

ANNEXURE - "C"

TECHNICAL SPECIFICATIONS

FOR

GREEN HYDROGEN BASED MICROGRID PROJECT

At

POWERGRID's 400/220kV NEEMRANA Sub Station

Power Grid Corporation of India Limited

Technical Specifications for Green Hydrogen based Microgrid Project at Neemrana Sub station

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1.0 INTRODUCTION

Power Grid Corporation of India Limited (POWERGRID) intends to set up Green Hydrogen based Microgrid Project on turnkey basis at POWERGRID's 400/220KV Neemrana Sub Station, Rajasthan to meet the entire captive auxiliary load demands of Neemrana Substation.

The estimated average daily auxiliary load requirements of the Neemrana substation are about 2000kWh, out of which about 40% of the load (i.e. about 800kWh) is required to be catered during solar hours and balance 60% (i.e. about 1200kWh) of the load is required to be catered during non-solar hours.

The Project envisage of setting up the solar plant, the green hydrogen production plant using electrolysis of water, the hydrogen storage facility and fuel cell for generation of electricity to meet both day and night load demands of the substation. The day load shall be met directly through solar energy. The night load/ non solar hour load of the substation shall be met by the electricity produced through fuel cell system.

The site coordinates are 28°0'3.0492"N, 76° 26'7.332"E. The site map is attached at **Annexure-I**.

2.0 GENERAL INFORMATION

- i. These specifications are intended to cover the product and services that must be provided in respect of the execution of the complete microgrid project on turnkey basis. The broad scope of work is specified in subsequent clauses.
- ii. Before submitting bid, the bidders are advised to visit the site, inspect and examine it to satisfy themselves with the quantum and nature of work, quantity of materials necessary for completion of the work, means of access to site and enable themselves to prepare the bid at their own cost. No consequent extra claims on any misunderstanding or otherwise shall be allowed by the POWERGRID.
- iii. Bidders are requested to carefully examine and understand the specifications and seek clarifications, if required, to ensure that they have understood the specifications. Bidder's offer should not carry any sections like clarifications, interpretations and/or assumptions. However, if the bidder feels that, in his opinion, certain features brought out in their offer are superior to what has been specified, these may be highlighted separately.

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- iv. The Bidder's proposal shall address all functional and performance requirements within these specifications and shall include sufficient information and supporting documentation in order to determine compliance with the specifications without further necessity for inquiries.
- v. The Bidder's proposal shall clearly identify all features described in the specifications or in any supporting reference material that will not be implemented; otherwise, those features shall become binding as part of the final contract.
- vi. It should be noted that preliminary design information and bill of quantity are indicative only. The contractor shall verify jointly (with employer) the design data during the site surveys & detail engineering and finalize the BoQ as required for ultimate design & system performance.
- vii. An analysis of the functional and performance requirements of these specifications and/or site surveys, design, and engineering may lead the contractor to conclude that additional items are required that are not specifically mentioned in these specifications. The Contractor shall be responsible for providing at no added cost to the Employer, all such additional items so that a viable and fully functional Microgrid Project is implemented that meets or exceeds the performance requirements specified. Such materials shall be considered to be within the scope of the contract. To the extent possible, the Bidders shall identify and include all such additional items in their proposal.
- viii. The equipment and civil works must conform to high standards of engineering, design and workmanship, sourced from reputed manufacturers and should be able of performing continuous operation, in a manner acceptable to the employer, who will interpret the meaning of the specification, drawings etc. Also, the employer shall have a right to reject or accept any work or material which in his assessment is not adequate to meet the requirements of these specifications and/or applicable Indian/International standards/mentioned elsewhere in the specifications, guidelines and policies of Govt. of India.
- ix. All material constructed or otherwise shall be considered as the property of supplier till its handover to the employer upon successful commissioning of the project.

3.0 SCOPE OF WORK

Bidder shall be responsible for: -

- i. Design, Engineering, Manufacturing, Fabrication, Packing, Supply, Transport, Freight & Insurance, Handling, Unloading, Construction, Erection, Installation, Integration, Commissioning, Testing, mandatory spares, obtaining statutory approvals including drawings and documents, Training and comprehensive O&M of the microgrid project

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based upon green hydrogen and fuel cell at POWERGRID's Substation at Neemrana on turnkey basis.

- ii. The Microgrid Project shall comprise of the following systems:

S No.	Description	Quantity
1	Solar Plant	1 Lot
2	Hydrogen generation system (Electrolyzer and BoP)	1 Lot
3	Hydrogen Compression, storage and depressurization system	1 Lot
4	Fuel Cell system	1 Lot
5	Integrated Control System, Instrumentation and allied works including Fire & Gas detection & control system.	1 Lot
6	Complete Electrical Works (starting from power generation through Solar plant to electrolyser and its BoP to fuel cell and its integration with the existing auxiliary load of the substation at 415V AC, including DC distribution, PCU/ Inverter, AC distribution etc.	1 Lot
7	Complete Civil & Mechanical Works for the Project including Water borewell and water storage tank	1Lot
8	Operations & Maintenance of the complete system including scheduled, preventive and breakdown maintenance, replacement of spares & consumables, fulfilling statutory requirements etc.	10 Years

- iii. The system should be flexible for future expansion for setting up Hydrogen Refueling station, if required. The space utilization, layout of the plant and associated BOP etc. should be designed accordingly.
- iv. Borewell for the extraction raw water required for the hydrogen production and solar plant. Further, the provision for suitable utilization of waste water shall also be kept in order to limit ground water extraction. The cost for the same shall be in bidder scope
- v. Complete civil works for setting up of the plant including site grading, ground preparation/filling/levelling, compaction of the identified area for the project, landscaping

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- and façade, boundary wall, fencing, gates , demolishing of portion of existing boundary wall and construction of separate gate entry/exit for the hydrogen plant etc.”
- vi. Complete electrical system starting from generation of power through solar plant to integrating with the existing 415V switchgears, HT and LT switchgears, DC/AC converters, step-up/step-down transformers, electrolyser and its BoP, fuel cell, electrical distribution system and other auxiliaries.
 - vii. Integrated Control System (ICS) for the overall monitoring and control of the entire microgrid system and sub systems within the facility shall be provided. The control system should be operatable from the control room and also from the remote locations. The system should be microprocessor-based design capable of fully automatic operation with integrated safety controls as laid out in a manner so as to conform to applicable national/ international standard. Monitoring of the real time parameters and alarms of the microgrid plant shall be available in the control room on the LED screens.
 - viii. System design for both stand-alone mode of operation as well as in tandem with local distribution grid. All interlocking, protections, safety arrangements required to make the system operational for successful commissioning shall be in the scope of bidder. Further, the Interfacing of the fuel cell output with AC distribution system as per the actual site requirements are also in the scope of bidder.
 - ix. Transformers, rectifiers, DC bus duct, inverters/ UPS, battery back-up, switchgears, protection system, metering systems, cables, arrangements or any other requirements for interface with local distribution system are in the scope of bidder.
 - x. To carry out Hazard and Operability study (HAZOP), Safety Integrity Level (SIL), Hazard Identification and Risk Assessment (HIRA), Quantitative Risk Assessment (QRA), Hazardous area classification (HAC), Escape Muster and Emergency Response Analysis (EMERA) for the complete plant and outcome of those shall be incorporated in the design and implementation of the system.
 - xi. Comprehensive fire prevention, detection and extinguishment with all gas, smoke, and flame detectors. Inert gas flooding system in all control rooms and closed enclosures.
 - xii. Comprehensive gas leakage detection and control mechanism.
 - xiii. Adequate safety systems are to be installed for proper monitoring and ensuring healthiness of every equipment on a continuous basis. The certification of all equipment to be done on a regular basis, maintaining the OEM guidelines as well as Indian standards. The last date of certification/ calibration should be mentioned on the equipment.
 - xiv. To coordinate and arrange the necessary regulatory approvals from Petroleum and Explosives Safety Organization (PESO) for the storage and high-pressure components and also for the layout of the hydrogen production, storage and utilization station.

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- xv. To coordinate and arrange the necessary approvals from all the relevant authorities for the electrical systems (alongwith CEA inspection, if required) and NOC from Fire dept. and Pollution Control Board etc. (if required) in consultation with POWERGRID.
- xvi. To adhere to the CPWD/NBCC guidelines for civil works and relevant IS/ISO/IEC/OISD/NFPA/ASME/API standards etc.
- xvii. All license fees, technology fees, customs clearance (including reconciliation with customs authorities as required), port clearance, port charges, statutory requirements, and clearance are in the scope of bidder.
- xviii. Appropriate number of CCTV cameras (high resolution, manual and digital focus with night color vision) covering entire Microgrid Project with at least 15 days storage of data. The feed from the CCTV cameras shall be made available locally at control room.
- xix. Temporary Arrangement of Site office and stores with complete facilities, amenities etc., which are required to be set up at the site for execution of the project shall be provided by the bidder.
- xx. Pavement and gravel base to avoid weed growth in the plant area.
- xxi. Cutting, clearing, transporting and disposal of plants, bushes, other vegetation, roots, stubs, etc. as required for the construction of plant is under the scope of the bidder.
- xxii. Brick or concrete boundary wall with plastering and concertina wire fence for the outer area and wire mesh boundary wall for internal area of Microgrid Project.
- xxiii. Procurement and installation of Display board/LED signages at appropriate locations of the plant.
- xxiv. Appointment of Project Manager, Design Engineer & other resources for successful & timely completion of project.
- xxv. The detailed engineering and commissioning plans that is consistent with the scope of the project and Employer's specified objectives, vetted through any India based certified Project Management Consultant (PMC) who have experience in hydrogen-based Project consultancy and Project management should be submitted for review and approval of the employer.
- xxvi. Project management, project scheduling, including periodic project reports documenting progress during the contract period.
- xxvii. Factory and site acceptance testing of the equipment, components and material, hardware, software etc. to be provided for the project.
- xxviii. Shipment of all equipment and documentation to the Employer designated location.

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- xxix. Staging, maintenance and security of the staging area including the full responsibility for protection from fire and theft.
- xxx. Undertake Trial test and Performance guarantee test for successful commissioning of the project.
- xxxi. Ensuring availability of all the spares at all the times.
- xxxii. Defect liability period (DLP) of 01 year after project commissioning.
- xxxiii. Comprehensive O&M for ten (10) years including manpower, materials, replacement components (solar PV system, electrolyser, storage and fuel cell stack) tools and tackles, spares, and consumables, as necessary for smooth functioning and operation of the plant.
- xxxiv. 02 nos. of 3D models of the entire plant shall be supplied: - one for the main control room of sub-station and another for hydrogen plant control room.
- xxxv. Any other equipment, materials and services whether explicitly stated or otherwise required for setting up and smooth functioning of the project shall be arranged by the bidder on his own cost and POWERGRID will not bear any additional cost.
- xxxvi. To abide by any revision/ modifications/ changes in the applicable standards referred herein and/or relevant with regard to this project.
- xxxvii. Bidder should also comply the requirements for the subsystem as specified in Annexure-VIII of this technical specifications.

4.0 Facilities to be provided by Employer

- i. Providing access to the site.
- ii. Identification and providing land parcel within Sub-station for setting up the project.
- iii. Providing power supply at 415 V during construction activity on chargeable basis.
- iv. Providing support to the bidder for arranging approvals from the respective authorities including PESO etc.

5.0 Project Completion Schedule

The entire microgrid project including solar PV plant, green hydrogen production and storage facilities, Fuel cell and its integration with the auxiliary load of sub-station and the successful performance guarantee testing of the integrated system shall be completed within 12 months from the date of placement of letter of award (LOA).

6.0 Technical Specifications of the Major Components of the Project

6.1 Solar Plant

That is consistent with the scope of the project and Employer's specified objectives.

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- i. The broad capacity requirements of the Solar plant are as below;

S No.	Parameter	Description/ Specifications
1	Technology	Solar PV
2	DC Capacity	1500kWp
3	DC to AC Ratio	1.2
4	Operation	Standalone mode as well as tandem operation with the local grid
5	Connectivity	LT distribution system of the substation

- i. The solar Plant shall consist of SPV arrays, Module Mounting Structures, Power Conditioning Units (PCU) consisting of Maximum Power Point Tracker (MPPT), Inverters, Controls & Protections, interconnecting cables, junction boxes, distribution boxes, switches, earthing and lightening protection.
- ii. The estimated power generation from the Solar plant should be as per minimum CUF of 20% and should be able to run the electrolyser, Balance of System (BoS) & Balance of Plant (BoP) and meet the sub-station auxiliary load during day time.
- iii. Components and parts used in the Solar PV plant including the PV modules, metallic structures, cables, junction boxes, switches, PCUs etc. shall conform to the applicable BIS or IEC or International standards.
- iv. The total solar PV array capacity shall not be less than rated plant capacity (kWp) and shall comprise of **mono crystalline half cut solar modules** of minimum 545 Wp and above wattage. Module capacity less than 545 Wp shall not be accepted.
- v. All the modules shall be of same make and rating.
- vi. The rated output power of any supplied module shall have positive tolerance of 5 watts.
- vii. Each Solar PV module used in solar power plants/ system must be warranted for their output peak watt capacity at standard test condition as per IEC 61215 with respect to name plate wattage, which shall not be less than 90% at the end of 10th year and 80% at the end of 25th year from the commissioning of the plant. The bidder shall provide warranty for the reliability and performance of the individual modules/ equipment as well as for the complete system.
- viii. Module manufacturer should be from latest approved ALMM (Approved List of Module manufacturers) list notified by Ministry of New and Renewable Energy.

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- ix. The modules must have been tested and approved by the IEC authorized test centers.
- x. The module frame shall be made of corrosion resistant materials, preferably having anodized aluminum.
- xi. The modules shall have been tested with relevant dust standards (IEC 60068-2-68) to operate in high dust environment.
- xii. The Modules deployed must use a RF identification tag. The following information must be mentioned in the RFID used on each module, which should be inside the laminate;
 - i. Name of the manufacturer of the PV module
 - ii. Name of the manufacturer of Solar Cells
 - iii. Month & year of the manufacture (separate for solar cells and modules)
 - iv. Country of origin (separately for solar cells and modules)
 - v. I-V curve for the module, Wattage, Im, Vm and FF for the module
 - vi. Unique Serial No and Model No of the module
 - vii. Date and year of obtaining IEC PV module qualification certificate
 - viii. Name of the test lab issuing IEC certificate.
 - ix. Other relevant information as per ISO 9001 and ISO 14001
- xiii. The module shall be provided with a junction box either with the provision of external screw terminal connection or sealed type and with arrangement for provision of by-pass diode. The box shall have hinged, weather proof lid with captive screws and cable gland entry points or may be of sealed type and IP-65 rated.
- xiv. Each PV module shall be interconnected by MC connector.
- xv. Hot dip galvanized MS mounting structures shall be used for mounting the modules/ panels/arrays. Each structure shall have angle of inclination as per the site conditions to take maximum insolation. The mounting structure shall be able to support seasonal tilt. Bolts required to lose and tighten seasonally for seasonal tilting in the module mounting structure should be of good anti-seize finish and proper wax coating.
- xvi. The Mounting structure shall be so designed to withstand the wind speed in the wind zone as applicable for the sub-station location. It shall be ensured that the design has been certified by a recognized Lab/ Institution in this regard. The wind loading calculation sheet shall be submitted by the bidder. Suitable fastening arrangement such as grouting and calming shall be provided to secure the installation against the specific wind speed.
- xvii. The fastener should be made of stainless steel. The structures shall be designed to allow easy replacement of any module. The array structure shall be so designed that it will occupy minimum space without sacrificing the output from the SPV panels.
- xviii. All wind pressure loading and wind co-efficient as per latest IS standards shall be used for the design of foundation system for the modules. The proposed foundation system for module mounting structures (MMS) shall be based on findings/ results of the

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approved geo technical investigation report. Top of concrete/ height of collar for MMS foundation shall be minimum 400 mm above finish ground level to avoid water logging or any vegetation growth.

- xix. The bird spike shall be provided at the highest point of array/module structure to avoid sitting of birds on solar PV modules.
- xx. Adequate space may be provisioned in solar array arrangement for cleaning of solar PV panels.
- xxi. The junction boxes are to be provided in the PV array for termination of connecting cables. The Junction Boxes (JBs) shall be made of GRP/FRP/Powder coated Aluminum/ cast Aluminum alloy with full dust, water & vermin proof arrangement. All wires/cables must be terminated through cable lugs. The JB's shall be such that input & output termination can be made through suitable cable glands.
- xxii. The Copper bus bars/terminal blocks housed in the junction box with suitable termination threads shall conforming to IP65 standard and IEC 62208, hinged door with EPDM rubber gasket to prevent water entry. There shall be Single/ double compression cable glands and provision of earthing.
- xxiii. Each Junction Box shall have high quality suitable capacity Metal Oxide Varistors (MOVs) / SPDs, suitable Reverse Blocking Diodes. The Junction Boxes shall have suitable arrangement for monitoring and disconnection for each of the groups.
- xxiv. Suitable markings shall be provided on the bus bar for easy identification and the cable ferrules must be fitted at the cable termination points for identification.
- xxv. The JB's shall have suitable arrangement for the followings:
 - i. Combine groups of modules into independent sub-arrays.
 - ii. Provide arrangement for disconnection for each of the groups.
 - iii. Provide a test point for each sub-group for quick fault location.
- xxvi. A Suitable Solar PV module cleaning system through water washing and mopping system with pressure pump, piping, valves, wipers, mops etc. shall be provided for regular cleaning of the solar PV modules.

6.2 Electrolyser

- i. Non-containerized/ Containerized electrolyser system (hydrogen generation system) shall be provided for generation of hydrogen.
- ii. The broad capacity requirements of the electrolyser system are as below;

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S No.	Parameter	Description/ Specifications
1	Technology	Alkaline/ PEM etc.: Bipolar type complying to ISO 22734: 2019 or equivalent
2	Electrolyser Capacity	1MW
3	Specific Energy Consumption of electrolyser and balance of plant (BoP) (Compressor, DM Water treatment Plant, Raw Water extraction, chiller, auxiliary load of hydrogen plant control room etc) at BOL i.e. beginning of life of the system	$\leq 58\text{kWh}$ per kg of hydrogen generated
4	Minimum Hydrogen Output at full load	17.85kg/hour. Output Pressure as per OEM design
5	No. of Electrolyser Units	2X50% or 3X34% of total capacity (Independent streams of operation starting from rectifier till separator input)
6	Hydrogen Purity	$\geq 99.995\%$
7	Production Capacity Dynamic Range (Turn Down Ratio)	30-100%. Better turn down ratio with starting value less than 30% shall also be acceptable
8	Design Life	20 years
9	Stack life for continuous Operations	70,000 Hrs.
10	Cold Start-up time	≤ 35 minutes
11	Warm start-up time	≤ 5 minutes
12	Ramp up rate	As per OEM design for safe operation based on offered technology
13	Ramp down rate	As per OEM design for safe operation based on offered technology
14	Water consumption	≤ 12 Liters/kg H ₂ (DM water)
15	De-Oxo and Dryer Unit per Electrolyser	As per OEM design for safe operation based on offered technology
16	Noise Level at a distance of 1meter from enclosure	$\leq 75\text{dB}$
17	Dew Point Temp at ambient conditions	-60°C (Max)

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- iii. Hydrogen production curve at part load shall be submitted.
- iv. The hydrogen generation system should essentially comply with all relevant National and International Standards for safe and reliable operation including;

ISO 22734:2019 or equivalent latest amendments	Hydrogen generators using water electrolysis — Industrial, commercial, and residential applications
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- v. The hydrogen generation system (electrolyser) should be designed to operate in Indian environment on continuous basis to produce desired hydrogen of specified purity and dryness.
- vi. The hydrogen generation system (electrolyser) should also have the flexibility to operate on part load of the rated capacity on continuous basis without any disconnection or interruption of operation and without compromising the specified purity and dryness of the hydrogen produced.
- vii. The hydrogen generation system (electrolyser) should be able to operate based upon generation of RE power and associated intermittencies from the solar plant.
- viii. The System should be able to efficiently separate the H₂ gas from the H₂-water mixture and O₂ from O₂ water mixture for producing H₂/O₂ at specified purity.
- ix. PLC based control system having provision for display and monitoring the efficiency, power consumption, quantity and quality (purity and dryness) of hydrogen generated.
- x. The Hydrogen Generation Plant shall be equipped with all requisite protections to safely shutdown/trip the plant in case of any exigencies and emergencies with respect to operation of Hydrogen Generation plant and safety of equipment and persons.
- xi. Hydrogen leak detection and interlock system shall be provided in the hydrogen generator and hydrogen filling area for alarm and trip of hydrogen generation plant. Provision for Emergency Shut Down (ESD) tap-off facility shall also be operatable through OFC cable connection (to be extended upto control room) for remote shutdown of the hydrogen generator.
- xii. All measuring instruments, controller and control valves required for automated remote and safe operation shall be provided.
- xiii. Appropriate Safety devices are to be provided for Hydrogen Generation System for safe release of Hydrogen, pressure build up etc.
- xiv. Proper sealing shall be provided to avoid any leakage of hydrogen to the Rectifier system.
- xv. Water deionization system and two numbers of circulation pump (1Running + 1Standby) for water circulation in electrolyser system.

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- xvi. The electrolyser design should allow it to be dismantled, cleaned and reassembled easily. Bidder shall provide the cleaning procedure for the electrolyser.
- xvii. Bidder shall specify the stack and/ or detailed list of components of the electrolyser system and their quantity required to be replaced/refurbished during 70,000 hrs. of operation
- xviii. Bidder shall also provide the system for safe shutdown of the system in case of insufficient solar generation for prolonged periods. The details may be submitted during detail engineering for approval of POWERGRID.

6.3 Hydrogen Compression & Storage System

The Hydrogen Compression & storage system should meet the following requirements;

S No.	Parameter	Description/ Specifications
COMPRESSOR		
1	Hydrogen Compressors	Diaphragm/ Ionic gas compressor with chiller.
2	Buffer tank before compressor	As per System design
HYDROGEN STORAGE		
1	Storage Capacity	150Kg @200 bar for usable hydrogen
2	Storage Type	Type-1 or better Cylinders meeting all the PESO requirements of safety and handling
3	Enclosure	Cascaded with mechanical & environment protection

Compressor should be 2 x 100 % (01 main + 01 standby).

6.4 Hydrogen Pressure Reduction System

- i. Hydrogen pressure reducing unit shall be provided for reduction of hydrogen pressure from 200 bar to the required pressure for fuel cell operation.
- ii. Installation of pressure regulators, H₂ purity meter (Coriolis), dew point meter, shutoff and safety valves, control valves, flow meters etc. shall also be carried out by the bidder.
- iii. Outlet of safety valves to be vented to atmosphere through flame arrestor.
- iv. The components and equipment being installed shall be of a reputed make and the conform in all respects to high standards of engineering, design, workmanship and shall meet all the requirements of relevant standards.

6.5 Fuel Cell System

- i. The fuel cell shall be required to generate the electricity from hydrogen and feed it to the auxiliary load of the substation during non-solar hours. The fuel cell should be able to operate for minimum of 12-14 hours per day and meet peak load demand of 200kW per hour of the auxiliary systems of substation.
- ii. The Fuel cell shall generate the electrical power (Net) for the AC load capacity of 200kW using PEM type Fuel Cell.
- iii. The nominal output shall be 415V AC, 50Hz, 3 Phase
- iv. The load modulation shall be 10-100%
- v. The fuel cell shall generate minimum 15 kWh of electricity per kg of hydrogen (with purity of 99.97% as per ISO 14687:2019). The offered Fuel cell must comply with IEC 62282-3 standards/latest amendments.
- vi. The Fuel Cell shall be directly interfaced with AC grid through DC/AC converter.
- vii. Fuel Cell shall operate in standalone mode as well as in tandem operation with local grid comprising Solar PV, DG Set, etc.
- viii. The design life of the fuel cell shall be 20 years.
- ix. The system life shall be minimum of 25000 hrs. of operation without any degradation in the performance.
- x. The fuel cell shall have modular design.
- xi. The fuel cell shall be able to operate at part loads without any disconnection, interruption and shall produce electric power of specified voltage and current on continuous basis.
- xii. Bidder shall specify the list of components of the fuel cell and their quantity required to be replaced/refurbished after completion of 25000 hrs. of operation.

6.5.1 Fuel Cell Sub-System

- i. A hydrogen pump and metering device shall be provided to ensure the availability of hydrogen at required pressure to the fuel cell.
- ii. Humidification Module (as required) shall be installed to control the moisture in the hydrogen.
- iii. A cooling and heating (as per requirement with respect to given ambient condition) unit to be provided to heat/cool the hydrogen delivered to the fuel cell.

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6.6 Rectifier

- i. Adequate numbers of rectifiers shall be provided to independently cater to the load of each of the electrolyser stack. The system shall be designed to have adequate redundancy and reliability in plant operation.

- ii. The Rectifier shall meet the following capacity requirements;

S No.	Parameter	Description/ Specifications
1	AC Input	415V \pm 10% AC, 50Hz \pm 5%, 3 Phase
2	DC Output	Vendor to Furnish as per electrolyser design
3	Type	IGBT/MOSFET/EQUIVALENT
4	Current Adjustment	10 – 100%
5	Operating Condition	Ambient Temperature: 0°C to 55°C
6	Cooling	Naturally/ Forced Air cooled
7	Degree of Protection	IP 54 (min.)
8	Operation	Continuous
9	Installation	Indoor
10	% Ripple	Upto 8% at rated load and nominal input
11	Power Factor	0.9 at rated load and nominal input
12	Efficiency	Min. 95% at rated load and nominal input
13	Input Termination	Vendor to Furnish
14	Output busbar size (Size & Drawing to be specified)	Vendor to furnish

- iii. The rectifier equipment shall be complete in all respect with rectifier transformer, thyristor converter, electronic control and annunciation, filter choke, etc. mounted in the suitable panel.
- iv. Relevant IS/IEC standards shall be applicable for Rectifier Assembly for Hydrogen Generation Plant.

6.7 DC Distribution Panel

- i. DC Distribution panel shall be provided to receive the DC output from the Solar array field.
- ii. The bus bars shall be made of copper of desired size. MCBs/MCCBs of suitable capacity shall be provided for controlling the DC power output to the PCU along with necessary surge arrestors.

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- iii. DC Distribution Panel Boards (DPBs) shall have dust & vermin proof enclosure conforming to IP 65 protection.

6.8 PCU/ INVERTER

As Solar PV array produce direct current electricity. It is necessary to convert this direct current (DC) into alternating current (AC) and adjust the voltage levels to match the grid voltage. This conversion shall be achieved using an electronic Inverter and the associated control and protection devices. All these components of the system are termed as “Power Conditioning Unit (PCU)”. Additionally, PCU shall also house MPPT (Maximum Power Point Tracker), an interface between solar PV Array & inverter. Power conditioning unit should be grid interactive and capable of operating in **OFF-Grid** and **ON-Grid** mode. Inverter output shall be compatible with the grid voltage, frequency, phase sequence etc.

- i. The Typical technical features of the inverter shall be as follows:

Switching devices	IGBT/MOSFET
Control	Microprocessor /DSP
Nominal AC output voltage and frequency	415V, 3 Phase, 50 Hz (In case single phase inverters are offered, suitable arrangement for balancing the phase must be made)
Grid Frequency Synchronization range	± 5 Hz
Ambient Temperature	0°C to 55 °C
Humidity	95 % Non- Condensing
Protection of Enclosure	IP-54 (min) for indoor IP-65(min) for outdoor
Frequency Tolerance range	± 5 Hz
Grid Voltage tolerance	$\pm 10\%$
No-load losses	Less than 1% of the rated power
Inverter efficiency	>97%
Total Harmonic Distortion	< 3%
PF	> 0.9

- ii. Three phase PCU/ inverter or equivalent shall be used with each pocket of solar arrays of Solar PV system.
- iii. PCU/inverter shall be capable of completely automatic operation including wake-up, synchronization & shutdown.
- iv. The power factor of PCU/ inverter shall be suitable for all voltage ranges or sink of reactive power. Inverter should have internal protection arrangement against any sustainable fault in feeder line and against the lightning on feeder.

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- v. Built-in meter and data logger to remotely monitor plant performance through external computer shall be provided.
- vi. Anti-islanding (protection against Islanding of Grid): The PCU shall have anti islanding protection in conformity to IEEE 1547/UL 1741/IEC 62116 or equivalent BIS standard.
- vii. In PCU/Inverter, there shall be a direct current isolation provided at the output by means of a suitable isolating transformer. If isolation Transformer is not incorporated with PCU/Inverter, there shall be a separate Isolation Transformer of Suitable rating provided at the output side of PCU/PCU units.
- viii. The PCU/Inverter, generated harmonics, flicker, DC injection limits, Voltage Range, Frequency Range and Anti-Islanding measures at the point of connection to the utility services, should follow the latest CEA (Technical Standards for connectivity Distribution Generation Resources) guidelines.
- ix. The power conditioning units/inverters should comply with applicable IEC/ equivalent BIS standard for efficiency measurements and environmental tests as per standard codes IEC 61683/IS 61683 and IEC 60068- 2(1,2,14,30) /Equivalent BIS Std.
- x. The MPPT units environmental testing should qualify IEC/BIS standards. The junction boxes/ enclosures should be IP 65 (for outdoor)/ IP 54 (indoor) and as per IEC-529 specifications. In case the inverters are placed outside, then complete assembly should be placed inside a protective shed with suitable projections.
- xi. The PCU/ inverters shall be tested from the MNRE approved test centers/NABL /BIS /IEC accredited testing- calibration laboratories. In case of imported power conditioning units, these should be approved by international test houses. All Test reports shall be submitted to the Owner.

6.9 AC DISTRIBUTION PANEL

- i. AC Distribution Panel Board (DPB) shall control the AC power from PCU/ inverter and shall have necessary surge arrestors. Interconnection from ACDB to mains at LT bus bar while in grid tied mode.
- ii. All switches and the circuit breakers, connectors shall conform to IEC 60947, part I, II and III/ IS60947 part I, II and III.
- iii. The changeover switches, cabling work etc. shall also be in the scope of contractor.
- iv. All the Panels shall be metal clad, totally enclosed, rigid, floor mounted, air - insulated, cubical type suitable for operation on three phases, 415V, 50 Hz.
- v. The panels shall be designed for maximum ambient temperature of 55°C, 80% humidity and dusty weather.

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- vi. All indoor panels shall have protection of IP-54 or better. All outdoor panels shall have protection of IP65 or better.
- vii. All 415 AC or 230 volts devices/equipment like bus support insulators, circuit breakers, VTs switchgears etc., mounted inside the AC distribution panels shall be suitable for continuous operation and satisfactory performance under the following supply conditions; -

Variation in supply voltage	+/- 10 %
Variation in Supply Frequency	+/- 5 Hz

6.10 PCU/ARRAY SIZE RATIO

- i. The combined wattage of all inverters at unity power factor and at ambient temperature of 55°C shall not be less than rated capacity of power plant under STC.
- ii. Maximum power point tracker shall be integrated in the PCU/inverter to maximize energy drawn from the array.

6.11 Integrated Control System

- i. Integrated Control System (ICS) of standard make for overall monitoring and control of the entire microgrid system and sub systems within the facility shall be provided by the bidder. The ICS shall comprise of following components as a minimum;
 - a. Controllers capable of performing algorithms and logics relating to analogue control sequence and interlocks required during start up, shutdown and normal, continuous and emergency operations.
 - b. Human Machine Interface (HMI) required for the operators to monitor and perform control actions. Minimum 2 no. of Operator Work Stations (OWS) with minimum 32inch LED monitors.
 - c. Input/Output cards with racks, communication processors and power supplies that can interface to field connected input/output devices.
 - d. Cabinets to house various electronic components with required accessories for power/signal conditioning such as MCB/MCCB, convertors, barriers and surge protection and cable termination and dressing. Cabinets houses ICS related components shall be designed for flame-proof protection.
 - e. Shutdown related inputs shall be hardwired from the local emergency pushbuttons.
 - f. Servers facilitating access to real time live data and processed/stored data with network printers.

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- ii. PLC and SCADA for the overall control of the microgrid station. The system shall have dual processor, one for normal operation and another for hot standby;
 - a. Integrated Energy Management System (EMS) for real time monitoring, operation and control of the microgrid station.
 - b. EMS and SCADA shall have the following facilities for optimization of solar power, scheduling the electrolyser and compression and Fuel Cell system operation:
 - i. To start and stop in auto mode based on the scheduled or actual generation/Time of the day or both and
 - ii. To ramp up/ramp down the loading based on scheduled or actual generation of RE power.
 - c. EMS and SCADA system shall provide real time monitoring of the various parameters and alarms of the microgrid system. The final configuration shall be finalized during detail engineering.
 - d. SCADA shall be able to acquire real time data with data storing and retrieval capacity of at least one year data. It shall also have facility to provide statistical data in form of reports.
- iii. The Bidder shall provide the licenses for all the software being used with the offered system. The software licenses shall be provided for the project and shall not be hardware /machine specific i.e. if any hardware/machine is upgraded or changed, the same license shall hold good and it shall not be necessary for employer to seek a new license/renew license due to up gradation/change of hardware/machine. All licenses shall be valid for the entire duration of plant life.
- iv. **Fail-safe operation:** Loss of signal or loss of excitation or failure of any component shall not cause breakdown of the monitoring system.
- v. **Redundancy:** the system should have sufficient redundancies so that a single failure shall not cause any stoppage of the intended functioning of the system.
- vi. **Reliability and Availability:** The system availability should be >99.99% at all the times.
- vii. The offered system should be of latest proven state of the art technology with latest versions of software and hardware components to guard against technology obsolescence.
- viii. The control room to have the facilities to monitor and control the entire microgrid station without requirement of manual intervention and should have PAM (Personnel Area Monitor). PAM system should measure O₂ gas and H₂ gas continuously at site with required alarm annunciation for low (19.5%) and enriched (23.5%) O₂ atmosphere.

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- ix. Control System shall be configured for remote monitoring and shall have all infrastructure, internet facilities, web interface with secured access. In case of malfunction of the microprocessor(s) or in an emergency, the unit should shut down immediately.
- x. Dedicated UPS (with minimum 6 hours backup time) shall be provided for PLC and SCADA system.
- xi. Power System and Control System equipment's shall be designed and tested for its cyber security and the guidelines issued by Ministry of Power against Circular no. No.25- 1 l/6/2018-PG dated 02.07.2020 and Circular No. 12/34/2020-T&R dated 08.06.2021 and other latest issued guidelines. Compliance to CEA guidelines on cyber security October 2021 shall be ensured as applicable. Network segregation from existing networks and internet connectivity, if any through firewalls, shall be ensured by bidder.

The detailed requirements of Integrated Control System (ICS) are provided at **Annexure-III**.

7.0 Integration of Solar PV, Hydrogen Generation System & BoP with Auxiliary Load of Sub-station

- i. The AC output of the individual solar grid inverters must be combined in the Main Switch Board (MSB) using suitable interface.
- ii. The AC output shall be fed to the
 - a. Hydrogen production system and BoP for its operation.
 - b. Existing LT distribution panel to meet the auxiliary load of the substation during day time.
- iii. Any additional HT/LT Panel required to be installed including any modifications/ replacements in existing system, safety interlocking etc. for smooth running of the system shall be in the scope of the bidder.
- iv. Integration of the 415V AC output of the fuel cell with HT/LT Panel required to meet the auxiliary load requirements of the substation during non-solar hours shall be performed.
- v. The suitable engineering design and drawings for the above configuration shall be submitted to POWERGRID for its approval.
- vi. Utmost care must be taken that auxiliary load requirements of the substation are met at all the times primarily through solar PV generated energy during day time and through fuel cell produced electricity during non-solar hours.
- vii. An alternate backup arrangement through utility/ tertiary transformer to meet the substation load requirements during any time of the day/ night (as per existing setup) shall also remain in place.

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- viii. Modifications and installation of necessary switching/ protection devices/ relays etc. shall be in the scope of the bidder.
- ix. In case of breakdown of power output from solar generation and fuel cell, the system should be designed such that **the sub-station auxiliary load as well as hydrogen plant control room/ auxiliary load** and part of electrolyser load is immediately shifted to existing sub-station LT distribution system. Bidder may submit hydrogen plant/fuel cell system/control room auxiliary load details for enhancement of existing LT load connection if required. Proper schematics/calculation shall be submitted for the approval of POWERGRID.

The indicative block diagram of the existing system is provided at **Annexure-II**. The existing SLD of the Main Switch Board and AC Distribution Board (ACDB) of Neemrana Sub-station has been attached as annexure-VII.

8.0 ELECTRICAL

The bidder shall be responsible for the complete system starting from solar plant, switchgears, step-up/step-down transformer, power electronics converters, electrical components for hydrogen generation, compression, storage, fuel cell and other auxiliaries.

Bidder shall design the power system to adapt and maintain the power quality parameters (harmonics and power factor etc.,) as per IEC 519, IEC 61000, IEC 62586, IEEE, CEA, Grid Code regulations.

8.1 Electrical Equipment

- i. All HT and LT breakers shall have numerical relay for the protection, remote operation and monitoring. Also, HT and LT breakers and LT module shall be of draw-out type. Automatic dead and manual live changeover shall be provided (Automatic Transfer System) with synchro check relay.
- ii. All HT and LT incomer shall have Tri-Vector Energy Meter and/or net metering with interfacing provision for metering purposes and as per CEA/CERC guidelines.
- iii. In switchgear room, floor shall have an electrical insulation coating of respective voltage levels in accordance with IEC/ISO standards.
- iv. All electrical equipment's shall be of higher efficiency (IE3 or better). Equipment's installed in hazard zone shall be of flameproof and explosive proof. It shall also comply with NFPA, IEC etc.
- v. All electrical equipment's shall be provided with suitable canopy for weather protection. All panels, distribution boards, junction boxes installed in outdoor environment shall be of IP 65 protection or better.

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- vi. Selection of cables shall comply with IS, NFPA, IEC standards and suitable for hazardous areas.
- vii. All switchgears in compliance with IEC 60439, IEC 60529, IEC 66271 and IEC 60898 and other international standards. Short circuit rating shall be verified according to IEC 60439.
- viii. The electrical supply extension for construction power from the identified feeder to plant switchgear shall be under bidder's scope.

8.2 Earthing System

- i. All SPV panels, electrical equipment and LT switchgear panels shall be suitably earthed. The Earthing plan shall be submitted to POWERGRID for its approval.
- ii. Design shall conform to IS:3043 2018 and lightning protection to IS/IEC: 62305, OISD0180, National Building Code (NBC) and Code of Practice for Electrical Wiring Installations IS 732:2019 will be followed.
- iii. All electrical equipment operating above 110 Volts shall have two separate and distinct connections to earth grids. Separate earthing grid shall be provided for instrument, control system and electrical power.
- iv. Static Electric Discharge system shall have a dedicated earthing system.
- v. Smart online earthing measurement system shall be provided by the bidder.
- vi. Lightning protection shall be designed according to the Lightning Protection Level-I (LPL-I), all the components shall be tested as per IEC 62561.
- vii. Surge protection shall be designed based on IEC 61643 with type-1 SPD.

8.3 HVAC System

- i. Adequate HVAC system to be provided for the complete set-up including control room, switchgear, security room etc.
- ii. Adequate ventilation shall be provided for Switchgear room.

8.4 Lighting System

- i. Lighting levels throughout the plant shall comply with hazardous area working conditions of NFPA and IEC standards. It shall also comply with IS 3646:1992 or latest.
- ii. LED fixtures with anti-glare shall be provided for outdoor and indoor lighting. It shall comply with hazardous area requirements.
- iii. Separate emergency lighting and exit light fixtures shall be provided at desirable locations.

8.5 Cables

- i. Cables shall be sized based on the following considerations;
 - a. Rated current of the equipment
 - b. The voltage drops in the cable, during motor starting condition and during full load running condition shall be as per standards and motor duty cycle.
 - c. Short circuit withstand capability: This will depend on the feeder type. For a fuse protected circuit, cable should be sized to withstand the let-out energy of the fuse.
- ii. The cables shall be suitable for laying on racks, in ducts, trenches, conduits and underground buried installation with chances of flooding by water.
- iii. Cables shall be armored, flame retardant, low smoke (FRLS) type designed to withstand all mechanical, electrical and thermal stresses develop under steady state and transient operating conditions.
- iv. Aluminum conductor used in power cables shall have tensile strength as per requirements of the project.
- v. The type of cables, their current, temperature withstand capacities and other technical parameters shall meet the project requirements. Same shall be submitted for approval of POWERGRID during detail engineering.

8.6 Cable Trench/Tray

- i. All LT cables shall be laid down in trenches as per the approved layout plant. The trenches shall conform of IS:1255 or any other relevant standards and its latest edition/amendments. PCC flooring of built-up trenches shall be sloped for effective drainage.
- ii. Cable trays shall be ladder/perforated type of suitable sizes (of fiber or MS) complete with matching fittings (like brackets, elbows, bends, reducers, tees, crosses, etc.) accessories (like side coupler plates, etc. and hardware (like bolts, nuts, washers, G.I. strap, hook etc.) as required.
- iii. Cable tray shall be ladder type for power & control cables and perforated for instrumentation cables.
- iv. No overcrowding of cables in the cable trays will be permitted. Where cables cross roads, the cables shall be laid in Hume pipe/ HDPE pipe. Hume pipes shall be NP3 type as per IS 458.
- v. The cable laying scheme for plant shall be finalized during detailed engineering. Any other fitting material, cable lugs, ferrules etc. required for cable laying shall be in the scope of the bidder.

9.0 Danger Boards & Signage

Danger boards/ signage should be provided as and where necessary as per IE act. Text of signage may be finalized during detailed engineering.

10.0 Fire Detection & Control System

- i. Fire alarm system consisting of multisensory detectors, cabling, junction boxes, instrumentation, fire alarm cum control panel etc. shall be provided at various places of the plant as per PESO standards and requirements.
- ii. **Existing fire-fighting piping** shall be extended to the hydrogen plant with suitable modifications. The fire alarm cum control panel shall be interfaced with control room PLC for information exchange.
- iii. Fire extinguishers at all vulnerable locations of the plant shall be provided.
- iv. Sand buckets shall be provided in the control room.

11.0 Gas Leak Detection and Control system

- i. The hydrogen leak detection sensors for individual equipment (Electrolyzer, Compressor, storage, Fuel cell etc.) shall be provided and integrated to central control system with appropriate automated control sequence for safe and quick shutdown of the system.
- ii. H₂ leak detection sensors as per the applicable NFPA/PESO guidelines may be provided in the pipeline or other section, susceptible to leakage.

12.0 Instrumentation

- i. Solar pyranometer shall be provided.
- ii. Dedicated online mass flow meter and gas analyzer shall be provided in each stream of hydrogen generation system.
- iii. Instruments shall have a feature for switching-off of Pressure and Temperature compensation.
- iv. The microgrid station shall be equipped with all required protections to safely shutdown/trip the station locally as well as remotely at certain distance (Area Isolation System-AIS) from the station. The AIS must be hardwired type to isolate the entire H₂ related system.
- v. Minimum 60-inch LED screen to be put up in the sub-station room for display of various real-time parameters and alarms.
- vi. All critical parameters like pressure, temperature, flow, levels shall have both local and remote indications with 100% redundancy on instruments.
- vii. All panels, instruments, junction boxes, push button station, control cabinet installed in outdoor environment shall be of at least IP-65 protection.

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- viii. Appropriate Safety devices (with 100% redundancy for critical signals) are to be provided for the entire system for safe release of hydrogen, pressure build up etc. Hydrogen leak detection 0–100% of LEL, smoke detectors, heat sensors and interlock system.
- ix. Instrumentation and control system shall in general meet the requirement of API- RP- 551, 552, 554, 555 or EN 334, EN 14382 to the extent applicable.
- x. Emergency Push Buttons at different locations (Solar, HOS and Control Room, Switchgear, Electrolyser, Compressor, Fuel Cell, Security, Transformer)

13.0 Mechanical

- i. Purging/flushing of the system with nitrogen during commissioning and at every time during maintenance work. The required devices and setup for the purging/ flushing shall be in the scope of the bidder. Supply and maintaining adequate quantity of nitrogen gas at all times including during O&M activities and emergency situations is in the scope of bidder.
- ii. All solenoid valves, control valves, critical manual valves shall have feedback mechanism about its status.
- iii. Piping/Tubing
 - a. Pipeline materials, vessels, towers/coolers shall be of superior grade SS materials of high degree safety and capable to withstand hydrogen embrittlement, hydrogen induced cracking etc.
 - b. All piping/tubing must be labelled as per ANSI/ASME A13.1 standard. Associated items such as valves/check valves/filters must be tagged legibly for quick identification.
 - c. Piping/tubing in gaseous and liquid hydrogen service and to pipelines in gaseous hydrogen service as per ASME B31.12:2019 standard.
 - d. All piping systems shall be hydro tested at 1.5 times the design pressure subject to Indian Boiler Regulation-1950, Regulation 374 or ASME B31.12:2019. However, for such systems where it is practically not possible to do hydro tests, the tests as called for in ASME B31.1:2022 in lieu of hydro test shall also be acceptable.
 - e. Piping/Tubing should be cleaned as per ASTM G93/G93M-19 standard on Oxygen side before putting into commissioning/service.
- iv. All vents shall be routed to a safe area and in a manner that gas vented out is blown away from the nearest building. All vents shall be fitted with flame arrestors. Height of vent shall be minimum five (5) meters above ground level. Distance between vent and fence shall be minimum five (5) meters from at least 3 sides as per PESO requirements. It shall

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have a separate venting system for electrolyser, compressor, storage, and fuel cell. Flame arrestor with temperature transmitter to be installed in all venting points. NFPA 2 Hydrogen technologies compliance shall be followed.

- v. Proper canopies, ramp protection to be provided at appropriate locations.
- vi. Piping laid in underground shall have the cathodic protection.
- vii. Bidder to provide facility for service air and instrument air as per their system and maintenance requirements.
- viii. All tubes and fitting shall comply with EC-79 or better standards.
- ix. Color codes for all equipment's shall be decided during detailed engineering.
- x. Noise level shall not exceed 75dB or Indian and international standards, whichever is less.

14.0 Civil Work

- i. All civil works including men and material required for setting up and commissioning of the microgrid project including control room building, switchgear room with store etc. shall be in the scope of the bidder.
- ii. While preparing the detailed layout and planning station facilities, the Bidder shall ensure the following aspects:
 - a. The microgrid project should have sufficient space, proper design, interior furnishing, proper ventilation, proper lighting, dust free atmosphere etc.
 - b. Bidders shall evolve the overall design and present it in the form of detailed drawings during detailed engineering stage.
 - c. All statutory requirements including safe distances between various facilities as per applicable rules/acts/laws including PESO guidelines, local bye-laws are met. reference standard shall be ISO 19880(1-8):2020
 - d. The buildings and allied works shall be designed to meet the requirements of NATIONAL BUILDING CODE, NFPA, IEC, relevant Indian Standards and latest ECBC standards.
- iii. Bidder has the responsibility to get the plant layout approved from PESO. Before submission of the plant layout to PESO, bidder must get it approved from POWERGRID. Any changes suggested by PESO must be again submitted to POWERGRID for its approval before re-submission to PESO.
- iv. The survey, site leveling, trees and vegetation clearance, removal of existing temporary structures, excavation work required for erection, support structure construction of

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sheds/weather enclosure, building, site peripheral boundary wall, separate gate with security post etc. shall be carried out by the bidder.

- v. Cable ducts/ slits, cable trenches with covers, buried cable trench along with associated foundations etc. wherever required, cable/pipe supporting arrangement, Water drainage system in and around all structures and connecting it to the owner's drain system shall be responsibility of the bidder.
- vi. Supply of all materials, tools & tackles, safety equipment, personal protective equipment required for construction of the project shall be in the scope of the bidder.
- vii. Bidder shall arrange the appropriate lifting arrangements for the equipment for unloading and placement at site.
- viii. Grouting of all equipment, steel/cast iron inserts, plates, bolts, nuts, sleeves, as required must be carried out by the bidder.
- ix. Construction of temporary office, store, workshop, laboratory etc. required for commissioning of the plant shall be in the scope of bidder.
- x. Bidder shall arrange the experienced and expert manpower in sufficient no. to carry out all the civil work.
- xi. All foundations, structural designs and drawings shall conform to relevant IS/IEC standards be vetted by certified structural engineer.
- xii. Special Requirements: -
 - a. For corrosion protection, painting is to be applied following the corrosive Category as per ISO 12944-2:2017.
 - b. The rainfall data in one hour (in mm) in wettest month in the last 5 years as per meteorological data from IMD shall be considered for the design of the drainage.
 - c. The provisions of Criteria for earthquake resistant design of structures as per IS 1893-1:2016 shall be followed for the design of the foundation, building structure and other facilities.
 - d. The provisions for basic wind speed shall be as per Code of Practice for Design Loads (other than earthquake) for Buildings and Structures IS 875-3:2015

The Building Material Specifications are provided separately at **Annexure- IV**.

The Sample Water Test Report is provided at **Annexure-V**.

The existing Soil Investigation Report is provided at **Annexure-VI**

15.0 Standards and Safety Systems

- i. Adequate safety systems are to be installed for proper monitoring and ensuring healthiness of every equipment and personnel safety on continuous basis. The certification of all equipment to be done on a regular basis, maintaining the OEM guidelines as well as Indian and International standards. The last date of certification/calibration should be mentioned on the equipment.
- ii. The contractor shall take necessary regulatory approvals from Petroleum and Explosives Safety Organization (PESO) for the layout of the microgrid project including hydrogen production and its storage.
- iii. The hydrogen cylinder shall comply with Gas Cylinder Rules, 2016/latest amendment or as mentioned by PESO Nagpur. All product related compliances and approvals are to be provided by the bidder within the project timelines and all site approvals would be in bidder scope.
- iv. Following safety studies shall be carried out by the bidder;
 - a. Hazard and Operability study (HAZOP) of the whole system (Electrolysers, compressor, storage, fuel cell etc.) and SIL study before starting of installation activity.
 - b. Quantitative Risk Assessment (QRA), Hazardous area classification (HAC) and Escape Muster and Emergency Response Analysis (EMERA) studies for the complete system shall be carried out by the agency.
 - c. Hazard Identification Risk Assessment (HIRA) also to be conducted and report to be submitted before completion of Trial operation.

Apart from the above, any other relevant studies as mandated by statutory guidelines/requirements shall also be carried out by the bidder and its report shall be submitted.

- v. Proper operation of hydrogen gas leak detection system (with 100% redundancy) should be tested before starting trial operation by applying sample gas. The leak detection system should be calibrated and checked between its interface and the control system at Site.
- vi. Gas leakage determination and ventilation are based on IEC/EN 60079 standards. Response time of sensor shall be as minimum as possible. It shall have 100% redundancy at all installation of the equipment's.
 - d. Point detection devices for the confined space and covering all areas of operation (Electrolyser, Compressor, Storage, Fuel Cell etc.)
 - e. Ultrasonic leak detection devices for open space (Electrolyser, Compressor, Storage, Fuel Cell etc.,)

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- f. Flame detection devices at all locations (Electrolyser, Compressor, Storage, Fuel Cell etc.,).
- vii. All panels, distribution boards, junction boxes, pushbutton stations, control cabinet, instruments installed in hazards zone shall be flameproof and explosive proof. It shall comply with ATEX and IECEx directives.
- viii. All high-pressure joints shall be of welded constructions and radiographed.
- ix. All piping/tubing must have integrity of continuity to avoid static energy generation. Accordingly, all piping/tubing must have grounding/bonding provisions.
- x. All major isolation and critical valves should have/must be installed for easy/proper LOTO (Lock-out/Tag-out) provisions.
- xi. All necessary instrumentation, isolation valves and safety equipment like safety valves etc., to be provided for the safe operation of the pressure vessel. All the Safety Valves shall be ASME UV code stamped.
- xii. Safety device (water sprinklers, water hydrant, CO₂ flooding system and inert gas system) and portable fire extinguishers of DCP and CO₂ Cylinders shall be installed at various locations of microgrid project as per IS and NFPA guidelines. Quantity of portable fire extinguishers shall be finalized during HAZOP study.
- xiii. The bidder must have necessary first-aid facilities for all his employees, representatives and workmen working at the Site during the project execution and O&M phase.
- xiv. Bidder shall provide the display and safety sign boards, evacuation routes signs, warnings signs, layouts, display of do's & don'ts at locations of the project.
- xv. The project area shall have sufficient illumination.

16.0 Quality Assurance

- i. The bidder shall submit the Quality Assurance Plan (QAP) for all components of microgrid project for review and approval of POWERGRID immediately on award of contract.
- ii. The QAP shall essentially cover raw material inspection, process parameters, performance test etc.
- iii. All comments of POWERGRID shall be incorporated suitably in the QAP without any cost and time overrun. All inspection and testing shall be as per approved QAP or relevant codes/ standards/ statues at the discretion of POWERGRID.
- iv. Any or all the tests, shall be witnessed by POWERGRID authorized inspection agency/personnel.

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- v. Inspector(s) will have the liberty to inspect assembly to verify the dimensions as per the approved drawings.
- vi. Contractor shall ensure availability of all documentation, testing procedures, calibrated test equipment during inspection including at various sub-vendors premise as required.
- vii. No material shall be dispatched before getting quality clearances from POWERGRID.

17.0 Trial Test of the Project

- i. Upon successful completion of the microgrid project after construction and integration stage, Trial Test (Trial Operation) shall be carried out to check the health and working of various systems and subsystems including BoP and their integration to achieve the desired output.
- ii. The responsibility for conducting the trial test (Trial Operation) shall be of the contractor. The contractor shall arrange all material, equipment and expert manpower, specified or otherwise required to carry out Trial Test at his own cost.
- iii. The contractor shall submit the detailed plan and procedure for trial operation of the entire system for approval of POWERGRID.
- iv. The safety check list for and during trial testing shall be prepared and submitted by the contractor for approval of the employer during detailed engineering.
- v. The calibration of instruments used in the test shall be carried out by a Govt. approved test laboratory and should be valid during the period of test.
- vi. All safety aspects must be adhered to during trial test.
- vii. The trial operation shall be considered successful only if the system runs trouble-free for 3 consecutive days, producing the desired amount of solar power, hydrogen and electricity through fuel cells, feed the load and meet all the desired parameters of the project including working of the Control and instrumentation, safety and emergency switches etc. as per specifications with all relevant input and data available in the control room.
- viii. A day's operation means requisite amount of hydrogen generation, compression and storage during solar hours and dispensing through fuel cell during non-solar hours to meet electrical load demands of auxiliary system of sub-station or its equivalent in one day.
- ix. Errors and issues shall be identified and resolved by the contractor as on case basis.
- x. The observations and data during the trial testing shall be recorded and detailed report shall be submitted to the employer.

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- xi. The necessary modifications required, if any, observed during trial operation, shall be in the scope of the contractor without any cost overruns.

18.0 Performance Guarantee Test (PG Test)

- i. Consequent upon successful completion of Trial Operation, Performance Guarantee Test (PG Test) for the entire integrated system and subsystems shall be carried out by the contractor.
- ii. The Performance Guarantee test shall be considered successful only if the entire integrated microgrid system runs trouble free for a continuous period of 96 hours and all the desired parameters are met that includes but not limited to: -
 - a. Working of Solar PV system for production of the desired amount of solar power
 - b. Working of Electrolyser and BoP for production of desired amount of hydrogen at the rated values of input energy and water
 - c. Working of Compressors and hydrogen storage system at desired pressure levels
 - d. Working of fuel cell during non-solar hours at desired output levels
 - e. Working of EMS, PCU, SCADA system and availability of all the instrumentation and control in the control room including display of all relevant data of the running system on real time basis. The Control and instrumentation should be able to run the plant as per specifications.
 - f. Integration of entire microgrid project with auxiliary load of sub-station and its smooth, automatic working.
 - g. Additionally, separate exhibit of automatic and manual start/stop operation of the entire system, emergency stop operations, automatic changeover of substation auxiliary load from microgrid to utility feeder etc. and vice versa shall also be part of PG test.
- iii. The Performance Guarantee Test (PG test) requirements and the procedure for PG test shall be submitted by the contractor for approval of POWERGRID during detail Engineering Stage and POWERGRID's decision in this regard shall be final.
- iv. The calibrated instruments and any other measuring devices and tools etc. required for carrying out the PG test shall be in the scope of the bidder.
- v. If the contractor fails to achieve the guaranteed performance levels, the contractor shall at its own cost rectify all the defects identified during the test and take necessary steps/efforts to pass the PG Test within the stipulated time span. Subsequent to rectification, the PG test will be restarted and performance of the PG Test shall be re-measured. In case of destruction due to component failure the test shall be repeated.

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- vi. The continued failure or shortfall in intended performance will invite imposition of liquidated damages of maximum 10% of the total contract value (exclusive of O&M, Freight & insurance charges) and other measures as applicable as per the contract.
- vii. There shall be no incentive/ reward for positive performance deviation.

19.0 Warranty Clause

Warranty of all systems and modules shall be as per requirements as specified in the technical specifications of respective systems/ components etc. The warranty start date shall commence from date of commissioning of the project. Warranty of all other equipment shall necessarily be covered within O&M period from the date of commissioning and the contractor shall be solely responsible for the same (replacement and operation) without any additional cost to POWERGRID.

20.0 Documentation

Documents and drawings as listed below shall be submitted for the approval of employer;

- i. Layout of Microgrid Project including control room and switchgear building drawing with all dimensions, simulation model etc.
- ii. Relevant drawings, specifications, datasheets etc. of complete system.
- iii. All civil, mechanical, electrical, instrumentation design data and calculations, inbuild drawings etc. including architectural drawings required for execution of construction work.
- iv. All necessary third-party certificates for all the critical components (solar, electrolyzers, compressor, fuel cell, hydrogen storage etc.)
- v. Design criteria, survey & investigation reports, drawing/documents of the Civil Infrastructure, Super structure and Sub-structure, foundation for approval of the employer before the start of works.
- vi. Factory/laboratory calibration certificates of devices/instrument/ panels etc.
- vii. Hazard and Operability study (HAZOP), QRA, HAC, EMERA, HIRA reports.
- viii. Ingress Protection (IP) standard compliance certificates
- ix. Write-up on various statutory requirements and their compliance for various facilities and systems etc.
- x. All ownership certificates should be in the name of employer.
- xi. User's manual, operating manual, vendor manuals, product catalogues, wiring diagrams, drawings, termination drawing and interconnecting schematic diagram etc. for the whole

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system (solar, electrolyzers, compressor, storage tubes/vessels, fuel cell etc.) besides their soft copies.

21.0 Training

The contractor shall arrange training with regards to various systems, control room operations, O&M etc. of the system for up to 3 persons (before the system is commissioned) without any additional cost implications to POWERGRID.

22.0 Defect Liability Period

The next day (00.00 hrs.) after successful PG test, the defect liability period will start. The defect liability period shall be for 12 months from its start date.

23.0 O&M Services

This section defines the Scope, Philosophy and terms & conditions for Operations and maintenance services during and after the defect liability period.

The scope of work under O&M Services includes Operations, Preventive, breakdown and curative maintenance including spares management, repair of all the equipment (both hardware & software etc.) being supplied under this Project.

The bidder shall quote for the ten (10) years for O&M of the microgrid project including manpower, spares etc.

- i. The next day (00.00 hrs.) after completion of successful PG test for the project will be considered as the start date of O&M contract for the bidder.
- ii. The Scope of the bidder includes the complete O&M of the solar plant, hydrogen generation, compression, storage and fuel cell system for the period of 10 years.
- iii. All the spares including replacement items and consumables, tools, tackles, experts, engineers, manpower, vehicles, handling equipment, safety devices, PPEs required for the O&M of the system is in the scope of the bidder.
- iv. One complete set of tools and tackles (safety and special), portable measuring and monitoring instruments, portable gas leak detectors shall be provided by the agency at the end of O&M period.
- v. POWERGRID will have right to physically inspect the availability of spares and regular upkeep/ maintenance of the facilities.
- vi. The bidder directly or through their authorized agencies having experiences with equipment requiring Zone-0/Zone-1 compliance (hazardous area classification) for a period of not less than two years, will provide O&M services.
- vii. The O&M period may be further extended at the sole discretion of POWERGRID for the time and cost as agreed between the parties.

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- viii. Bidder shall carry out all required additional augmentation or modification on the system during O&M periods to meet the stipulated technical specification requirement without any additional cost implications to POWERGRID.
- ix. The detailed O&M philosophy including spare management shall be submitted by the bidder for approval of POWERGRID during detail engineering.
- x. The detailed scope of O&M work shall include but not limited to;
 - a. Continuous operation of the microgrid plant at the desired values of the input and output parameters.
 - b. Deployment of trained and expert manpower for O&M.
 - c. Comprehensive Annual Maintenance Contract (AMC) from Original Equipment Manufacturer (OEM) or OEM authorized service provider for all the bought out items.
 - d. Replacement of all items, if required, within the O&M period of 10 years.
 - e. To carry out all tests and work as required by prevalent statutory regulations.
 - f. To carry out annual preventive maintenance and planned shutdown maintenance as per schedule.
 - g. In case of any emergency/breakdown, take the complete/part system under shutdown and ensure that the system is returned to normal operation within the shortest possible time.
 - h. To take all safety measures at site, including Safety PPEs and time to time safety training to its workers, to avoid accidents to the facilities, workers and damage to the surroundings.
 - i. To maintain spares necessary for smooth functioning of the project.
- xi. The average annual availability of the green hydrogen based microgrid system (also called **Total System Availability**) should be more than 95%. Further there shall not be any incidence of interruption of the system exceeding 48 hours on continuous basis in a single stretch. The “*Interruption of the system*” means that the microgrid project is not able to meet the safe and reliable power requirements of the auxiliary load of the substation.

“**Total System Availability**” shall mean the ratio of actual number of annual operational hours for which the Solar power plant and the Green Hydrogen Plant and the Fuel cell plant including their associated sub-systems etc. are able to generate safe and reliable power as per technical specifications to meet the auxiliary load requirements of the substation to the total number of operational hours available annually (i.e. 12410 hrs.).

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$$\text{Total System Availability} = \frac{\{12410 - (FM + S + U)\}}{(12410 - FM)} \times 100\%$$

Total no. of Operational hours available annually = 12410 hrs.

(i.e. Sum of annual Operational hours of Solar PV plant + green hydrogen plant + Fuel cell system including their associated sub-systems etc.)

- i. Annual Operational hours for Solar PV plant (@avg.10 hrs. per day) = $10 \times 365 = 3650$ hrs.
- ii. Annual Operational hours for Hydrogen generation plant = $10 \times 365 = 3650$ hrs.
- iii. Annual Operational hours for Fuel Cell (@avg. 14 hrs. per day) = $14 \times 365 = 5110$ hrs.

Total (i + ii + iii) = 3650 + 3650 + 5110 = 12410 hrs.

FM = Force Majeure hours

S = Schedules maintenance hours

U = Unscheduled or Forced Maintenance hours

Note:

- a) The system will be considered available only when it meets all the desired technical parameters of the individual components i.e. solar PV/hydrogen generation plant /fuel cell etc. and provide safe and reliable power to meet the auxiliary load requirements of the substation.
- b) In case of solar unavailability due to weather condition, the same shall be considered under force majeure conditions. However, if solar plant is unavailable for other reasons, then both hydrogen plant and fuel cell shall also be considered unavailable during that period of time.
- c) In case Fuel-cell is not able to produce electricity due to unavailability of hydrogen generation plant then both Hydrogen Generation Plant and Fuel Cell shall be considered unavailable during that period of time. Similarly, if Hydrogen produced by Hydrogen Generation Plant is not utilized due to unavailability of the Fuel Cell then both Hydrogen Generation Plant and Fuel Cell shall be considered unavailable during that period of time.
- d) Payment shall be made at the end of each quarter of O&M services. The applicable deductions towards shortfall/ degradation in the system performance shall be made in the first quarter payment of every subsequent year.

In case the total system availability falls below the desired annual levels of 95%, then deductions shall be made from yearly applicable O&M charges (including retention amount by POWERGRID in case the quoted O&M are <15% of total supply cost) as below;

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Sl. No.	Average Annual Availability	Corresponding deductions from yearly O&M charges
1	≥95%	No Deductions
2	≥90% but < 95%	5% Deductions in yearly O&M charges
3	≥80% but <90%	15% deductions in yearly O&M charges
4	≥60% but < 80%	25% deductions in yearly O&M charges
5	<60%	100% deductions in the yearly O&M charges

In case of any interruption in the system exceeding 48 hours at a stretch in the single instance then additional 2% deductions shall be made from the yearly O&M charges for each such case.

Further, liquidated damages based on quoted degradation parameters for the solar plant, specific energy consumption for electrolyser and fuel cell output degradation for the respective years shall be leviable as under: -

Solar Performance Ratio (PR) to be quoted for 10 years period on monthly basis: -

Sl. No.	Month	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10
1	January										
2	February										
3	March										
4	April										
5	May										
6	June										
7	July										
8	August										
9	September										
10	October										
11	November										
12	December										

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Applicable Liquidated damages

- i. Performance Shortfall = (Difference of Actual and Guaranteed Performance Ratio)
- ii. Liquidated damage = (Yearly O&M Charges) x 30 % x (Performance Shortfall)

Specific Energy Consumption (SEC) for Electrolyser and Output for the Fuel Cell System to be quoted for 10 years period: -

S No.	End of Year	Hydrogen SEC (kWh/kg)	Fuel Cell Electrical Output Energy per Kg of input H2 (kWh/kg)
1	Y1		
2	Y2		
3	Y3		
4	Y4		
5	Y5		
6	Y6		
7	Y7		
8	Y8		
9	Y9		
10	Y10		

Applicable Liquidated damages

For Electrolyser Plant

- i. Performance Shortfall = (Difference of Actual Specific Energy Consumption and Guaranteed Energy Consumption)/Guaranteed Energy Consumption
- ii. Liquidated damage = (Yearly O&M Charges) x40% x (Performance Shortfall)

For Fuel Cell

- i. Performance Shortfall = (Difference of Actual Electrical Output Energy per kg of input hydrogen and Guaranteed Electrical Output Energy Output per kg of input hydrogen)/ Guaranteed Electrical Output Energy per kg of input hydrogen
- ii. Liquidated damage = (Yearly O&M Charges) x30% x (Performance Shortfall)

24.0 Handing over of System at the end of O&M period

Upon completion of 10 years O&M period, if the O&M period is not further extended by the employer, the contractor shall handover the microgrid system to the employer with major components of the project working at following performance levels;

- i. **Solar:** Solar power generation shall be demonstrated for the generating capacity of min. 90% of the 1500 kWp at any point of time/month/season (no correction is allowed).
- ii. **Electrolyser:** The output of electrolyser at full load should not be less than 200 Nm³/hr and the specific energy consumption should not deteriorate to more than 64.5 kWh/kg including the BOP.
- iii. **Fuel Cell:** The fuel cell output at full load must be 200 kWe (irrespective of hydrogen consumption)

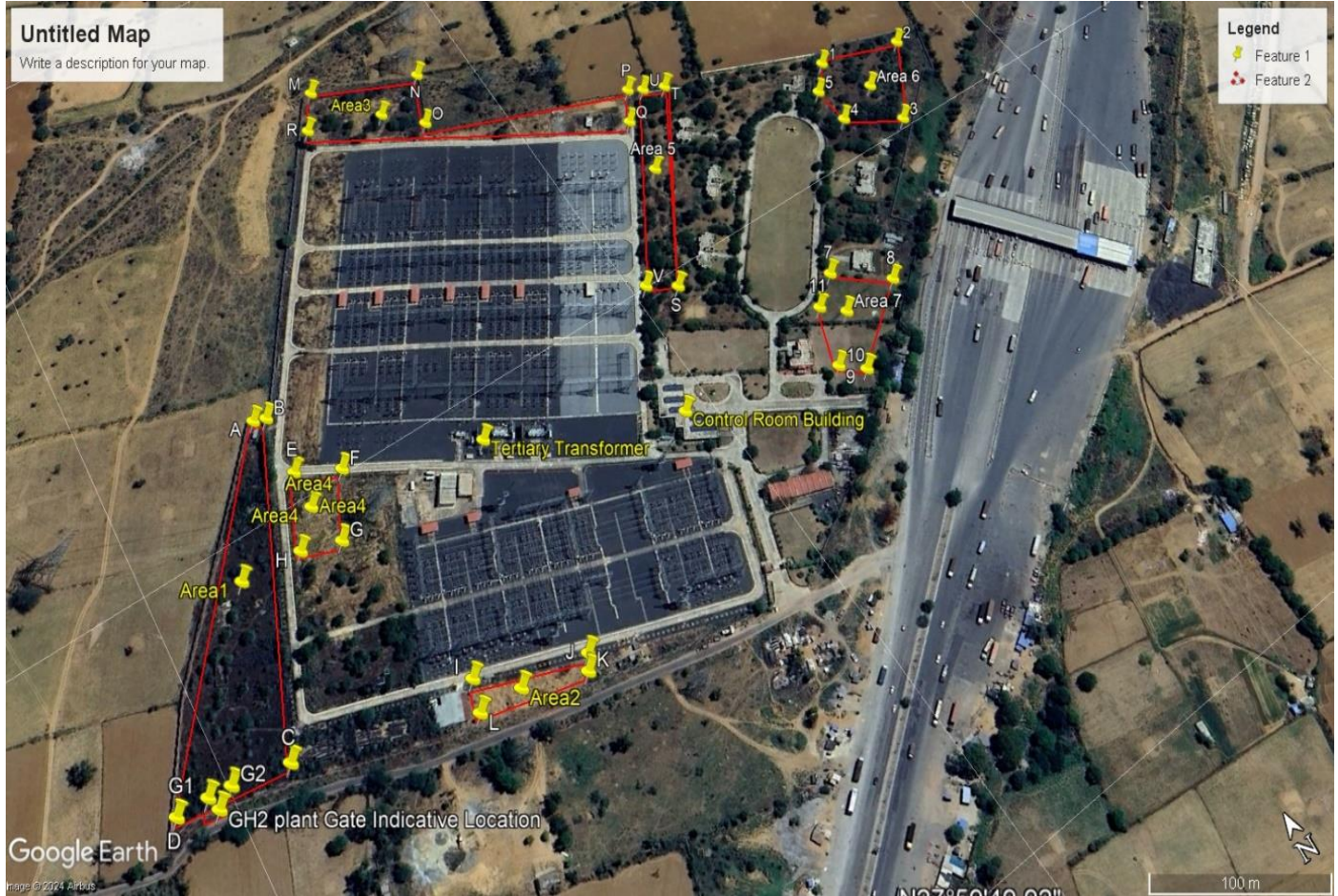
25.0 Project Management

- i. The Contractor shall assign a Project Manager with the authority to make commitments and decisions that are binding on the Contractor. The Project Manager's responsibility shall include to interface and coordination with his counterpart of Employer. The Employer will designate a Project Manager to coordinate all the Employer project activities.
- ii. The Project Manager shall provide updated project schedules and complete progress reports on fortnightly basis for the duration of the project. All references to the reporting period throughout this Specification shall refer to this fortnightly period.
- iii. Within one week of contract signing, the Contractor shall submit detailed project schedule. The project schedule shall include all tasks to track overall direction and integration of the project from inception through completion.
- iv. The contractor shall deploy qualified and well-trained Engineer(s) of OEM with experience in the relevant field during project execution to assist field/ site teams. These Engineers shall be responsible for smooth and successful installation & commissioning of equipment and act as a facilitator among field Installation engineers.
- v. **Progress Meetings:** The Project Managers shall schedule and attend Progress Meetings as deemed necessary but no less than once every month.
- vi. The actual progress made to date and the scheduled delivery date for the completed systems shall be closely monitored by both the Contractor and the Employer project managers. An overview and general assessment of all the Employer and Contractor activities and any progress or delays in these activities shall be regularly reported to the Employer in a clear and concise manner.

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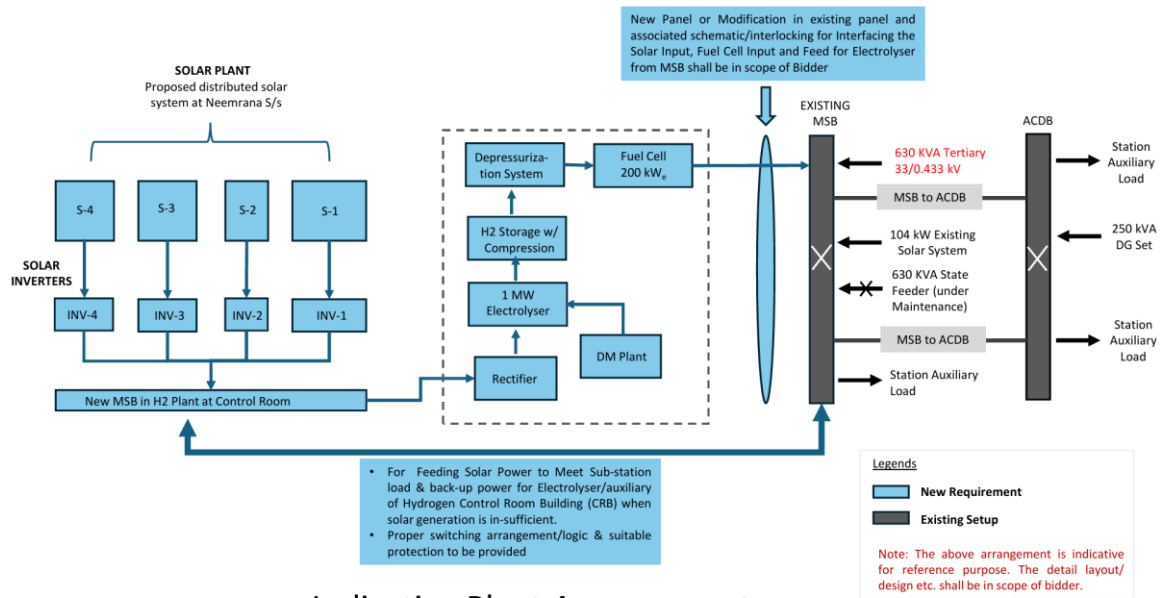
Annexure-I: Layout Map of Neemrana Sub-station



First Priority Areas considered for setup of the plant	Second Priority Areas Considered for set up of the plant
Area- 1	Area-5
Area-2	Area-6
Area-3	Area-7
Area-4	

Proposed Separate Entry/ Exit Gate for the Green Hydrogen plant: Point- G1-G2

Annexure-II: Plant layout of Neemrana Sub Station



Indicative Plant Arrangement

Annexure-III: Instrumentation & Control System

Minimum Requirement of ICS System

1.0 Human Machine Interface

1. The human machine interface should at least include the following:-
 - I. Graphic (HMI) display with 3D representations with rich color combinations for static and dynamic indications of all processes, showing equipment status (ready, working/ not working) and values of critical process variables.
 - II. Alarm display and logs, showing the alarm tag number, title, date and time and its status.
 - III. Trend displays
 - IV. Loop displays showing PID controller settings
 - V. Password controlled multiple user access levels
2. Graphic panels shall be created to replicate process and equipment using ISA standard and/or custom build symbol library.
3. Data refresh rate in graphics for hardwired IOs shall be 1-2 sec and through communication shall be 3-5 sec.
4. Reports shall support standard and custom developed formats allowing multiple report formats (shift-wise, daily, weekly, monthly etc.), scheduled and adhoc reporting.
5. The number of reports and graphics shall be based on operational needs.
6. Ability to configure and operate sequence and control functions in
 - a. Auto and Manual modes
 - b. Start-up Bypass and Overrides for interlocks
 - c. Maintenance Modes
7. Ability to synchronize
8. Ability to send alerts on critical alarms and/or data to key operation/maintenance personal over SMS.
9. Diagnostic details from various system components

2.0 SCADA Server

The SCADA Server (SCD) shall be PC based running SCADA/HMI software on latest Windows Sever. This server will collect raw data from the ICS Controller, Safety System, Fire and Gas System, and third-party PLCs to make it available to operator works stations. The SCADA servers shall be configurable as a redundant pair. The following hardware requirements apply, else virtual hardware should be assigned with

similar capability.

Minimum specification for Server shall be:

- Intel I7 processor or better
- 16 GB RAM, SSDs with Raid 1
- Dedicated Graphics Card, Network Card
- 32" LED Monitor, Keyboard and Mouse

3.0 Operator Workstation (OWS)

Operator Workstation (OWS) shall be PC based running SCADA/HMI software on Windows latest operating system. Operator shall use this as a single window for the monitoring and control of the entire microgrid processes and facility related input/outputs.

Minimum specification for OWS shall be:

- Intel I7 processor or better
- 16 GB RAM, SSDs
- Dedicated Graphics Card, Network Card
- 32" LED Monitor, Keyboard and Mouse.

4.0 ICS - Controller

Features and requirements of CPU stated below shall be met.

- i. Robust design based on latest intel or equivalent microprocessor with 64MB memory mounted on the board.
- ii. Support redundancy for hot-standby operations with Switch overtime shall be of the order of 300 msec.
- iii. Support multiple scan times for digital processing (50 msec), critical analogue controls (500 msec) and 1 second for the rest.
- iv. Capable of solving application logic, storing the application program and having an OLED status display.
- v. Possess dedicated ethernet ports with speeds of 10/100/1000mbps for IO communication.
- vi. The CPU should have the capability to interface to the cloud and send data, if required.

5.0 ICS – Input / Output

ICS shall include dedicated IO racks and connected to the centralized CPUs. IO racks shall include power supplies, communication to CPU and various types of IO cards.

6.0 Data Historian

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SCADA server shall be capable of storing raw, computed and aggregated data as defined in a structured database for one year. Data from the historian shall be used for reporting, performing analytics.

7.0 ICS – Single Window

The ICS shall be the single unified platform for monitoring and controlling the entire microgrid plant. To the extent possible, all IO(s) from processes and equipment shall be wired to the ICS and controls implemented in it.

Annexure-IV: Building Material

Building Materials Specifications

1. CEMENT

- I. Cement for Concrete shall be Ordinary Portland Cement (OPC, Grade-43) conforming to IS: 8112 or better.
- II. Cement for all other applications shall be Ordinary Portland Cement (OPC, Grade-53) conforming to IS: 8112 or Fly ash-based Portland Pozzolona cement conforming to IS: 1489 (Part-I) and / or any other type of cement meeting IS: 456 requirements.

2. AGGREGATES

- I. **Coarse Aggregate:** Coarse aggregate for concrete shall be chemically inert, hard, strong durable against weathering, of limited porosity and free from deleterious materials. It shall be properly graded. It shall meet the requirements of IS: 383.
- II. **Sand:** Sand shall be hard, durable, clean and free from adherent coatings of organic matter and clay balls or pellets. Sand, when used as fine aggregate in concrete shall conform to IS: 383. For plaster, it shall conform to IS: 1542 and for masonry work to IS: 2116.

3. REINFORCEMENT STEEL

- I. All reinforcement steel shall be TMT (Thermo Mechanically Treated) of grade Fe 415 conforming to IS:1786 unless noted otherwise. However, TMT reinforcement bars of grade Fe 500 conforming to IS:1786 satisfying ductility requirement of Fe 415 may also be used.
- II. Mild steel & medium tensile steel bars and hard drawn steel wire shall conform to grade - 1 of IS: 432 (Part - I). Welded wire fabric shall conform to IS: 1566.

4. STRUCTURAL STEEL

- I. Structural steel (including embedded steel) shall be straight, sound, free from twists, cracks, flaw, laminations and all other defects. Structural steel shall be of tested quality and shall be of Mild steel of Grade 'A' upto 20mm thickness and of Grade 'B' normalized for thickness above 20 mm and shall conform to IS: 2062.
- II. High Strength low alloy steel (HSLA) conforming to IS: 8500 may also be used in place of Mild steel. Chequered plate shall conform to IS: 3502 and pipes for hand rail shall conform to medium grade IS: 1611. All gratings shall be pressure locked/

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electro- forged.

5. BRICKS

Bricks shall be table moulded / machine made of uniform size, shape and sharp edges and shall have minimum compressive strength of 75 kg/cm². Burnt clay fly ash bricks and fly ash lime bricks shall conform to IS:13757 and IS:12894 respectively. Minimum fly ash content in fly ash based bricks shall be minimum 25%. Common burnt clay bricks shall conform to IS: 1077

6. The following minimum grades of concrete for design mix and nominal mix shall be adopted for the type of structures noted against each unless not specified elsewhere;

Grade as per IS 456	Non-coastal area
M25	All RCC structural elements above and below ground level, precast concrete, MMS foundation, cable trench, oil pit, Grade Slab, Paving, culverts & road.
M20 (Equi. nominal Mix of 1:1.5:3) *	Fencing work.
M15 (Equivalent Nominal Mix of 1:2:4)	Base slab of drains.
M10 (Equivalent Nominal Mix of 1:3:6)	Plain Concrete Cement.

The bidder shall carry out the design mix of M-25 and M-20 grade concrete on priority. The design mix shall be approved from POWERGRID before the start of work.

* The use of nominal mix for M-20 grade may be accepted only in exceptional cases subject to approval of POWERGRID Engineer-In-Charge.

IS: 2502 Code of Practice for Bending and Fixing of Bars for concrete Reinforcement must complied for reinforcements. IS 5525 and SP 34 shall be followed for reinforcement detailing.

A minimum 75 mm thick PCC shall be provided below RCC wherever RCC structure is laid over the ground. Proper and sufficient formwork/shuttering shall be provided for the required period as per IS 456.

7. PAINTING

All painting on masonry or concrete surface shall preferably be applied by roller. If applied by brush, then same be finished off with roller. Minimum two finishing coats of paint shall be applied over a coat of primer. Colour shade shall be approved / accepted by POWERGRID

All Steel surfaces shall be provided with 2 coats of Inorganic Zinc Silicate Primer Coat (Solid by Volume Minimum 60%) of Minimum 75 Micron Dry Film Thickness (DFT) applied over blast/ wire brush cleaned surface to near white metal. Finish Coat shall be followed with the application of Final Finish Coat of Polyurethane based colour pigmented

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Paint (Solid by Volume Minimum 40%) of Minimum 30 Micron DFT. This Coat shall be applied within Seven (7) days (from the completion of Finish Coat) after Erection by brush and/ or spray. Paint colour and shade shall be approved by POWERGRID

For painting on concrete, masonry and plastered & surface, IS: 2395 shall be followed. For painting on steel work and ferrous metals, IS: 1477 shall be followed. For painting on woodwork IS: 2338 shall be followed.

Annexure-V: Sample Water Test Report (Attachment)

Annexure VI: Soil Investigation Report (Attachment)

Annexure VII: SLD Existing Main Switch Board/ACDB (Attachment)

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Annexure VIII QR for sub-systems

S. No.	Item	Qualification Requirements
1	SPV Module	The vendor should be enlisted in Approved List of Models and Manufactures (ALMM) of MNRE for the offered make & model of the SPV module meeting the desired specifications as per TS.
2	Fuel Cell	The vendor should have manufactured OR got manufactured a hydrogen-based fuel cell of minimum rated generation capacity of 10 kW AC or DC load during last 7 years and the above fuel-cell should have been either successfully commissioned at customer's premises or tested for performance at OEM's works as on originally scheduled date of bid submission
3	Hydrogen Compressor	The sub vendor should have manufactured an ionic or diaphragm hydrogen compressor of minimum rated capacity of 50Nm ³ / hr. and minimum discharge pressure rating of 200 bar during the last 7 years and should have been under satisfactory operation as on originally scheduled date of bid submission.

The bidders are free to list more than one sub-contractor/ vendor against each sub-system. The list of vendors meeting the above criteria shall be submitted for approval of the employer within 01 month from the date of Notification of Award (NOA).