DETAILED PROJECT REPORT

Project Title: 500KWp Solar PV Grid-Connected Plant
(RESCO Model)

Client/ Site Location :

The Registrar,
Central University of Jharkhand
Vill. Cheri-Manatu, PO Kamre,
PS Kanke Ranchi -835222 (Jharkhand)
Email: registrar@cuj.ac.in
Contact no: 9304953705
JBVNL Consumer no: 7023/ KKHT28

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PART – A – General Details of the Project

1. Project Title : 500KWp Solar PV Grid-Connected Plant

2. EXECUTIVE SUMMARY

CUJ new campus has several buildings in operation and many new buildings are under construction which may also start operating in an year or so. Existing buildings having an average monthly consumption of 19000 units @ Rs 8/ unit (all inclusive) and may increase to 60000-65000 units/ month in an year with the under construction buildings in operation. Quality of power supply is reliable for Grid-Connected Solar PV Plant operation and power cuts are rare in this location.

Considering existing yearly energy consumption of 2.25 Lakh units which is expected increase to 7.5 to 8 Lakh units within a year, we have suggested 500KWp Rooftop Solar PV Grid Connected Plant to meet upto 90% of energy consumption in Net-Metering mode. The Solar PV Plant is expected to generate 7.5 Lakh units annually assuming 95% grid availability.

The facility has existing cumulative sanctioned load of 500KVA hence proposed Solar PV Plant Capacity of 500KWp is feasible as per Net-Metering Guidelines of JERC.

Since the continuous operating load varies during daytime, the Solar PV Plant shall be designed to operate in Net-Metering mode only. Solar PV Plant Output comprising of several inverters shall be at 415VAC which will be terminated at existing LT Distribution Panel of each building. The injection point for export of excess solar power is at existing HT Metering Point at the facility where the HT meter shall be replaced with Bi-Directional Net-Meter by JBVNL.

The proposed Solar PV Plant Capacity shall be installed on the available rooftop area of 4000sqm. The SPV power plant with cumulative proposed capacity of 500KWp would be connected to grid. No battery storage has been provided. It would meet partial load of the buildings during day time. The grid connected SPV project would be a demonstration plant to harness renewable energy and the data on generation would be utilized for analysis of the various aspects of operation as also that of availability of power.

The 500KWp SPV power plant is estimated to afford annual energy feed of 750 MWh considering efficiency of the solar module as 17%, Inverter as 98 % and losses as 3% in the DC and AC system.

LOCATION / SITE DETAILS OF THE PROJECT

Address of Site	Central University of Jharkhand(CUJ), Vill. Cheri-Manatu, PO Kamre, PS Kanke Ranchi -835222 (Jharkhand)
Access Railhead Road	Ranchi Railway Station
Location	Ranchi
Ownership	Ministry of Education
Other Meteorological Parameters Ambient Temperature Latitude Longitude	27degC, Latitude – 23.34, Longitude – 85.30
Elevation	651m
Tilt Angle	23
Feeding Point	On the LT Side (415VAC) within the premises

3. SOCIO-ECONOMIC JUSTIFICATION

There are growing trends in setting up grid-tied power plants worldwide. In grid tied mode the solar power can be utilised to its full potential. All the requirements are being fulfilled by the site conditions of CUJ Building which has no other source of power generation except Diesel Generator. This project will help in adding the power in JBVNL grid thus indirectly will reduce the import of power from other sources.

- Abundant sun light is available.
- Grid availability is high.
- Technical staff is available for care taking the technical things.
- Round the clock security is available.
- The project will be installed and taken care by the highly professional team of 'Rooftop Urja'
- The power produced by this project will be directly fed to LT side.

4. BENEFITS FROM THE PROJECT

Since, CUJ Building has no other source of power generation except Diesel Generator this project will help in adding the power in JBVNL grid thus directly will reduce the import of power from the Utility Source.

5. NAME OF THE PROJECT PROPONENT/ IMPLEMENTING AGENCY

Name, designation and Complete address of the Authorised representative for correspondence	.....
Telephone Number	.....
FAX Number	
E-mail	.....
Category	.....

PART - B

TECHNICAL DETAILS

6. TECHNICAL AND TECHNOLOGY ARRANGEMENTS / FACILITIES FOR SPV POWER PLANTS

Name of the Work (RESCO Model):

Design, Supply, Erection, Testing & Commissioning along-with Operation and Maintenance of 25 years for 500KWp Grid-Tied SPV Power Plant as per design and power evacuation on LT side as per the following details:

Site Name: Central University of Jharkhand(CUJ), Vill. Cheri-Manatu, PO Kamre, PS Kanke Ranchi-835222 (Jharkhand)

Solar Photovoltaic Modules

The total solar PV array capacity should not be less than the SPV plant capacity on max. Radiation day and shall be comprise of solar mono / multi/ poly crystalline modules of >300 watts. The Photovoltaic modules shall be tested **& approved by one of the IEC authorized test centers , Test Certificates can be from any of the NABL / BIS accredited testing / calibration laboratories** the module type must be qualified as per IEC 61215(Second Edition). In addition PV modules must qualify to IEC 61730 Part I to II for safety qualification testing. SPV module conversion efficiency shall be greater than 15% under STC.

1. The PV module shall perform satisfactorily in humidity up to 100 % with temperature between (-) 10 deg. C to + 85 deg. C. Since the modules would be used in a high voltage circuit, the high voltage insulation test shall be carried out on each module and a test certificate to the effect provided.

2. The module shall have warranty of 25years with degradation of power generated not exceeding 20% of the minimum rated power over the 25 years period and not more than 10% after 10 years period as per MNRE guidelines.

3. Other general requirements for the PV modules and subsystems shall be the following:

    a) Raw materials and technology employed in the module production processes shall not be considered relevant so long as the given specifications are satisfied.
    b) The rated output power of any supplied module shall not have negative tolerance.
    c) The peak-power point voltage and the peak-power point current of any supplied module and/or any module string (series connected modules) shall not vary more than 3 (three) per cent from the respective arithmetic means for all modules and/or for all module strings, as the case may be.
    d) Except where specified, the front module surface shall consist of impact resistant, low-iron and high-transmission toughened glass.
    e) The module frame, if any, shall be made of a corrosion-resistant material which shall be electrolytically compatible with the structural material used for mounting the modules.

f) The module shall be provided with a junction box with provision of external screw terminal connection and with arrangement for provision for by-pass diode. The box shall have hinged, weather proof lid with captive screws and cable gland entry points of may be of sealed type.
g) Necessary I-V curves are required to be furnished along with the SPV modules.

h) IDENTIFICATION AND TRACEBILITY

Each PV module used in any solar power project must use a **RF Identification Tag (RFID)**, which must contain the following Information. The RFID will be inside, the module laminated, but must be able to withstand harsh environmental Conditions

i. Name of the manufacturer of PV Module
ii. Name of the manufacturer of solar cells
iii. Month and year of the manufacturer (separately for solar cells and modules.
iv. Country of Origin (separately for solar cells and modules
v. I-V Curve for the module
vi. Peak wattage , Im , Vm and FF for the module
vii. Unique Serial No and Model No of the Module
viii. Date and year of obtaining IEC PV module qualification certificate.
ix. Name of the test lab issuing IEC certificate

2. ARRAY STRUCTURE

PV PANEL STRUCTURES

i. Wherever required, Suitable number of PV panel structures shall be provided. Structures shall be of flat-plate design with combination of I, C and L sections as per structure design requirement.

ii. Structural material shall be corrosion resistant and electrolytically compatible with the materials used in the module frame, its fasteners, nuts and bolts. Galvanizing should meet ASTM A-123 hot dipped galvanizing or equivalent which provides at least spraying thickness of 70 microns as per IS5909, if steel is used.

iii. Aluminium extruded frame structures with adequate strength and in accordance with relevant BIS standards can also be used with proof that the design of the structure can withstand the wind speed of 150 km per hour as per BIS Standards.

iv. Structures shall be supplied complete with all members to be compatible for allowing easy installation at the site.

V. The Structure shall be made out of either Galvanized steel or Aluminium member as per design to be submitted by firm. The structures shall be designed to allow easy replacement of any module.

VI. Each structure should have angle of inclination as per the site conditions as well as from aesthetic consideration keeping in view, building aesthetic look.

VII. Each panel frame structure be so fabricated as to be fixed on the ground.
The structure should be capable of withstanding a wind load of 150 km/hr after grouting & installation. The front end of the solar array should not be less than 30 cms from the roof. Grouting material for SPV structure shall be as per M15 (1:2:4) concrete specification (wherever applicable).

VIII. The structures shall be designed for simple mechanical and electrical installation. There shall be no requirement of welding or complex machinery at the installation site. If prior civil work or support platform is absolutely essential to install the structures, the supplier shall clearly and unambiguously communicate such requirements along with their specifications in the bid. Detailed engineering drawings and instructions for such prior civil work shall be carried out prior to the supply of Goods.

IX. The supplier shall specify installation details of the PV modules and the support structures with appropriate diagrams and drawings. Such details shall include, but not limited to, the following;

a) Determination of true south at the site;
b) Array tilt angle to the horizontal, with permitted tolerance;
c) Details with drawings for fixing the modules;
d) Details with drawings of fixing the junction/terminal boxes;
e) Interconnection details inside the junction/terminal boxes;
f) Structure installation details and drawings;
g) Electrical grounding (earthing);
h) Inter-panel/Inter-row distances with allowed tolerances; and
i) Safety precautions to be taken.

IX. As per need of aesthetic look, the structure may be kept as penetrating type on roofs of building having low height (one or two storey).

X. The array structure shall support SPV modules at a given orientation and absorb and transfer the mechanical loads to the ground. All nuts and bolts shall be of very good quality stainless steel except foundation bolts which will be of MS (GI Coated).

3. Grid-Tie Inverter

The Grid-Tie Inverter not less than the SPV Power Plant capacity i.e. 400KW Inverter (cumulative capacity) have been provided to convert DC power produced by SPV modules, in to AC power. The power conditioning unit in multiples string Inverters. Grid Tied solar inverter with a highly efficient conversion unit having minimum following specifications:

Type	: Self commuted, current regulated, high frequency IGBT based with Trench Gate Structure
Output voltage	: 3 phase, 415 V ac (+12.5 %, - 20 % V ac)
Frequency	: 50 Hz ±1 Hz
Continuous rating	: Not less than SPV Power Plant capacity
DC input Operating range	: 580 V to 850 V nominal
Total Harmonic Distortion	: less than 3 %
Operating temperature Range	: 0 to 55 deg C
Housing cabinet	: Not Applicable – IP65 Standard
Inverter efficiency	: >95 % at full load.
Power Control	: MPPT

Other important Features/Protections required in the Inverter

- Authentic tracking of the solar arrays maximum power operation voltage (MPPT).
- Array ground fault detection.
- LCD and piezoelectric keypad operator interface Menu driven.
- Automatic fault conditions reset for all parameters like voltage, frequency and/or black out.
- MOV type surge arresters on AC and DC terminals for over voltage protection from lightning-induced surges.
- Inverter should be rated to operate at 0 to 55 deg. Centigrade above ambient temp
- All parameters should be accessible through an industry standard communication link.
- The Inverter should go in sleep mode when there is no grid supply.

3.1 Since the Inverter is to be used in solar photo voltaic energy system, it should have high operational efficiency. The idling current at no load must not exceed 2 percent of the full-load current.

3.3 The Inverter output shall be 415 VAC, 50 Hz 3 phase.

3.4 The Inverter shall include appropriate self protective and self diagnostic features to protect itself and the PV array from damage in the event of Inverter component failure or from parameters beyond the Inverter's safe operating range due to internal or external causes. The self-protective features shall not allow signals from the Inverter front panel to cause the Inverter to be operated in a manner which may be unsafe or damaging. Faults due to malfunctioning within the Inverter, including commutation failure, shall be cleared by the Inverter protective devices and not by the existing site utility grid service circuit breaker.

The Inverter shall go to shut down/standby mode, with its contacts open, under the

following conditions before attempting an automatic restart after an appropriate time delay; in sufficient solar power output etc.

a) Insufficient Solar Power Input.

When the power available from the PV array is insufficient to supply the losses of the Inverter, the Inverter shall go to a standby/shutdown mode. The Inverter control shall prevent excessive cycling during rightly shut down or extended periods of insufficient solar radiation.

The inverters should be applicable IEC/ equivalent BIS standard for efficiency measurement and environmental testing as per standard code IEC 61683 and IEC 60068 2(6,21,27,30,75,78) and drop test (IEC 60068-2-26). The charge controller/ MPPT units should qualify IEC 62093 and IEC 60068 2 (6,21,27,30,75,78). The junction boxes/ enclosures should be IP 65 (for outdoor)/ IP 54 (indoor) and as per IEC 62208 specifications.

The Inverter's should be tested from the MNRE approved test centres / NABL /BIS accredited testing- calibration laboratories. In case of imported power conditioning units, these should be approved by international test houses. Party must supply and upload the test report of inverter along with the tender document.

b) Utility-Grid Over or Under Frequency

The Inverter shall restart after an over or under frequency shutdown when the utility grid voltage has returned to the within limits for minimum of two minutes.

3.6 The Inverter generated harmonics measures at the point of connection to the utility services when operating at the rated power shall not exceed a total harmonic current distortion of 3 percent, a single frequency current distortion of 3 percent and single frequency voltage distortion of 1 percent, when the first through the fiftieth integer harmonics of 50 Hz are considered.

3.7 The Inverter Power factor at the point of utility service connection shall be 0.95 lagging or leading when operating at above 25 percent of the rated output, but may be less than 0.95 lagging below 25 percent of the rated output.

3.8 The high voltage and power circuits of the Inverter shall be separated from the low-voltage and control circuits. All conductors shall be made of standard copper.

3.9 The Inverter shall withstand a high voltage test of 2000 V rms, between either the input or the output terminals and the cabinet (chassis).

3.10 Full protection against accidental open circuit and reverse polarity at the input shall be provided.

3.11 The Inverter shall not produce Electromagnetic Interference (EMI) which may cause malfunctioning of electronic and electrical instruments including communication equipment, which are located within the facility in which the Inverter is housed.

3.12 The Inverter shall have an appropriate display on the front panel to display the instantaneous AC power output and the DC voltage, current and power input. The display shall be visible from outside the Inverter enclosure. Operational status of the Inverter, alarms, trouble indicators and ac and the dc disconnect switch positions shall also be communicated by appropriate messages or indicator lights on the front cover of the Inverter enclosure.

3.13 Electrical safety, earthing and protection:

A) Internal Faults: In built protection for internal faults including excess temperature, commutation failure, overload and cooling fan failure (if fitted) is obligatory.

B) Over Voltage Protection: Over Voltage Protection against atmospheric lightning discharge to the PV array is required. Protection is to be provided against voltage fluctuations in the grid itself and internal faults in the power conditioner, operational errors and switching transients.

C) Earth fault supervision: An integrated earth fault device shall have to be provided to detect eventual earth fault on DC side and shall send message to the supervisory system.

D) Cabling practice: Cable connections must be made using PVC Cu cables, as per BIS standards. All cable connections must be made using suitable terminations for effective contact. The PVC Cu cables must be run in GL trays with covers for protection.

E) Fast acting semiconductor type current limiting fuses at the main bus-bar to protect from the grid short circuit contribution.

3.14 The Inverter shall include an easily accessible emergency OFF button located at an appropriate position on the unit.

3.15 The Inverter shall include ground lugs for equipment and PV array grounding. The DC circuit ground shall be a solid single point ground connection in accordance with WEC 69042.

3.16 All exposed surfaces of ferrous parts shall be thoroughly cleaned, primed, and painted or otherwise suitably protected to survive a nominal 30 years design life of the unit.

3.17 The Inverter enclosure shall be weatherproof and capable of surviving *climatic changes and should keep the Inverter* intact under all conditions in the room where it will be housed. *The Inverter located indoor should be floor mounted*. Moisture condensation and entry of rodents and insects shall be prevented in the Inverter enclosure.

3.18 Components and circuit boards mounted inside the enclosures shall be clearly identified with appropriate permanent designations, which shall also serve to identify the items on the supplied drawings.

3.19 All doors, covers, panels and cable exists shall be gasketed or otherwise designed to limit the entry of dust and moisture. All doors shall be equipped with locks. All openings shall be provided with grills or screens with openings no larger than 0.95 cm.

3.20 The design and fabrication of the Inverter the site temperature (0^{O} to 50^{O} C), incident sunlight and the effect of ambient temperature on component life shall be considered carefully. Similar consideration shall be given to the heat sinking and thermal for blocking diodes and similar components.

3.22 Operating Modes:

The following operating modes are to be made available:

Night or Sleep mode: Where the inverter is almost completely turned off, with just the timer and control system still in operation, losses should not exceed 2 watts per 5 kilowatt.
In case of Grid Failure, the Inverter goes in sleep mode/ turned off immediately.

Standby mode : Where the control system continuously monitors the output of the solar generator until pre-set value is exceeded (typically 20 watts)

Operational or MPP tracking mode : The control system continuously adjust the voltage of the generator to optimize the power available. The Inverter must automatically re-enter stand-by mode when input power reduces below the standby mode threshold. Front Panel display should provide the status of the Inverter, including AC Voltage, Current, Power output & DC Current, Voltage and Power input, pf and fault Indication (if any)

3.23 Codes and Standards

The quality of equipment supplied shall be controlled to meet the guidelines for engineering design included in the standards and codes listed in the relevant ISI and other standards, such as :

IEEE 928 Recommended Criteria for Terrestrial PV Power Systems.

IEEE 929 Recommended Practice for Utility Interface of Residential and Intermediate PV Systems.

IEEE 519 Guide for Harmonic Control and Reactive Compensation of Static Power Controllers.

National Electrical NEPA 70-(USA) or equivalent national standard.

National Electrical Safety Code ANSI C2- (USA) or equivalent national standard.

JRC Specification 503 (Version 2.2 March 1991) or JPL Block V standard for PV modules.

3.24. METERING

1. PV array energy production: Digital Energy Meters to log the actual value of AC/ DC Voltage, Current & Energy generated by the PV system shall have to be provided for each SPV plant.

2. A data logging system for each SPV Power Plant control and monitoring shall be provided. For remote date monitoring of the plant parameters the PC shall be provided with complete functional software and remote linkage access through service provider for call / email / data transfer / IP linkage for plant operations monitoring throughout the 25 years operation & maintenance period shall be provided.

All major parameters shall be available on the digital bus and logging facility for energy auditing through the internal microprocessor and can be read on the digital front panel at any time the current values, previous values for up to a month and the average values. The parameters should be accessible via the operating interface display.

Protective function limits (Viz-AC Over voltage, AC Under voltage, Over frequency, Under frequency ground fault, PV starting voltage, PV stopping voltage, Over voltage delay, Under voltage delay over frequency, Ground fault delay, PV starting delay, PV stopping delay).

BALANCE OF SYSTEM

5. ARRAY JUNCTION BOX(AJB)/ DC Distribution Box

Array Junction Box / DC Distribution Box to receive the DC output from the array field with provision of SPD (surge protection device) and Diode circuit or Fuse. Each inverter have independent Array Junction Box. AJB/ DC distribution board(built—in) is complying with IP-65 standard.

6. COMMON AC DISTRIBUTION PANEL BOARD(ACDPB)

6.1. Common AC Distribution Panel Board (DPB) shall control the AC power from inverter. AC Distribution panel (ACDP) shall consist of MCB with 3Phase AC SPD and a Power Contactor as per Grid-Connected Rooftop Solar PV Plant Guidelines of TANGEDCO.

6.2 Bi-Directional Net-Meter is required to be installed as the energy consumption varies during daytime.

7. CABLES:-

a) ISI marked as per given brands PVC/XLPE insulated Copper Cond. Cable of various sizes as per load requirement for connecting all the modules / arrays to Jn. Boxes and from Jn. Boxes to DC distribution box and from DC distribution box to inverter. Copper/ Aluminium armoured Cables of appropriate size from Inverter onwards in A.C. side

b) Cabling in the yard and control room : Cabling in the yard shall be carried out as per IE Rules. Cabling inside control room and array area should be in cable pipes with proper water/moisture protection sealing. All other cabling above ground should be suitably mounted on cable trays with proper covers..

c) Wires : Only copper wires of appropriate size and of reputed make shall have to be used. On D.C. side only D.C. solar Cu cable to be used.

However aluminium cables can be used on A.C side of transmission.

d) Cables Ends: All connections are to be made through suitable cable/lug/terminals; crimped properly & with use of Cable Glands.

e) Cable Marking : All cable/wires are to be marked with proper manner by good quality ferule or by other means so that the cable can be easily identified.

All the Cu/Al. PVC or XLPE insulated Armoured Sheathed cables required for the plant will be provided by the manufacturer. However Cables for both D.C/A.C as per brands and specifications mentioned can be used.

8. LIGHTNING PROTECTION

There shall be the lightning arrestor installed in the array area. Lightning protection shall be provided by the use of metal oxide arrestors and suitable earthing such that induced transients find an alternate route to earth. Protection shall meet the safety rules as per Indian Electricity Act **.**

9. EARTHING PROTECTION

Each array structure of the PV yard should be grounded/ Earthing properly as per IS:3043-1987.In addition the lighting arrester/masts should also be provided inside the array field. Provision should be kept for shorting and grounding of the PV array at the time of maintenance work. All metal casing/shielding of the plant should be thoroughly grounded in accordance with Indian electricity Act./IE Rules. Earth Resistance should be tested in presence of the representative of Department after earthing by calibrated earth tester. Inverter ACDB and DCDB should also be earthed properly.

10. COMPREHENSIVE MAINTENANCE

All the equipments (Except SPV Modules for which the guarantee period is 25years) shall be provided with comprehensive Maintenance for 25 years against unsatisfactory performance and/or break down due to defective design, workmanship of material. The equipments or components, or any part thereof, so found defective during Comprehensive Maintenance period shall be forthwith repaired or replaced free of cost to the satisfaction of the Engineer-in-charge.

12. EXPECTED ELECTRICAL ENERGY GENERATION:

The minimum expected electrical energy generation is 1500 (Kwh) per year per 1 KWp System on LT side with degradation as per Industry standard year on year.

7. OPERATION AND MAINTENANCE

SCOPE OF OPERATION & MAINTENANCE OF SPV POWER PLANT FOR A PERIOD OF 5 YEARS FROM DATE OF COMMISSIONING

Regular operation & maintenance of the SPV Power Plant for a period of 25 years after commissioning along with supply of consumable items as and when necessary and submission of daily performance data of the power plant shall come, under the operation & maintenance contract.

The break down maintenance of the entire system including supply of necessary spare parts, if any, are already under the coverage of warranty clause of the specific condition for a period of 25 Years from date of commissioning of power plant.

8. PERFORMANCE MONITORING MECHANISM

Details of data monitoring on Daily, Monthly and Annual energy generation (data logging and compilation and sharing with MNRE)

Own mechanism	The remote monitoring system with the project from where data of inverter can be accessed through Internet
Third party	
Remote monitoring	

9. Typical Bill of Quantity – 500KWp Solar PV Grid-Tied Plant

Basic BOQ					
S.no	**Description**	**Specification**	**Make**	**Unit**	**Qty**
1	Solar PV Mono-PERC/ Bifacial Module	540Wp – BIS Certified	Made in India – as per RFS	Nos	926
2	Inverter	100KW - Grid Connected	Sungrow/ SMA/ SolarEdge	No	4
3	PVC Double Insulated Copper DC Cable	4Sq.mm, 1000 Volts Rated	Polycab	Mts	8000
4	DC Cable Connector	4mm2 cable,MC4 Compatible,IP67	Nordic	Pair	400
6	DC Breaker Switch	Built-in Inverter		Nos	
7	DC Distribution board	N.A (Built-in Inverter with Fuses, SPD and DC Isolator)		Nos	
9	Solar Generation Meter	3Phase Uni-Directional Meter	Discom Approved makes	Nos	1no
10	AC Cable	As per requirement	Polycab/ Equivalent	Mts	As reqd
11	AC Power Distribution Board	IP66 Box	Rittal	Nos	As reqd
12	Earthing Cable	As per requirement	Polycab	Mts	As reqd
13	PV Module Structure	Hot Dip Galvanized/ Aluminium Structure as per MNRE guidelines	Fabrication	Kgs	As reqd
14	Concrete				As reqd
15	Earthing	Dedicated Earthing)/ Copper plate /green earth cable/			As Required
16	Nut / Bolt / Screws/ Fasteners	Nut and bolt to fix PV module & Inverter in the structure		Nos	As Required
17	Conduit Pipe	Heavy Duty PVC Conduit pipe/ UV protected Conduits		Mts	As Required
18	Accessories	As Required		Mts	As Required