voltage difference
BMS Control Outputs	• Independent control of battery contactor • Pre-charge circuit • Charge/discharge enable • Fault trip
Independent Operation	• BMS operation continues when the PC is OFF, LabVIEW is OFF, Ethernet is disconnected or the central EMS is unavailable • Local display of pack voltage, current, SoC, temperature and fault status
Balancing Capabilities	• Passive Balancing • Active Balancing: Switched-capacitor based
Balancing Research	• Switched-capacitor active balancing: charge transfer from higher-voltage to lower-voltage cells through switched capacitors, selectable alongside passive balancing

	• Balancing current measurable per cell and programmable through firmware
SoC Estimation Methods	• **Coulomb Counting:** Current integration over time • **OCV Method:** Uses voltage-SOC look-up tables during rest periods • **Kalman Filter:** State estimator with noise rejection and model correction • **Extended Kalman Filter (EKF):** Advanced nonlinear estimation model • **Custom Algorithms:** Users can deploy their own models via LabVIEW or firmware
Algorithm Development	• Existing Coulomb Counting, OCV, Kalman Filter and EKF methods retained • User can develop and test own SoC, SoH, balancing, fault-detection, state-estimation and thermal-management algorithms • BMS algorithm can be replaced/modified without changing the battery hardware
Open Data Access	• Cell voltages, pack voltage, pack current and cell temperatures • SoC, SoH, cell balancing status and fault status
External BMS/Controller Interface	• CAN 2.0B (CAN-FD through interface module) • RS-485/Modbus RTU • Digital I/O and analog I/O
User Interface	LabVIEW-based GUI: Real-time graphical interface for data visualization, logging, and control
Central Controller	Microcontroller Board
Data Logging	Format: .csv, image Maximum 10 samples per second
Data Recording & Export	• Cell-level data recorded during charging, discharging, balancing, rest and fault conditions • Raw data export in CSV
Firmware	• Open-source microcontroller code (C or LabVIEW MICROCONTROLLER modules) • Editable logic for protections, balancing, and SoC algorithms

Source Code	• Complete firmware/source code provided
Battery Research Capabilities	• OCV-SoC characterisation • Capacity testing • Internal-resistance measurement • Charge/discharge curves • Cycle-life testing • SoC/SoH algorithm validation • Battery degradation studies

C. Environmental Chamber with thermal camera

C1. Handheld Thermal Imaging Camera: Qty-1

S.No.	Component / Parameter	Specification / Details
1	**Application**	Thermal imaging of cells, pack, busbars and BMS during charging, discharging, balancing and fault tests
2	**IR Resolution**	256 × 192 pixels (49,152 pixels)
3	**Thermal Sensitivity (NETD)**	< 40 mK at 25 °C (F#1.0)
4	**Field of View**	50.0° (H) × 37.2° (V); IFOV 3.43 mrad Fixed focus; frame rate 25 Hz
5	**Temperature Range & Accuracy**	-20 °C to 400 °C ±2 °C or ±2% of reading (whichever is greater)
6	**Visual Camera & Image Modes**	8 MP visual camera Thermal, optical, fusion and picture-in-picture modes 1× to 4× digital zoom
7	**Display**	3.5-inch LCD touchscreen, 640 × 480
8	**Measurement & Alarms**	Manual, automatic and one-tap level/span adjustment High-temperature alarm
9	**Storage & File Formats**	16 GB internal memory Radiometric JPEG images; MP4 video
10	**Connectivity & Software**	Wi-Fi (2.4 GHz and 5 GHz) and Bluetooth Mobile app and PC software for thermal analysis and reporting
11	**Battery Life**	Approximately 4 hours continuous operation
12	**Ruggedness & Weight**	IP54; 2 m drop tested Approximately 218 g

C2. Environmental Chamber: Qty-1

Equipment	Parameters	Specifications
Environmental Chamber	Temperature Range	-10 to 60 deg. C
	Humidity Range	60%-90%RH
	Control	Independent temperature/humidity controller with local display
	Safety Shutdown	Independent over-temperature safety cut-out with automatic shutdown

D. Additional components and interconnection support

D1. Central Controller and User Interface: Qty-1

Component	Parameter	Specifications
Central Controller	Microcontroller board	• 32-bit ARM Cortex -M4 with FPU core, 1-Mbyte Flash memory, 192-Kbyte RAM in an LQFP100 package • Board power supply: through USB bus or from an external 5 V supply voltage • External application power supply: 3 V and 5 V
User Interface	LabVIEW-based GUI: Real-time graphical interface for data visualization, logging, and control	
Data Logging	Format: .csv, image	
Firmware	• Open-source microcontroller code (C or LabVIEW MICROCONTROLLER modules) • Editable logic for protections, balancing, and SoC algorithms	

D2. Operator Control and Visualization: Qty-1

S.No.	Component / Parameter	Specification / Details
1	**Operator Desktop Workstation**	Processor: Intel Core i7 | RAM: 16 GB | Storage: 512 GB SSD
2	**Large-Format Display**	Size: 75 inches
3	**Animated System Introduction Video**	Duration: 2–3 minutes

D3. Battery Testing Safety

S.No.	Component / Parameter	Specification / Details
1	**Over-Temperature Shutdown**	Automatic shutdown on cell/pack over-temperature through the BMS and the environmental chamber safety cut-out
2	**Smoke/Fire Detection**	Smoke detector in the battery test area with alarm and automatic power isolation, where applicable
3	**Emergency Isolation**	Emergency stop push-button Emergency power isolation Contactor isolation of the battery pack
4	**Fuse Protection**	DC fuse protection on the battery pack and test connections
5	**Safe Enclosure**	Battery pack housed in a safe, flame-retardant enclosure during testing

D4. Fault Test Demonstration and Documentation: Qty-1

S.No.	Component / Parameter	Specification / Details
1	**Controlled Fault Test Demonstration**	Over-voltage Under-voltage Overcurrent Temperature fault Communication failure Sensor failure BMS controller failure
2	**Documentation**	Complete battery wiring diagrams, BMS architecture, firmware, communication protocol, source code and test procedures

E. Must have Features

Features	• The system supports battery configurations of up to 23 cells in series and 5 strings in parallel (23S5P), enabling users to create smaller configurations like 3S2P or 5S3P as required. • It includes a 115-channel voltage monitoring system that allows continuous, real-time tracking of each individual cell's voltage. • High-precision sensors are integrated to measure total pack voltage, bidirectional current, and multi-point cell temperatures, offering comprehensive monitoring. • It provides real-time display of important battery parameters including State of Charge (SoC), State of Health (SoH), cycle count, and the maximum and minimum cell voltages. • The system supports passive balancing using resistive elements and switched-capacitor active balancing for research.

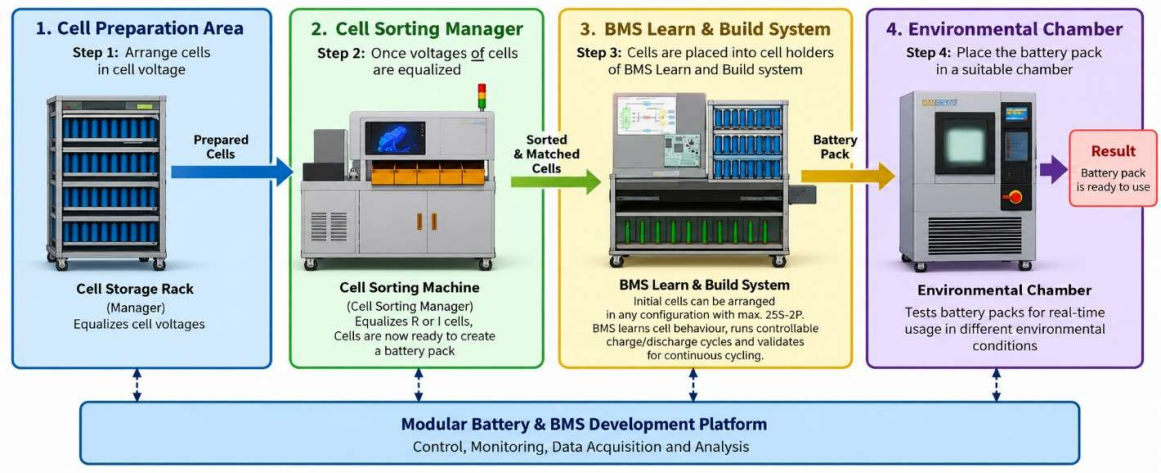
Sensing Interface	• **Voltage Monitoring:**
	  ○ Each of the 23 cells in the series string is monitored for voltage.
	  ○ A multiplexer or 23-channel ADC collects the data and feeds it to the controller.
	• **Current Monitoring:**
	  ○ A **bi-directional current sensor** measures both charging and discharging current.
	• **Temperature Sensing:**
	  ○ Multiple thermistors or RTDs are attached to key cells and terminals.

Protection Algorithms	• Over-voltage / Under-voltage • Over-temperature / Under-temperature • Over-current • Short-circuit detection • All protection triggers are handled locally by the BMS hardware and microcontroller, independent of the PC, and communicated to the user via LabVIEW GUI.

Balancing	• **Passive Balancing:**
	  ○ Uses resistor banks to dissipate excess energy from high-voltage cells.
	  ○ Controlled by Relays and managed via firmware.
	• **Switched-Capacitor Active Balancing:**

	○ Transfers charge from higher-voltage cells to lower-voltage cells through switched capacitors, with lower energy loss than passive balancing. ○ Capacitor switching managed via firmware; balancing current measured and programmable.
SoC Estimation Algorithms	The BMS supports: • Coulomb Counting • Open Circuit Voltage (OCV) method • Kalman Filter • Extended Kalman Filter (EKF) • Customizable logic in LabVIEW for advanced techniques (e.g., machine learning, adaptive algorithms)
Software and Control Interface	• Fully integrated with **LabVIEW GUI** ○ Real-time visualization of every parameter ○ Debug console for algorithm development • Open-source code and modifiable microcontroller firmware allow users to: ○ Implement their own safety logic ○ Change balancing behavior ○ Develop new SOC/SOH models

B. Block Diagram



3. SMART AND PROGRAMMABLE HYBRID AC/DC MICROGRID WITH DISTRIBUTED RENEWABLE ENERGY SOURCES

The proposed system shall be a modular, open and research-oriented platform. Each major equipment/subsystem shall be capable of independent standalone operation using its dedicated local control, measurement, switching/isolation and protection system. The same equipment shall also be capable of integrated operation with the common microgrid/EMS/controller. In addition, suitable interfaces shall be provided for connection of external/user-developed controllers, algorithms and measurement systems. The central supervisory computer, LabVIEW software or communication network shall not constitute a single point of failure for the safe operation and protection of individual equipment. Critical electrical and safety protections shall remain functional independently of the supervisory software and communication network."

Vendor must also submit the following before supply:

29. Detailed electrical single-line diagram.
30. Control architecture/block diagram.
31. Individual equipment control architecture.
32. Protection architecture.
33. Switching/isolation architecture.
34. Communication architecture.
35. Complete I/O list.
36. External controller interface details.
37. List of all hardware protections.
38. List of all software protections.
39. Source-code access statement.
40. Compliance matrix against every specification.
41. FAT/SAT procedure.
42. Demonstration of standalone + integrated + external-controller operation of each major subsystem.

Specifications

System Overview

The system shall be a Smart and Programmable Hybrid AC/DC Microgrid with Distributed Renewable Energy Sources comprising a Renewable Energy Microgrid domain and an Electric Vehicle Mobility domain interconnected through a common 120 V DC link. Both domains shall be independently operable as well as capable of integrated operation.

The system shall be a modular, research-grade platform and not only a centrally controlled training kit. Each major subsystem shall support standalone/local operation, integrated operation with the common microgrid EMS, and operation through an external/user-developed controller, as detailed in Sections F to I.

A. Renewable Energy Microgrid

A.1. WIND TURBINE EMULATOR -2 kW			
S.No.	**Component**	**Specification**	**Qty**
1	**DC Motor**	**Output Power:** 4 HP (3 kW) **Nominal Field Voltage:** 220 V DC **Nominal Armature Voltage:** 220 V DC **Rated Speed:** 1500 RPM	**1**
2	**DC Drive**	**Topology:** DC-DC Buck Converter **Switch Type:** IGBT **Input Voltage:** 220 V DC **Output Voltage:** 200 V DC **Output Current:** 30 A **Switching Frequency:** 10 kHz **Cooling:** Forced Air **Controller:** Dedicated local controller with local HMI/indication; NI FPGA (sbRIO-9607) for supervisory/integrated operation; external speed/torque reference input via Research Interface Panel **Protection:** OVP, UVP, OCP, short-circuit and over-temperature protection; hardware gate-driver protection with independent fault trip	**1**
3	**PMSG Generator**	**Type:** Permanent Magnet Synchronous Generator **Rated Power:** 2 kW **Line-to-Line Voltage:** 415 V AC **Rated Speed:** 1500 RPM	**1**
4	**Buck Converter (Post-Generator)**	**Topology:** DC-DC buck converter **Switch Type:** IGBT **Input Voltage:** 450 V **Output Voltage:** 120 V DC **Output Current:** 20 A **Switching Frequency:** 10 kHz **Cooling:** Forced Air **Controller:** Dedicated local controller with local HMI/indication; NI FPGA (sbRIO-9607) for supervisory/integrated operation; external PWM/duty-cycle input via Research Interface Panel **Protection:** OVP, UVP, OCP, short-circuit and over-temperature protection; hardware gate-driver protection with independent fault trip	**1**
5	**FPGA Control Card**	**Technology:** FPGA **ADC Inputs:** Available **PWM Ports:** Available	**1**

6	**Sensing Board — WTE**	DC Voltage Sensors DC Current Sensors	4 3
7	**Measurement Instruments**	**DC Link Voltmeter:** 0–1000 V **Armature Voltmeter:** 0–1000 V **Battery Voltmeter:** 0–200 V **Battery Ammeter:** 0–10 A **Tachometer:** 0–2000 RPM	1 1 1 1 1
8	**Autotransformer 3-Phase (Motor Supply)**	**Voltage Range:** 0–450 V **Maximum Current:** 15 A	**1**
9	**Autotransformer 3-Phase (Grid)**	**Voltage Range:** 0–450 V **Maximum Current:** 8 A	**1**
10	**Local Controllers**	Dedicated local controller for the DC drive (prime mover) and for the post-generator buck converter **Local Controller Specifications:** **Microcontroller Board:** 32-bit ARM Cortex-M4 with FPU core, 1-MB Flash, 192-KB RAM, LQFP100 **Board Power Supply:** USB bus or external 5 V supply	2
11	**Wind Profile & Measurement**	Programmable wind-speed and speed–torque profiles (Manual, Table and field-data playback) Measurement of speed, torque, voltage, current and generated power	1
12	**External Control Interface**	External speed/torque reference input for the DC drive External PWM/duty-cycle command input for the buck converter Sensing feedback signals available on the Research Interface Panel	1
13	**Independent Protection**	Overspeed, overcurrent, overvoltage and over-temperature protection implemented locally in hardware Protection remains active independent of the central EMS/LabVIEW computer Hardware emergency stop, MCB/fuse and isolating contactor	1

A.2 SOLAR PV EMULATOR – 2kW			
S.No.	**Component**	**Specification**	**Qty.**
1	**Solar PV Emulator**	**Rated Output Power:** 2000 W **Number of Channels:** 1 **Supply Voltage:** 230 V AC / 50 Hz **Open Circuit Voltage (Voc):** 0–100 V DC **Short Circuit Current (Isc):** 0–20 A **Voltage Slew Rate:** 0.01–2 V/ms **Current Slew Rate:** 0.01–1 A/ms	**1**
2	**Boost Converter**	**Topology:** DC-DC boost converter **Switch Type:** IGBT	**1**

		Input Voltage: 10–100 V **Output Voltage:** 120 V DC **Output Current:** 10 A **Switching Frequency:** 10 kHz **Cooling:** Forced Air **Controller:** Dedicated local controller with local HMI/indication; NI FPGA (sbRIO-9607) for supervisory/integrated operation; external PWM/duty-cycle input via Research Interface Panel **Protection:** OVP, UVP, OCP, short-circuit and over-temperature and reverse-polarity protection; hardware gate-driver protection with independent fault trip	
3	**Local Controller (Boost Converter)**	Dedicated local controller; PV Emulator → Boost Converter → DC Load operation without the central EMS Local measurement and display of PV voltage/current and boost converter input/output parameters Built-in MPPT (P&O) with support for user-defined MPPT algorithms External PWM/duty-cycle command input via the Research Interface Panel **Local Controller Specifications:** **Microcontroller Board:** 32-bit ARM Cortex-M4 with FPU core, 1-MB Flash, 192-KB RAM, LQFP100 **Board Power Supply:** USB bus or external 5 V supply	1
4	**Protection**	OVP, UVP, OCP, short-circuit, over-temperature and reverse-polarity protection Hardware gate-driver protection with independent fault trip	1

A.3 REGENERATIVE GRID SIMULATOR – 9KVA			
S.No.	**Parameter**	**Specifications**	**Qty.**
1	**Rated Output Power**	**9 kVA**	**1**
2	**Operating Modes**	Grid Simulator, Four-Quadrant AC Power Source, AC/DC Electronic Load, Power Amplifier	
3	**Output Voltage Range**	0–350 V AC (L-N), up to 606 V AC (L-L, Three Phase)	
4	**Maximum Output Current**	**90 A RMS**	
5	**Output Frequency Range**	**16 Hz to 2400 Hz**	
6	**Phase Configuration**	Single Phase and Three Phase	

7	**Output Waveforms**	Sine, Square, Triangle, Arbitrary Waveforms (CSV Import Supported)	
8	**Operating Quadrants**	Four-Quadrant Source and Sink Operation	
9	**Regenerative Capability**	Bidirectional energy flow with regeneration of absorbed power back to the utility grid	
10	**Power Factor**	Programmable leading and lagging	
11	**Phase Angle Control**	0°–360°, programmable	
12	**Voltage Resolution**	**0.01 V**	
13	**Current Resolution**	**0.01 A**	
14	**Voltage Accuracy**	**< ±(0.1% of Reading + 0.1% FS)**	
15	**Current Accuracy**	**< ±(0.1% of Reading + 0.2% FS)**	
16	**Harmonic Simulation**	User-programmable harmonic generation and analysis (up to 50th harmonic)	
17	**Grid Disturbance Simulation**	Voltage Sag, Swell, Interruptions, Frequency Variations, Phase Shift, Flicker, Harmonics	
18	**Programmable Modes**	LIST, STEP, SWEEP, Surge & Sag	
19	**Dynamic Response**	High-speed transient response suitable for inverter and converter testing	
20	**Protection Features**	Over Voltage, Over Current, Over Power, Over Temperature, Short Circuit, Watchdog Protection	
21	**Communication Interfaces**	USB, LAN (Ethernet), CAN, Digital I/O	
22	**Optional Interfaces**	GPIB, Analog Programming Interface, RS-232	
23	**Display**	Color Touchscreen with Graphical User Interface	
24	**Form Factor**	3U Rack Mount	
25	**Parallel Expansion**	Master-Slave operation for higher power systems (up to 960 kVA depending on configuration)	
26	**Applications**	Testing of Grid-Tied Inverters, Energy Storage Systems (ESS), EV Chargers (EVSE), V2G/V2X Systems, UPS, Microgrids, Power Electronics, Renewable Energy Systems, Research Laboratories	
27	**Standalone Operation**	Fully operable through its own local interface in addition to computer control. Four-quadrant source/sink operation, programmable waveforms, power factor, phase angle and regeneration remain available in standalone mode	

A.4 5KW FUEL CELL SIMULATOR			
S.No.	**Parameter**	**Specifications**	**Qty.**
1	**Simulator Type**	Programmable Bidirectional DC Power Supply configured as Fuel Cell Simulator	1
2	**Rated Output Power**	**5 kW**	
3	**Output Voltage Range**	**0–80 V DC**	
4	**Output Current Range**	**±150 A** (Source & Sink)	
5	**Maximum Output Power**	**±5 kW**	
6	**Fuel Cell Curve Simulation**	Programmable PEM Fuel Cell Polarization Curve (V-I Characteristics)	
7	**Dynamic Response Simulation**	Supports dynamic fuel cell response under varying load conditions	
8	**Fuel Cell Model Parameters**	Open Circuit Voltage (OCV), Activation Loss, Ohmic Loss, Concentration Loss, Internal Resistance, Stack Configuration	
9	**Operating Modes**	Constant Voltage (CV), Constant Current (CC), Constant Power (CP), Constant Resistance (CR), Fuel Cell Simulation Mode	
10	**Bidirectional Operation**	Two-quadrant source and sink operation with seamless transition	
11	**Regenerative Capability**	Up to **90% efficiency**, returning absorbed energy back to the AC grid	
12	**Voltage Programming Resolution**	**1 mV**	
13	**Current Programming Resolution**	**10 mA**	
14	**Power Resolution**	**1 W**	
15	**Voltage Programming Accuracy**	**±(0.02% of Setting + 0.02% FS)**	

16	**Current Programming Accuracy**	**±(0.1% of Setting + 0.1% FS)**	
17	**Power Accuracy**	**±(0.5% of Setting + 0.5% FS)**	
18	**Voltage Ripple**	≤120 mVpp (20 Hz–20 MHz)	
19	**Transient Response Time**	≤2 ms	
20	**Voltage Rise Time**	≤15 ms (No Load), ≤30 ms (Full Load)	
21	**Voltage Fall Time**	≤30 ms (No Load), ≤15 ms (Full Load)	
22	**Remote Sense**	Up to **5 V** compensation	
23	**Waveform Generation**	Built-in arbitrary waveform generator with programmable profiles	
24	**Fuel Cell Dynamic Profile**	Supports transient load profiles and programmable driving cycles	
25	**Data Acquisition**	Real-time voltage, current, power and resistance monitoring with data logging	
26	**Communication Interfaces**	USB, LAN, CAN, Digital I/O	
27	**Optional Interfaces**	GPIB, RS-232, Analog Interface	
28	**Control Software**	FCS3000 Fuel Cell Simulation Software	
29	**Cooling Method**	Forced Air Cooling	
30	**AC Input**	198–264 VAC (single-phase) or 342–528 VAC (three-phase, depending on installation)	
31	**Operating Temperature**	0°C to 50°C	
32	**Storage Temperature**	−10°C to 70°C	
33	**Dimensions (W × D × H)**	483 × 801.6 × 151.3 mm (3U Rack Mount)	
34	**Weight**	Approximately 20 kg	
35	**Boost Converter for Fuel Cell Simulator**	**Topology:** DC-DC boost converter **Switch Type:** IGBT **Input Voltage:** 10–80 V **Output Voltage:** 120 V DC **Output Current:** 50 A **Switching Frequency:** 10 kHz **Cooling:** Forced Air **Controller:** Dedicated local controller with local HMI/indication; NI FPGA (sbRIO-9607) for supervisory/integrated operation; external PWM/duty-cycle input via Research Interface Panel	**1**

		Protection: OVP, UVP, OCP, short-circuit and over-temperature protection; hardware gate-driver protection with independent fault trip	
36	**Standalone Operation**	Operable from its own interface independent of the central EMS Programmable fuel-cell V-I characteristics in standalone mode Independent Fuel Cell Simulator → Boost Converter → DC Load operation	1
37	**Boost Converter Local Controller**	Dedicated local controller with local indication External PWM/duty-cycle control via the Research Interface Panel **Local Controller Specifications:** **Microcontroller Board:** 32-bit ARM Cortex-M4 with FPU core, 1-MB Flash, 192-KB RAM, LQFP100 **Board Power Supply:** USB bus or external 5 V supply	1
38	**Independent Protection**	OVP, OCP, UVP, OTP and short-circuit protection, independent of the central EMS	1

A.5 LFP BATTERY BANK — DUAL-ROLE STORAGE & VOLTAGE REFERENCE			
S.No.	**Component**	**Specification**	**Qty.**
1	**LFP Battery Bank**	**Chemistry:** Lithium Iron Phosphate (LFP) **Nominal Voltage:** 72 V **Capacity:** 24 Ah **Role 1 (Grid-Connected):** DC link energy storage buffer **Role 2 (Islanded):** DC link voltage reference at 120 V via bidirectional converter	**1**
2	**Bidirectional Converter (Battery–DC Link)**	**Topology:** bidirectional DC-DC converter **Switch Type:** IGBT **Input Voltage:** 72–105 V (battery side) **Output Voltage:** 120 V DC (DC link) **Output Current:** 10 A **Switching Frequency:** 10 kHz **Cooling:** Forced Air **Controller:** Dedicated local controller with local HMI/indication; NI FPGA (sbRIO-9607) for supervisory/integrated operation; external PWM/duty-cycle input via Research Interface Panel **Protection:** OVP, UVP, OCP, short-circuit and over-temperature protection; hardware gate-driver protection with independent fault trip	**1**

3	**Local Controller (Bidirectional Converter)**	Dedicated local controller for bidirectional converter **Local Controller Specifications:** **Microcontroller Board:** 32-bit ARM Cortex-M4 with FPU core, 1-MB Flash, 192-KB RAM, LQFP100 **Board Power Supply:** USB bus or external 5 V supply	1
3	**Smart BMS**	**Communication:** RS-485 Modbus RTU **Parameters:** Cell voltages, pack voltage, current, SoC, temperature, balancing	**1**
4	**Standalone Operation & Connectivity**	Standalone charge/discharge operation **Independently connectable through dedicated terminals to:** DC load, battery cycler, bidirectional converter, microgrid DC bus, external converter/controller	1
5	**Isolation & Protection**	DC contactor, fuse, pre-charge circuit and emergency disconnect	1
6	**BMS Independence**	Independent BMS that remains fully operational (monitoring, balancing and protection) when LabVIEW/EMS/Ethernet is unavailable Local display of pack voltage, current, SoC, temperature and fault status	1

A.6. GRID INTERFACE — THREE-PHASE VSI & TRANSFORMER			
S.No.	**Component**	**Specification**	**Qty.**
1	**Three-Phase Voltage Source Inverter (VSI)**	**Topology:** Three-phase voltage source inverter **Switch Type:** IGBT **Input Voltage:** 120 V DC **Output Voltage:** 112 V AC (line-to-line) **Output Current:** 25 A **Switching Frequency:** 10 kHz **Cooling:** Forced Air **Controller:** NI FPGA (sbRIO-9607) only, no separate standalone local controller; sensing feedback signals available on Research Interface Panel **Protection:** Overcurrent, DC-link over/under-voltage, short-circuit and over-temperature protection; hardware gate-driver protection with independent fault trip	1
2	**Step-Up Transformer**	**Connection:** Delta to Star **Rating:** 5000 VA **Delta Voltage:** 80 V | **Star Voltage:** 400 V	1
3	**Three-Phase LC Filter**	**Inductance:** 3 mH, 10 A **Capacitance:** 10 µF, 400 V	1
4	**ABB REF601 — Feeder Protection IED**	**Location:** PCC feeder **Functions:** Overcurrent (51/50-1/50-2), Earth Fault (51N/50N), Thermal Overload (49), Phase Discontinuity (46PD), Negative Sequence (46), CB Failure (50BF), Auto-Reclose (79)	1

		Communication: Modbus RTU, RS-485 2-wire (optional) **Event Log:** 100 events, 1ms timestamp resolution **Binary Inputs:** 4 | Binary Outputs: 6 | Weight: 1.43 kg **Standards:** IEC 60255, ANSI C37.112 | Product: Relion 605 series	
5	**ABB RET615 — Transformer Protection IED**	**Location:** Delta-Star transformer (primary and secondary CTs) **Functions:** Transformer Differential (87T), Overcurrent (51/50), Earth Fault (51N/50N), Thermal Overload (49), Inrush Detection (68), Restricted Earth Fault **Communication:** IEC 61850 Ed.2 over Ethernet (GOOSE + MMS), Modbus TCP/IP, IEC 60870-5-103 **Time Sync:** IEEE 1588 v2 Precision Time Protocol **GOOSE:** Sends and receives — enables RET615 to REF601 protection coordination **Configuration:** ABB PCM600 software | Product: Relion 615 series	1
6	**Phasor Measurement Unit (PMU)**	**Location:** Point of Common Coupling **Reporting Rate:** 100 frames per second **Measurements:** Voltage phasor (magnitude + angle), Current phasor, Frequency, RoCoF Time Synchronisation: GPS, sub-microsecond accuracy **Protocol:** IEEE C37.118.2 synchrophasor stream **Desktop Interface:** Dedicated Ethernet port **Software PDC:** LabVIEW VI — archives and displays synchrophasor data in real time	1
7	**VSI Operating Modes**	Grid Following operation Grid forming operation Grid supporting operation P/Q control Voltage/frequency control Droop control Grid-connected operation Islanded operation	1
8	**Grid Interface Switchgear & Protection**	MCCB/MCB Contactor Isolation Switch Overcurrent protection Earth-fault protection Synchronisation interlock Emergency trip	

A.7 PROGRAMMABLE LOADS			
S.No.	**Component**	**Specification**	**Qty.**
1	**Three-Phase RLC Load Bank**	**Total Capacity:** 3 KVA **Test Voltage:** 3ϕ 4W, 400 V, 50 Hz	1

		Resistive (total): 3 kW | Inductive: 3 kVAR | Capacitive: 3 kVAR **Per-Phase:** 1 kW / 1 kVAR / 1 kVAR **Control:** Software via RS485 **Measurements:** V, I, f, P, Q, PF, THD (V and I)	
2	**DC Load**	**Rated Voltage:** 120 V DC **Rated Power:** 1000 W **Type:** Resistive	1
3	**Switching & Protection**	AC and DC loads independently switchable through dedicated MCB/contactor Individual overcurrent protection for each load	1

B. EV Mobility Platform

B.1 TRACTION BATTERY PACK			
S.No.	**Component**	**Specification**	**Qty.**
1	**LiFePO4 Traction Battery**	**Chemistry:** Lithium Iron Phosphate (LiFePO4) **Nominal Voltage:** 72 V **Capacity:** 100 Ah **Life Cycles:** > 3000 at 80% DoD **Nominal Charge / Discharge Rate:** 0.5C **Peak Charge / Discharge Rate:** 1C **BMS:** Smart BMS with RS485 and Bluetooth communication	1

B.2 TRACTION BATTERY BIDIRECTIONAL CONVERTER — G2V & V2G INTERFACE			
S.No.	**Component**	**Specification**	**Qty.**
1	**Bidirectional DC-DC Converter (Traction Battery)**	**Topology:** Non-isolated bidirectional DC-DC (IGBT-based) **Switch Type:** IGBT **Input Voltage:** 72 V DC (battery side) **Output Voltage:** 120 V DC (DC link) **Output Current:** 42 A **Switching Frequency:** 10 kHz **Cooling:** Forced Air **Controller:** Dedicated local controller with local HMI/indication; NI FPGA (sbRIO-9607) for supervisory/integrated operation; external PWM/duty-cycle input via Research Interface Panel **Protection:** OVP, UVP, OCP, short-circuit and over-temperature protection; hardware gate-driver protection with independent fault trip	1
2	**Local Controller (Bidirectional Converter)**	Dedicated local controller for bidirectional converter **Local Controller Specifications:**	1

		Microcontroller Board: 32-bit ARM Cortex-M4 with FPU core, 1-MB Flash, 192-KB RAM, LQFP100 **Board Power Supply:** USB bus or external 5 V supply	

B.3 ULTRACAPACITOR & BIDIRECTIONAL CONVERTER — MOTOR TRANSIENT SUPPORT			
S.No.	**Component**	**Specification**	**Qty.**
1	**Ultracapacitor Bank**	Voltage: 48 V Capacitance: 165 F Role: Peak power buffering for PMSM acceleration / deceleration transients	1
2	**Bidirectional Converter (Ultracapacitor)**	**Topology:** bidirectional DC-DC converter **Switch Type:** IGBT **Input Voltage:** 48 V (supercapacitor side) **Output Voltage:** 72 V DC (DC link) **Output Current:** 35 A **Switching Frequency:** 10 kHz **Cooling:** Forced Air **Controller:** Dedicated local controller with local HMI/indication; NI FPGA (sbRIO-9607) for supervisory/integrated operation; external PWM/duty-cycle input via Research Interface Panel **Protection:** OVP, UVP, OCP, short-circuit and over-temperature protection; hardware gate-driver protection with independent fault trip	1
3	**Local Controller (Bidirectional Converter)**	Dedicated local controller for bidirectional converter **Local Controller Specifications:** **Microcontroller Board:** 32-bit ARM Cortex-M4 with FPU core, 1-MB Flash, 192-KB RAM, LQFP100 **Board Power Supply:** USB bus or external 5 V supply	1

B.4 PMSM TRACTION MOTOR & MOTOR CONTROLLER			
S.No.	**Component**	**Specification**	**Qty.**
1	**Traction Motor — PMSM**	**Type:** Three-Phase Permanent Magnet Synchronous Motor **Rated Voltage:** 72 V AC **Rated Power:** 5 kW **Rated Speed:** 3000 RPM **Efficiency:** > 90%	1
2	**Motor Controller — Inverter-1**	**Topology:** Three-phase voltage source inverter **Switch Type:** IGBT **Input Voltage:** 72 V DC (max. DC link) **Output Voltage:** 48 V AC **Output Current:** 60 A	1

		Switching Frequency: 10 kHz **Cooling:** Forced Air **Controller:** NI FPGA (sbRIO-9607) only, no separate standalone local controller; sensing feedback signals available on Research Interface Panel **Protection:** Overcurrent, DC-link over/under-voltage, short-circuit and over-temperature protection; hardware gate-driver protection with independent fault trip	
4	**3-Phase Sensor Boards**	Voltage and current sensing at every converter and inverter node Sampling Rate: > 10 kHz	1

B.5 PMDC LOADING MACHINE & INSTRUMENTATION			
S.No.	**Component**	**Specification**	**Qty.**
1	**PMDC Loading Machine**	**Type:** Permanent Magnet DC Machine **Rated Power:** 7 kW | Peak Power: 5 kW **Rated Speed:** 3000 RPM **Operation:** Power loading through resistive load only — no electrical energy regeneration path	1
2	**Encoder**	**Maximum Speed:** 5000 RPM	1

B.6 ONBOARD CHARGER (OBC) & EVSE — AC SLOW CHARGING PATH			
S.No.	**Component**	**Specification**	**Qty.**
1	**Onboard Charger (OBC)**	**Topology:** DC-DC Buck Converter **Switch Type:** IGBT **Input Voltage:** 230 V AC, single-phase (from EVSE) **Output Voltage:** 84 V DC **Output Current:** 12 A **Switching Frequency:** 10 kHz **Cooling:** Air-cooled **Controller:** Dedicated local controller with local HMI/indication; NI FPGA (sbRIO-9607) for supervisory/integrated operation; external PWM/duty-cycle input via Research Interface Panel **Protection:** OVP, UVP, OCP, short-circuit and over-temperature protection; hardware gate-driver protection with independent fault trip	1
2	**AC Slow Charger (EVSE)**	Type: Level 2 AC Slow Charger Connection: Point of Common Coupling (PCC) Battery Voltage Range: 48–90 V Power Rating: 3.3 kW Features: Pilot signal communication, fault injection capability Direction: One-way — AC grid to OBC only	1
2	**Local Controller (On-board charger)**	Dedicated local controller for on board charger	1

		Local Controller Specifications: **Microcontroller Board:** 32-bit ARM Cortex-M4 with FPU core, 1-MB Flash, 192-KB RAM, LQFP100 **Board Power Supply:** USB bus or external 5 V supply	

B.7 DATA ACQUISITION & SOFTWARE			
S.No.	**Component**	**Specification**	**Qty.**
1	**FPGA Controller**	**Type:** NI-based FPGA Controller **Function:** motor control, drive cycle control, DAQ	1
2	**Software Platform**	**Environment:** LabVIEW (primary); external access as per Section H Interface: Interactive GUI with real-time visualisation at all nodes **Capabilities:** motor control, drive cycle programming, G2V/V2G dispatch scheduling, data logging and post-processing **Access:** Full source code provided without restriction	

C1. Measurement Systems

S.No.	**Component / Parameter**	**Specification / Details**	**Qty.**
1	**LEM LV 20-P — Voltage Transducer**	Accuracy: ±0.9% | Bandwidth: DC to 200 kHz Locations: All DC converter voltage nodes Output: Analog voltage to NI 9684 analog input	All DC - DC converter voltage nodes
2	**LEM LA 25-P — Current Transducer**	Nominal: 25 A RMS | Accuracy: ±0.5% | Bandwidth: DC to 150 kHz Locations: Solar boost, wind buck, battery bank converter Output: Analog current to NI 9684 analog input	3
3	**LEM LA 55-P — Current Transducer**	Nominal: 50 A RMS | Accuracy: ±0.5% | Bandwidth: DC to 200 kHz Locations: PMSM phase currents, traction battery, Inverter-1 output Output: Analog current to NI 9684 analog input	5
4	**Digital Storage Oscilloscope**	Channels: 4 isolated differential | Bandwidth: ≥200 MHz | Sample Rate: ≥1 GS/s Vertical Resolution: 12-bit Nodes: Inverter-1 output, Solar Boost switching, Traction Bidir. switching, EVSE pilot Interface: USB → LabVIEW waveform export	1
5	**DC Power Analyser**	Parameters: DC V, I, P, E (Wh) | Location: DC load | Protocol: Modbus RTU RS-485	1

6	**Three-Phase AC Power Analyser (×2)**	Parameters: 3-phase V, I, P, Q, S, PF, f, THD | Locations: AC load + PCC Protocol: Modbus RTU RS-485	1

C2. Control Systems

S.No.	Component / Parameter	Specification / Details	Qty.
1	**NI sbRIO-9607**	FPGA: Xilinx Zynq-7020 SoC | RT Processor: 667 MHz dual-core ARM Cortex-A9 RAM: 512 MB | Storage: 512 MB | Network: Gigabit Ethernet FPGA: FOC, MPPT, PWM, hardware protection at 10 kHz RT: Shared Variable host, supervisory EMS, EMS-1 through EMS-5 logic	1
2	**NI 9684 Mezzanine Card**	Type: General Purpose Inverter Controller — RIO Mezzanine Card Connection: RMC direct board-to-board to sbRIO-9607 Outputs: Half-bridge digital outputs — IGBT gate drives for all converters and inverters Analog Inputs (Simultaneous): All LEM sensor signals, encoder signal, temperatures	1

C3. Operator Console and Visualisation

S.No.	Component / Parameter	Specification / Details	Qty.
1	**Operator Desktop Workstation**	Processor: Intel Core i7 | RAM: 16 GB | Storage: 512 GB SSD	1
2	**Large-Format Display**	Size: 75 inches	1
3	**Animated System Introduction Video**	Duration: 2–3 minutes	1

C4. Research-Grade Architecture and Independent Operation

S.No.	Component / Parameter	Specification / Details	Qty.
1	**Platform Architecture**	Modular research platform, not designed only as a centrally controlled training kit Each major subsystem (Solar PV Emulator, Wind Turbine Emulator, Fuel Cell Simulator, Battery Energy Storage System, DC/DC Converters, DC Bus, VSI/Grid Interface, Grid Simulator and Loads) supports: standalone/local operation, integrated operation with the common microgrid EMS, and operation using an external/user-developed controller (inverters as per S.No. 3)	

2	**Local Controllers (DC/DC Converters)**	Every DC/DC converter in the system has a dedicated local controller with access to its voltage, current, temperature, switching and protection signals Each converter can be independently controlled locally	1
3	**Inverter Control (VSI and Inverter-1)**	Inverters are operated through the NI FPGA controller only and do not have separate standalone local controllers	1
4	**Supervisory Control**	The NI sbRIO-9607 FPGA controller is used for supervisory and coordinated operation and is not the only control path for the DC/DC converters	1
5	**Fail-Safe Operation**	Failure or shutdown of the central EMS/LabVIEW computer does not disable local protection and safe operation of individual equipment	1

C5. DC Bus and DC/DC Converter Requirements

S.No.	Component / Parameter	Specification / Details	Qty.
1	**Common 120 V DC Bus**	DC voltage and DC current measurement OVP/UVP and OCP/SCP Pre-charge circuit and DC discharge circuit Contactor/isolation and emergency shutdown	1
2	**DC/DC Converters (each)**	Local controller with local HMI/indication Input/output voltage and current measurement Hardware gate-driver protection and independent fault trip External controller interface with PWM/duty-cycle access	1

C6. Research Interface, Measurement and Communication

S.No.	Component / Parameter	Specification / Details	Qty.
1	**Research/External Controller Interface Panel**	Panel for connecting user-developed controllers, DSPs, microcontrollers, dSPACE/OPAL-RT/NI controllers or equivalent research hardware External gate-signal (PWM) inputs for the DC/DC converters Conditioned sensing feedback signals (voltage, current, temperature) brought out as analog outputs Digital I/O for enable, fault and interlock signals	1
2	**Measurement / Test Points**	Dedicated measurement points for voltage, current, power, temperature and speed/torque (wherever applicable) on each major subsystem Banana terminals, isolated test points and patch panel for research measurements	
3	**Communication Interfaces**	Ethernet, Modbus TCP/IP, Modbus RTU/RS-485 CAN/CAN-FD wherever applicable	

		Digital I/O, analog I/O and external PWM input/output	
4	**Software Access**	LabVIEW is the primary software for operating the system LabVIEW is not the sole means of operation: with sensing feedback and gate signals available externally, the user can modify the system to operate through other software and interfaces	
5	**Protocol Documentation**	Complete communication protocol documentation, including register maps for all Modbus devices	

C7. Safety, Acceptance Test and Documentation

S.No.	Component / Parameter	Specification / Details
1	**Subsystem Safety**	Hardware emergency stop, fuse/circuit breaker and contactor on each subsystem Over-temperature protection and over-voltage/over-current protection as applicable Safe shutdown
2	**Acceptance Test Demonstration**	Operation with central controller ON Operation with central controller OFF (FPGA-controlled inverters remain safely disabled in this condition) Operation with Ethernet disconnected Operation with LabVIEW unavailable Operation through an external controller Individual fault isolation Emergency shutdown
3	**Documentation**	Complete electrical schematic, control architecture, protection architecture, wiring diagram, communication map, I/O list and source code

D. Must have Features

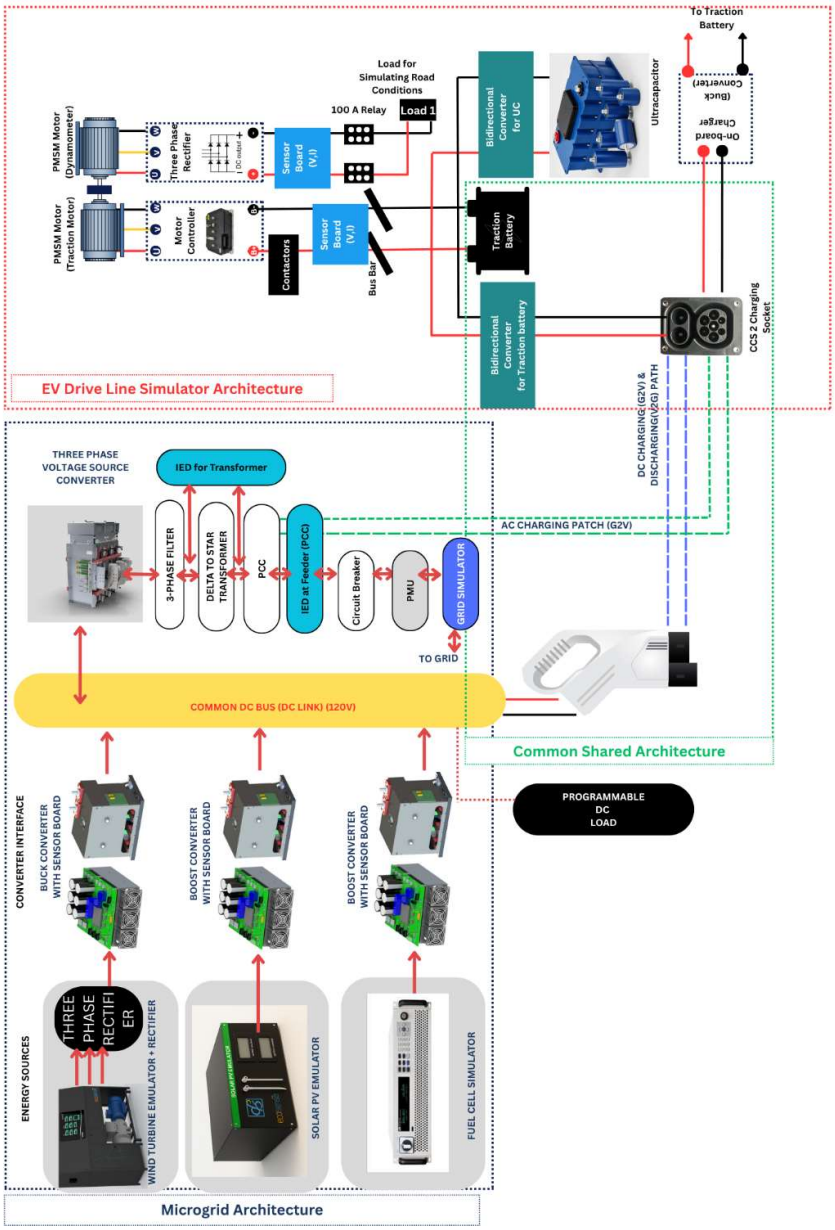
The hardware platform must support systematic characterisation of renewable sources, storage, motor drives, and grid interaction, in addition to protection engineering studies grounded in real relay hardware.

Renewable Generation & Storage Characterisation	● Solar PV I-V curve tracing and MPPT efficiency measurement under programmable irradiance and temperature. ● Wind turbine power coefficient and tip-speed-ratio characterisation under Manual, Table, and field-data playback modes. ● Fuel cell polarisation curve and transient response characterisation without hydrogen handling.

	• LFP battery dual-role behaviour: current-controlled charging versus voltage-source islanded operation. • Battery State-of-Health estimation via coulomb counting against rated capacity.
EV Drivetrain & Motor Control	• PMSM torque, speed, and efficiency characterisation under Field-Oriented Control. • Ultracapacitor transient buffering performance during acceleration and regenerative braking events. • Grid-to-Vehicle and Vehicle-to-Grid round-trip efficiency measurement. • IGBT switching-loss and dead-time analysis from oscilloscope waveform capture.
Grid Interaction & Protection	• Grid synchronisation, active/reactive power dispatch, and anti-islanding validation. • Synchrophasor-based grid dynamics monitoring at the point of common coupling. • Primary-backup protection coordination timing between transformer and feeder IEDs. • Grid-code compliance and ride-through verification using the Regenerative Grid Simulator. • Power-quality analysis — harmonics, power factor, and voltage sag/swell response — under the programmable RLC load bank.
Process Control & Instrumentation	• Direct FPGA-level access to MPPT duty-cycle, FOC current-loop, and grid-synchronisation control code. • Five simultaneous industrial communication protocols integrated within one LabVIEW environment. • Real-time historian logging of every Shared Variable, Modbus register, and synchrophasor stream. • Configurable rule-based EMS experiments (EMS-1 through EMS-5) for dispatch-logic research.
Safety & System Validation	• Four-layer protection: FPGA hardware protection, LabVIEW RT software protection, REF601 feeder IED, and RET615 transformer IED, each independent of the layers above it. • Independent operability of each research domain, allowing safe, isolated commissioning and fault-finding.

	• Forced-air cooled power stages rated for continuous laboratory duty cycles.
Open-Source Platform for Engineering Research	• The system must be built upon an open-source platform which supports new algorithm development and engineering research

B. Block Diagram



INTEGRITY PACT

Between **[the Procuring Organisation]** hereinafter referred to as "The Principal," and _____ hereinafter referred to as "The Bidder/ Contractor."

Preamble

The Principal intends to award contract/s for _____, under laid down organisational procedures. The Principal values full compliance with all relevant laws of the land, rules, regulations, economical use of resources, and fairness / transparency in its relations with its Bidder(s) and / or Contractor(s).

To achieve these goals, the Principal shall appoint Independent External Monitors (IEMs) who shall monitor the tender process and the execution of the contract for compliance with the principles mentioned above.

Section 1 – Commitments of the Principal

1. The Principal commits itself to take all measures necessary to prevent corruption and to observe the following principles: a. No employee of the Principal, personally or through family members, shall in connection with the tender for, or the execution of a contract, demand, take a promise for or accept, for self or third person, any material or immaterial benefit which the person is not legally entitled to. b. The Principal shall treat all Bidder(s) with equity and reason during the tender process. The Principal shall, in particular, before and during the tender process, provide to all Bidder(s) the same information and shall not provide to any Bidder(s) confidential / additional information through which the Bidder(s) could obtain an advantage in the tender process or the contract execution. c. The Principal shall exclude from the process all known persons having conflict of interest.

2. If the Principal obtains information on the conduct of any of its employees which is a criminal offence under the IPC/PC Act, or if there be a substantive suspicion in this regard, the Principal shall inform the Chief Vigilance Officer and in addition shall initiate disciplinary proceedings.

Section 2 – Commitments of the Bidder(s)/ Contractor(s)

1. The Bidder(s)/ Contractor(s) commits themselves to take all measures necessary to prevent corruption. The Bidder(s)/ Contractor(s) commits themselves to observe the following principles during participation in the tender process and the contract execution: a. The Bidder(s)/ Contractor(s) shall not, directly or through any other person or firm, offer, promise, or give to any of the Principal's employees involved in the tender process or the execution of the contract or to any third person any material or other benefit which they are not legally entitled to, in order to obtain in exchange any advantage of any kind whatsoever during the tender process or the execution of the contract. b. The Bidder(s)/ Contractor(s) shall not enter with other Bidders into any undisclosed agreement or understanding, whether formal or informal, in violation of the Competition Act, 2002 (as amended from time to time). This applies in particular to prices, specifications, certifications, subsidiary contracts, submission or non-submission of bids or any other actions to restrict competitiveness or to introduce cartelisation in the tender process. c. The Bidder(s)/ Contractor(s) shall not commit any offence under the relevant IPC/PC Act; further, the Bidder(s)/ Contractor(s) shall not use improperly, for purposes of competition or personal gain, or pass on to others, any information or document provided by the Principal as part of the business relationship, regarding plans, technical proposals, and business details, including information contained or

transmitted electronically. d. The Bidder(s)/Contractor(s) of foreign origin shall disclose the name and address of the Agents/representatives in India, if any. Similarly, the Bidder(s)/Contractor(s) of Indian Nationality shall furnish the name and address of the foreign principals, if any. Further details, as mentioned in the "Guidelines on Indian Agents of Foreign Suppliers," shall be disclosed by the Bidder(s)/Contractor(s). Further, as mentioned in the Guidelines, all the payments made to the Indian agent/representative must be in Indian Rupees only. Copy of the "Guidelines on Indian Agents of Foreign Suppliers" is placed on Annex hereto. e. The Bidder(s)/ Contractor(s) shall, when presenting their bid, disclose any and all payments made, is committed to, or intends to make to agents, brokers, or any other intermediaries in connection with the award of the contract. f. Bidder(s) /Contractor(s) who have signed the Integrity Pact shall not approach the Courts while representing the matter to IEMs and shall wait for their decision.

2. The Bidder(s)/ Contractor(s) shall not instigate third persons to commit offences outlined above or be an accessory to such offences.

Section 3 – Disqualification from the tender process and exclusion from future contracts

If the Bidder(s)/Contractor(s), before award or during execution, has committed a transgression through a violation of Section 2, above or in any other form such as to put their reliability or credibility in question, the Principal is entitled to disqualify the Bidder(s)/Contractor(s) from the tender process or take action as per laid down procedure to debar the Bidder(s)/Contractor(s) from participating in the future procurement processes of the Government of India.

Section 4 – Compensation for Damages

1. If the Principal has disqualified the Bidder(s) from the tender process before the award according to Section 3, the Principal is entitled to demand and recover the damages equivalent to Earnest Money Deposit/ Bid Security.

2. If the Principal has terminated the contract according to Section 3, or if the Principal is entitled to terminate the contract according to Section 3, the Principal shall be entitled to demand and recover from the Contractor liquidated damages of the Contract value or the amount equivalent to Performance Bank Guarantee.

Section 5 – Previous transgression

1. The Bidder declares that no previous transgressions occurred in the last three years with any other Company in any country conforming to the anti-corruption approach or with any Public Sector Enterprise in India that could justify his exclusion from the tender process.

2. If the Bidder makes an incorrect statement on this subject, the Principal shall act like para 2) of Section 4 above.

Section 6 – Equal treatment of all Bidders / Contractors / Subcontractors

In the case of Sub-contracting, the Principal Contractor shall take responsibility for adopting the Integrity Pact by the Sub-contractor. a. The Principal shall enter into agreements with identical conditions as this one with all Bidders and Contractors. b. The Principal shall disqualify from the tender process all bidders who do not sign this Pact or violate its provisions.

Section 7 – Criminal charges against violating Bidder(s) / Contractor(s) / Subcontractor(s)

If the Principal obtains knowledge of the conduct of a Bidder, Contractor, or Subcontractor, or of an employee or a representative or an allied firm of a Bidder, Contractor or Subcontractor which constitutes corruption, or if the Principal has substantive suspicion in this regard, the Principal shall inform the same to the Chief Vigilance Officer.

Section 8 – Independent External Monitor

1. The Principal shall appoint competent and credible Independent External Monitor(s) for this Pact after approval by the Central Vigilance Commission. The task of the Monitor is to review, independently and objectively, whether and to what extent the parties comply with the obligations under this agreement.

2. The Monitor is not subject to instructions by the parties' representatives and performs their functions neutrally and independently. The Monitor would have access to all Contract documents whenever required. It shall be obligatory for them to treat the information and documents of the Bidders/Contractors as confidential. They report to the Management of the Principal.

3. The Bidder(s)/Contractor(s) accepts that the Monitor has the right to access without restriction, all Project documentation of the Principal, including that provided by the Contractor. Upon their request and demonstration of a valid interest, the Contractor shall also grant the Monitor unrestricted and unconditional access to their project documentation. The same applies to Sub-contractors.

4. The Monitor is under contractual obligation to treat the information and documents of the Bidder(s)/ Contractor(s)/ Sub-contractor(s) with confidentiality. The Monitor has also signed declarations on 'Non-Disclosure of Confidential Information' and 'Absence of Conflict of Interest.' In case of any conflict of interest arising later, the IEM shall inform the Management of the Principal and recuse themselves from that case.

5. The Principal shall provide the Monitor with sufficient information about all meetings among the parties related to the Project, provided such meetings could impact the contractual relations between the Principal and the Contractor. The parties offer the Monitor the option to participate in such meetings.

6. As soon as the Monitor notices, or believes to notice, a violation of this agreement, they shall inform the Management of the Principal and request the Management to discontinue or take corrective action or other relevant action. The Monitor can, in this regard, submit non-binding recommendations. Beyond this, the Monitor has no right to demand from the parties that they act in a specific manner, refrain from action, or tolerate action.

7. The Monitor shall submit a written report to the Management of the Principal, within 8 to 10 weeks from the date of reference or intimation to him by the Principal and, should the occasion arise, submit proposals for correcting problematic situations.

8. If the Monitor has reported to the Management of the Principal a substantiated suspicion of an offence under the relevant IPC/ PC Act, and the Management of the Principal has not, within the reasonable time, taken visible action to proceed against such offence or reported it to the Chief Vigilance Officer, the Monitor may also transmit this information directly to the Central Vigilance Commissioner.

9. The word 'Monitor' would include both singular and plural.

Section 9 – Pact Duration

This Pact begins when both parties have legally signed it. It expires for the Contractor 12 months after the last payment under the contract, and for all other Bidders, 6 months after the contract has been awarded. Any violation of the same would entail disqualifying the bidders and exclusion from future business dealings. If any claim is made / lodged during this time, the same shall be binding and continue to be valid despite the lapse of this Pact as specified above, unless it is discharged / determined by the Management of the Principal.

Section 10 – Other provisions

1. This agreement is subject to Indian Law. The place of performance and jurisdiction is the place from where the Tender/ Contract is issued.
2. Changes, supplements, and termination notices must be submitted in writing. Side agreements have not been made.
3. If the Contractor is a partnership or a consortium, this agreement must be signed by all partners or consortium members.
4. Should one or several provisions of this agreement turn out to be invalid, the remainder of this agreement remains valid. In this case, the parties shall strive to come to an agreement according to their original intentions.
5. Issues like Warranty / Guarantee, etc., shall be outside the purview of IEMs.
6. In the event of any contradiction between the Integrity Pact and its Annex, the Clause in the Integrity Pact shall prevail.

(For & On behalf of the Principal)	**(For and on behalf of Bidder/ Contractor)**
(Office Seal)	**(Office Seal)**
Place	**Date**
Witness (Principal)	**Witness (Bidder/Contractor)**
Witness 1:	**Witness 1:**
Name: _____	Name: _____
Address: _____	Address: _____
_____	_____