
Mahanadi Coalfields Limited (MCL) intent to set up of a “Grid Interactive 2MWp Solar Photovoltaic Power Plant” at MCL, Anand Vihar, Burla, Sambalpur, Odisha-768020.

Bidders Conference is being organized to invite suggestions/observations from the prospective bidders on scope of work & technical specification for the above job, which can be downloaded from web site [www.mcl.gov.in](http://www.mcl.gov.in).

Interested participants are requested to attend the Bidders Conference along with their technical brochures including other technical details along with suggestion on the published technical aspects during the Bidders Conference.

<table>
<thead>
<tr>
<th>Contact information</th>
<th>Program &amp; Time Schedule</th>
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<tbody>
<tr>
<td>Shri M.THAPLIYAL, GM (E&amp;M), MCL</td>
<td><strong>Program:</strong> Bidders Conference</td>
</tr>
<tr>
<td>MCL HQ, JAGRUTHI VIHAR, BURLA, SAMBALPUR, ODISHA-768020</td>
<td><strong>Venue:</strong> Plot No: G-3, Gadakana, Mancheswar Rly Colany, Bhubaneswar, Odisha, PIN: 751017.</td>
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<tr>
<td>Ph. No: 0663-2542973, Ph. No: 0674-2434611</td>
<td><strong>Date:</strong> 27/05/2013</td>
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<tr>
<td>Fax: 0663-2542797</td>
<td><strong>Timings:</strong> 11.30 A.M</td>
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<tr>
<td>E-Mail: <a href="mailto:gm-enm.mcl@nic.in">gm-enm.mcl@nic.in</a></td>
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SCOPE OF WORK & TECHNICAL SPECIFICATION

1.0 INTRODUCTION

Mahanadi Coalfields Limited (MCL) has planned to set up a 2 MWp Crystalline Solar Photovoltaic Power Generation Project at Anand Vihar Colony of MCL HQ, Burla of Sambalpur District. The Project is hybrid using fixed and tracking structures for mounting of Solar panels. MCL will select the lowest offers from the responsive Bidders based on the pre disclosed evaluation criteria.

India has an abundance of sunshine and the trend of depletion of fossil fuels is compelling Energy Planners to examine the feasibility of using renewable source of energy like Solar, wind etc. Recently the Ministry of New & Renewable Energy (MNRE) has announced new tariff based incentives for Solar Photovoltaic based power generation. This write up describes a typical 2 MWp scale SPV Power Plant, which can be installed to generate and export power to the main grid. The system being modular in nature, it can be replicated to form multi MW rated plants.

2.0 Scope of Work

2.1 The scope of work includes Design, Manufacture, Supply, Installation, Erection, Testing and Commissioning of Grid Connected 2 MWp Solar Photovoltaic Power Plant with associated power evacuation system at Anand Vihar, MCL HQ. The system is to be integrated into Central Control Software of MCL and shall be consisting of the followings:

1. Supply of 2MWp SPV System consisting of:
   a) SPV Modules-240 Wp (+/-3%) or higher rating (totalling to min. 2 MWp)
   b) Power Conditioning Unit (4 x 500 kVA) with provision for SCADA interface
   c) Transformer (1X2.5 MVA) and HT yard equipment (11KV)
   d) Mounting Structures
   e) Junction Boxes
   f) Cables
   g) Earthing Kit
   h) Lighting Arrestors
   i) PVC Pipes and accessories
   j) Tool Kit
   k) Control Room & Civil Pedestals

2. Installation and Commissioning

Note:

i. The Space required for Plant shall be of approximately 36000 m2 (9 acres) shadow free area and shall be provided by the company.
ii. The required switchyard for power evacuation at 11 kV shall be within the scope of supply. The distance of the local substation from the solar plant area is 0.8 km. The necessary interconnection through 02 (two) length of 11kv cable from solar power complex to local sub-station shall also be within the scope of supply.
iii. Total Electrical energy generated per MWp Plant size shall be 1.47 Million units per Year.(minimum) with maximum standard degradation of 1% per annum limited to 16% in 20 years.
iv. Space required for control room to house PCU and ACDB/DCDB and other infrastructure in control room shall be approx. 100 m2
v. The Supply, Erection & Commissioning time for 2 MWp shall be 04 (Four) Months from the date of handing over of clear and levelled site.

vi. Operation & Maintenance (O&M) of Plant for five years with your personals and spares shall be within the scope of work the necessary training to MCL’s personals shall also be provided by the contractor.

vii. For remote SCADA facility necessary broadband connection upto the site will be provided by MCL.

viii. Standrad Fencing with mesh suitable for such solar plant for safety of solar panels and other infrastructure along with drainage arrangement shall be in the scope of Contractor.

2.2 The equipment and materials for Grid Connected 2 MWp Solar Photovoltaic Power Plant with associated power evacuation system shall include but not limited to the supply, erection, testing, commissioning and integration into the MCL Central control software following:

a) Solar PV modules of composite capacity as mentioned above including mounting frames, structures, array foundation and module inter connection,

b) Array Junction boxes.

c) Power Conditioning Units that are communicable on Modbus Protocol.

d) Common AC power evacuation panel with bus bars and circuit breakers along with Power Evacuation arrangement from Plant site to nearest grid Sub-Station.

e) Metering and protection /Isolation systems. Meters to be communicable on MODBUS Protocol

f) LV Power and Control Cables including end terminations and other required accessories for both AC & DC power.

g) Earthing system for PV Array, DC power system, lightning protection system, AC power system for LT, equipment etc for control room building, PCU, Data acquisition system with remote monitoring facilities, Comprehensive AMC of plant for 5 years after warranty period.

h) Pre-Commissioning & commissioning of all supplied equipment.

i) Test running of Grid Connect Solar Plant as well as load trials at site.

j) Contractor shall be responsible for obtaining all statutory clearances including but not limited from Electrical Inspector regarding operation of the Plant. Purchaser shall however facilitate to ensure that the same is obtained successfully.

k) The system should be capable of providing all the data including that of meter and PCU to the central software on IEC-104 protocol. All the equipment /hardware /software for complying to the same will be in the bidder’s scope.

l) UPS /Battery/ Battery charger system to be considered as part of the scope so as to keep the system live in case of grid failure, Battery back up to be provided for 30 minutes of backup in case of grid failure.

3.0 TECHNICAL ASPECTS

The power generated by the solar array needs to be ‘conditioned’ in respect of voltage, phase and frequency to make it grid-interactive. Main objectives of grid connected / grid – interactive SPV systems are to provide demand side management, tail end voltage support, and peak sharing requirements.

The electrical power generated by the PV array is fed into the grid. When the output of PV systems varies due to weather conditions / seasonal changes the balance between supply and demand of power at the load end is met by drawing it from the grid. In the event of total grid – outage a limited load depending on user’s essential requirements is catered to by the PV array. This however requires a suitable battery bank depending upon the load requirements.
Grid interactive SPV systems have following benefits/ advantages:

- Better quality of power than utility grid.
- Very low maintenance and running costs.
- Modular increase / up gradation of capacity
- In situ generation of power at the point of consumption avoiding transmission / transportation losses.
- No pollution by way of wastes / ashes / noise.

4.0 SYSTEM DESCRIPTION

The total system comprises of;

- Solar array employing 240 Wp or higher rating SPV modules.
- Support structure made of galvanized steel angles with SS304 hard wares.
- IP65 rated field junction box made of FRP/ Poly carbonate material.
- Multi-stranded, UV protected, PVC insulated, PVC sheathed copper cable. The cables are sized to minimize the voltage drops & the power loss. The cables confirm to IS1554/ IS 694. Snap on connectors are employed for interconnections.
- Power Conditioning Unit (PCU) receives DC power from SPV module array junction boxes. PCU has built in software based Maximum Power Point Tacking (MPPT) to harness maximum power from the solar array. Typically the solar array will operate at 650 to 750V DC under the maximum power point operation.
   The DC power is then inverted to utility quality three phase power & this power shall be exported to utility. Necessary grid synchronizer is incorporated in the PCU through unique software.
- Data acquisition system & Bi-directional energy metering is also built in to the system. An integrated unit (Import –export meter) for energy generated by the plant is also provided. An integrated SCADA system monitors the PCU & HV substation parameters. Certain operational controls are provided in the SCADA.

   In order to enable wheeling of power to HT line (11 KV) LT power generated from the PCU is taken through a Star –Delta HV transformer.

4.1 System Features & Specifications

The photo voltaic array is divided in to four each of 500kWp. Each string in the array may have (optional) its own string monitoring unit which shall be one of the major diagnostic tools for the system operator. The PV array has field connected solar radiation meter & SPV module temperature sensor. The respective digital outputs are taken to a supervisory controller located in the control room. The Inverter unit employs state of the art DSP based technology to have conversion efficiency over 95%. Electronic surge arrestors are provided at the DC input & the AC output of each inverter. Necessary HT switch gears such as 11KV VCBs are provided for HT isolation & protection.

Each 500KWp system will have an independent Data Acquisition System (DAS) which would produce the real time Data as well as event logs indicating all the supervisory faults also.

Data logger of each 500KWp unit shall be integrated in to a mini Web server for the purpose of integrating the Data. These Data via Profibus is taken to a master Supervisory Control & Data Acquisition (SCADA system).Service interface on the operator panel is also provided.
4.2 Solar Photovoltaic Modules and Mounting Structure

The photovoltaic modules are made of mono-crystalline / multi-crystalline silicon solar cells, which are connected in series to give required output. The interconnected cells are laminated in vacuum to withstand adverse environmental conditions.

**Salient features:**

- Cells are encapsulated under high-transmission toughened glass.
- Laminate edges are sealed by sealant.
- Framed using weather resistant RTV silicon sealant.
- Employ anodised aluminium frame for resistance to shock and corrosion.
- Have waterproof terminal box with provision for mounting bypass diodes.
- Technical Detail for the PV modules

4.3 Power Conditioning Unit

- The solar PV inverter converts DC power into single phase/three phase AC power that is directly fed to the grid. The output of the inverter is simply paralleled at the local distribution board level so that a grid is formed.
- The power generated is exported to the grid.
- The inverter output always follows the grid in terms of voltage and frequency. This is achieved by sensing the grid voltage and phase and feeding this information to the feedback loop of the inverter. This control variable then controls the output voltage and frequency of the inverter, so that the inverter remains synchronised with the grid provided the grid parameters are within the specified window.

4.3.1 Technical Specifications of Inverter

- DSP based inverter to ensure higher efficiency
- Voltage THD < 3 %
- No-load loss < 1 % of rated power
- Self commutated IGBT-based inverter with Pulse width modulation.
- Wide range of Grid voltage & frequency parameters for synchronization.
- Sinusoidal current modulation with excellent dynamic response.
- Unit wise & integrated Data logging.
- Dedicated Profibus / Ethernet for networking
- Protection against Over current, Sync loss, Over temp., DC bus over voltage, EMI & RFI

**ADDITIONAL FEATURES**

- Power regulation in the event of thermal overloading
- Degree of protection –IP-21 or better
- Bus communication via RS 232 / RS 485 / MPI/ Profibus DP-interface for integration
- Remote monitoring via telephone modem or mini –web server
- Integrated protection in the DC and three-phase system
- Insulation monitoring of the PV array with sequential fault location
- Ground-fault detector – which is essential for large PV generators in view of appreciable discharge current with respect to ground

4.3.2 SCADA

An integrated SCADA shall be supplied which should be capable of communicating with 4 nos 500 KW inverters and provide information of each 500 KW PCU and the entire 2 MWp Solar PV Grid connect power plant. The SCADA shall also provide information of the instantaneous output energy and cumulative energy for each of the inverters as well as for the 2 MWp grouped Solar PV Grid connect power plant. The integrated SCADA shall have the feature to be used either locally via a local computer and also remotely via the Web using either a standard modem or a GSM / WIFI modem and broad band.

A. SCADA system of PCU depicts the single line diagram of the plant on the monitor. Mimics shall be provided with radio buttons to show the following parameters:

1. Solar radiation (W/m2)
2. PV module back surface temp
3. Ambient temp
4. Inverter output power (3 line)
5. Line and phase currents
6. Cumulative energy exported

B. SCADA system performs following control operations:

1. Inverter ON/OFF
2. Set point editing through a proven password mechanism
3. Mimic control through PC key board operation

C. SCADA also incorporates following features:
Integrated system control and data acquisition facilities. The use of a local operator interface and latest technology features shall be incorporated to enable viewing of instantaneous parameter metering, changing of operator modes and review of system logged events. Further, with PC based latest software technology, solar plant shall be monitored remotely via satellite link. The major SCADA features incorporated in to the control system are listed below.

1. Operator interface of latest technology: Instantaneous grid, array, inverter, AC, and metering of all parameters.
2. Integrated AC,DC data point logging: Instantaneous logging of all parameters. Including AC parameters, generator run hours and energy details.
3. Fault and system diagnostics with time stamped event logging. Selectable event logging resolution for enhanced diagnostics
4. Remote SCADA features with specific needs of station monitoring and remote communication are to be incorporated. Remote system access software, secured transmission of data and central PC facility provided.
4.3.3  Power Quality

- Voltage tolerance +/- 10% of the nominal voltage(VL=240V/415V)
- Frequency tolerance +/-3Hz of the nominal frequency (Nominal freq=50 Hz)
- Total harmonic distortion < 3%, with no single harmonic greater than 2%

4.3.4  Safety Features

- When the grid fails, it leads to “Islanding” of the local grid and the load from the main grid. As a safety measure, the inverter is disconnected immediately and power is not exported to the grid.
- The inverter has unique features like sleep mode, invoke mode and export mode so that any disturbances on the grid such as overload short-circuit, over-voltage etc., disables the firing circuit of the inverter and causes it to quietly withdraw from the grid.

4.3.5  Protection Features

- The injection of DC power into the grid is avoided by using an isolation transformer at the output of the inverter.
- Over-voltage protection is provided by using varistors at the output of the inverter.
- Another set of varistors at the input of the inverter provides lightning protection.

5. ENERGY GENERATION

Factors that influence the energy generated by a solar power plant are
- Mean solar radiation at the given site location
- Site temperature
- Dust collection (called dust factor) on the SPV modules
- SPV module mismatch factor
- Inter connecting cable loss due to voltage drops
- Electrical contact drops in the JBs & power terminals of PCU
- Grid availability
- Inverter efficiency
- System availability.

Note: Considering the above factors it is estimated that, typically a 2 MWp solar power plant would generate 29 Lakhs units of electricity per annum with standard degradation of 1% per annum limited to 16% in 20 years.
Detailed Technical Specification

1.0 A. Solar Photo Voltaic Module (Crystalline)

1.1 The Solar PV module will be minimum 240Wp nominal rating.

1.2 Solar modules offered shall be certified as per latest edition of IEC 61215. The modules shall also qualify for IEC 61730 for safety qualification testing. For modules to be used in a highly corrosive environment throughout their lifetime they must qualify for IEC 61701. Applicable only for sea shore installations.

1.3 SPV module shall contain poly crystalline high power silicon solar cells. The solar cell shall have surface anti-reflective coating to help to absorb more light in all weather conditions.

1.4 The module frame shall be made of aluminium or corrosion resistant material, which shall be electrolytically compatible with the structural material used for mounting the modules.

1.5 Photo electrical conversion efficiency of SPV module shall not be less than 14%.

1.6 Fill factor of the module shall not be less than 0.70

1.7 Each module shall have low iron tempered glass front for strength & superior Light transmission. It shall also have tough multi-layered polymer back sheet for environmental protection against moisture & provide high voltage electrical insulation.

1.8 Solar PV module shall be highly reliable, light weight and shall have a service life of more than 25 years.

1.9 The rated output of any supplied module shall not vary by more than 3% from the average power rating of all ratings. Each module, therefore, has to be tested and rating displayed.

1.10 It shall perform satisfactorily in relative humidity upto 95% and temperature between – 10°C and 85°C. It shall be able to withstand wind gusts upto 180 Km/hr.

1.11 The solar modules should have suitable encapsulation & sealing arrangements to protect the silicon cells from the environment. The encapsulation arrangement shall ensure complete moisture proofing for the entire life of solar modules.

1.12 Bidder must consider Shading Losses as per the relevant Industry Standard & Practice while designing the proposed power plant and the same shall be specifically indicated.

1.13 Guarantee on power output of solar module will be as per standard performance deviation values mentioned elsewhere.

1.14 Marking:

Each module shall carry the following clear and indelible markings:
- name, monogram or symbol of manufacturer;
- type or model number;
- serial number;
- polarity of terminals or leads (colour coding is permissible)
- maximum system voltage for which the module is suitable
- Date & place of manufacture;
- I-V Curve for the module has to be provided along with the modules.
- Wattage, Im, Vm & FF for the module
Module shall have type approval certificate as per Annexure-A. Bidder shall provide the data sheet as per Annexure - B.

1.0 Module Mounting Structure:
1.1 The array structure shall be so designed that it will occupy minimum space without scarifying the output from SPV panels.
1.2 The structure shall be designed to allow easy replacement of any module and shall be in line with the site requirement.
1.3 The array structure shall be made of hot dipped galvanised MS angles of suitable size.
1.4 The support structure design and foundation shall be designed to withstand wind speed upto 180KMPH using relevant wind load codes applicable at Burla.
1.5 The module alignment and tilt angle shall be calculated to provide maximum annual energy output. This shall be decided based on the location of array installation.
1.6 The array structure grounded properly using maintenance free earthing kit.
1.7 Galvanised steel structural must be considered for all type of structural steel proposed for the power plant.

2.0 Junction Boxes:

3.1 The array junction boxes shall be dust, vermin and water proof and made of FRP/ABS plastic with IP-65 degree of protection.

3.2 The array junction boxe will also have suitable surge protection.

3.3 The junction boxes shall have suitable arrangement for the followings;
   a) Combine groups of modules into independent charging sub-arrays.
   b) Provide arrangement for disconnection for each of the groups.
   c) Provide a test point for each sub-group for quick fault location
   d) To provide group array isolation.
   e) The current carrying rating of the junction boxes shall be suitable with adequate safety factor to interconnect the solar PV array.

3.4 The junction boxes shall have suitable cable entry points fitted with cable glands of suitable sizes for both incoming and outgoing cables.

3.5 Suitable markings shall be provided in the bus bar for easy identification and cable ferrules shall be fitted at the cable termination points for identification.

3 Power Conditioning Unit (PCU)

3.1 The PCU shall supply the DC Energy produced by array to DC bus for inverting to AC voltage using its MPPT (Maximum Power Point Tracking) to extract maximum energy from solar array and produce 415VAC, 3phase, 50Hz to synchronise with the grid through LT/HT panels.

3.2 MPPT Controller, inverter and associated control and protection devices etc shall be integrated into PCU.

3.3 The rating of PCU shall be suitable to the capacity offered.

3.4 PCU shall provide 3ph, 415V+/- 2%V, 50+/-0.05Hz supply on AC side with THD<3%.
3.4 DC Voltage ripple content shall not be more than 3%.

3.5 Efficiency of PCU shall not be less than 94%.

3.6 Degree of protection should not be less than IP-56.

3.7 It shall have protection features such as over voltage, short circuit, over temperatures etc and other protection feature as elaborated elsewhere.

3.8 The inverter shall be efficient based on PWM MPPT with IGBT reliable power based design.

3.9 The system should be capable of providing all the data including that of meter and PCU to the central software on IEC-104 protocol.

4.10 All the equipment/hardware/software for complying to the same will be in bidder’s scope.

4.11 The PCU shall be capable of complete automatic operation including wake up, synchronisation & shut down.

4.12 PCU shall have facility to display basic parameters of the system.

4.13 PCU shall be capable to synchronise independently and automatically/to be phase locked with power supply Authority grid power line frequency to attain synchronisation and export power generated by solar panel to power supply authority grid.

4.14 Built-in with data logging to remotely monitor plant performance through external PC shall be provided.

4.15 Inverter shall be tested for islanding protection performance.

4.16 Only isolated inverters shall be used.

4.17 UPS/Battery charger system to be considered as part of the scope so as to keep the system live in case of grid failure.

4.18 PCU to be communicable on Modbus protocol.

INDICATIONS (through LEDs & LCD display)
- Inverter ON
- Grid ON
- Inverter under voltage/over voltage
- Inverter over load
- Inverter over temperature.

PROTECTIONS:
- Over voltage both at input & output.
- Over current both at input & output
- Over/under grid frequency
DC Distribution board shall be provided in between solar array and PCU. It shall have MCCB of suitable rating for connection and disconnection of array section.

It shall have meters for measuring the array voltage and array current. DCDB can also be integrated into PCU for space saving.

4. **Cables and Hardwares:**

   Cables of appropriate size to be used in the system shall have the following characteristics:

   - Will meet IS 694/1554 standards.
   - Temp Range -10degree centigrade to +80degree centigrade.
   - Voltage rating 660/1000V
   - Excellent resistance to heat, cold, water, oil, abrasion, UV radiation
   - Flexible.

   Cabling on DC side of the system shall be as short as possible to minimise the voltage drop in the wiring. Components and hardwares shall be vandal and theft resistant. All parts shall be corrosion resistant. The system description, general/technical requirements etc are given for general guidance only. The supplier/manufacturer shall submit the detailed design of the complete solar generating system by using their software to optimise the combination of modules considering the specific location, insolation, nature of load etc.

6.0 **Energy Meter:** An energy meter duly approved by appropriate authority shall be provided to measure the delivered quantum of energy to the Grid for sale. The approval of energy meter from appropriate authority shall be within the scope of supply.

6.1 Energy meter shall be import/export type ABT compliant, 0.5 class accuracy and must be Modbus compliant for further integration with central monitoring system.

7.0 **Civil Work Specification:**

   All the works including design, drawings, construction, fabrication, testing, erection, etc. shall be executed strictly as per relevant BIS Code of practices. Wherever no Indian Standard is available British, American, German, Russian or other international standards may be used only as per its applicability and justification.
Annexure : A

Quality Testing of PV-Module:

Modules used in crystalline PV solar panels shall have IEC 61215 compliance certificate. The Qualification testing procedure is defined in IEC 61215 to examine the impact of mechanical, thermal & electrical stress on power output. The bidder shall submit appropriate type approval certificate for the offered solar modules from IEC approved laboratory.

Method of Testing

1. Visual Inspection:

   Each module shall be carefully inspected under an illumination of not less than 1000 lux for the following conditions:
   a. Cracked, bent, misaligned or torn external surfaces.
   b. Broken / cracked cells
   c. Faulty interconnections or joints;
   d. Cells touching one another or the frame;
   e. Failure of adhesive bonds; bubbles or de-laminations forming a continuous path between a cell & edge of the module;
   f. Faulty terminations, exposed live electrical parts
   g. Junction box should have common terminals with suitable bypass diode for preventing hot spot problem.

2. Performance at STC: (As per IEC 61215:2005 & IEC61646)

   The current-voltage characteristics of the module shall be determined in accordance with IEC 60904-1 at a specific set of irradiance & temp conditions. Performance of PV-Module shall be generally evaluated at Standard-Test-Conditions (STC) as defined in IEC 60904 standards:
   - Cell temp of 25° C,
   - Incident solar irradiance of 1000W/m²,
   - Spectral distribution of light spectrum with an air mass AM=1.5

3. Deleted since these are not part of IEC 61215 tests

4. Acceptance Criteria:

   The Module is deemed to have passed the tests if the sample meets the following criteria:
   a. There is no evidence of a major visual defect such as a cracked or broken window, bubbles or de-lamination in the encapsulate etc.
   b. There are no cell breakages & no water infiltration into terminal boxes.
   c. No sample exhibits any open circuit or ground fault.
   d. No visible evidence of major defects that may affect the performance of the module.
   e. Insulation Resistance not less than 50M-ohm at 500 V DC.
   f. Degradation of performance may not exceed 5% after each single test or 8% after the whole sequence.
**Annexure B : Solar Module Data Sheet (Crystalline PV)**

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<tr>
<td>PV Module type</td>
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<td>No. of PV cells per Module</td>
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<td>Output cables</td>
<td>Polarized weatherproof DC rated multi-contact connectors</td>
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<td>Junction Box</td>
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<td>Construction</td>
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<td>Maximum system voltage</td>
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<td>Static load (front and back)</td>
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<td>Hailstone impact</td>
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## Annexure C: Power Conditioning Unit

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<thead>
<tr>
<th>Operating Parameters</th>
<th>Required</th>
<th>Offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make</td>
<td>Reputed Manufacturers like SMA, ABB etc.</td>
<td></td>
</tr>
<tr>
<td>Nominal Output Voltage</td>
<td>230/415 volts ±1% three phase, 4 Wire output, grid tracking Nominal voltage shall be adjusted by ±10% via system set points</td>
<td></td>
</tr>
<tr>
<td>Output Frequency</td>
<td>50Hz ± 0.5% Inverter to follow grid frequency up to ±3Hz of the nominal output frequency during normal operation</td>
<td></td>
</tr>
<tr>
<td>Continuous Rating</td>
<td>To be mentioned</td>
<td></td>
</tr>
<tr>
<td>Max DC Link Voltage Range</td>
<td>To be mentioned</td>
<td></td>
</tr>
<tr>
<td>MPPT Range</td>
<td>To be mentioned</td>
<td></td>
</tr>
<tr>
<td>Control Type</td>
<td>Voltage source, microprocessor assisted output regulation</td>
<td></td>
</tr>
<tr>
<td>Waveform</td>
<td>DSP/Microcontroller generated PWM for low THD, sinewave output</td>
<td></td>
</tr>
<tr>
<td>Parallel Operation Power</td>
<td>Phase Controlled Pulse Width Modulation (PWM)</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>THD</td>
<td>Less than 3%</td>
<td></td>
</tr>
<tr>
<td>Efficiency</td>
<td>Up to 94%</td>
<td></td>
</tr>
<tr>
<td>Internal Protection System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(using electronic detection)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Inverter continuous overload protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Inverter peak current (short circuit) protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Heatsink over temperature protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Over/under grid voltage AC voltage protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Over/under grid frequency protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Anti islanding protection</td>
<td></td>
</tr>
<tr>
<td>Alarm Signals</td>
<td></td>
<td>Via system fault relay (voltage free contact)</td>
</tr>
<tr>
<td>Front Panel Display (LCD)</td>
<td>40x4 LCD panel with membrane keypad displaying the following:</td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Front Panel Controls (via keypad)</td>
<td>To be mentioned</td>
<td></td>
</tr>
<tr>
<td>Front Panel Indicators</td>
<td>To be mentioned</td>
<td></td>
</tr>
<tr>
<td>Circuit Breakers</td>
<td>- Grid Input</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Solar Input</td>
<td></td>
</tr>
<tr>
<td>RFI</td>
<td>Designed to minimize both conducted and radiated RFI emissions</td>
<td></td>
</tr>
<tr>
<td>Earthing Provisions</td>
<td>AC bypassing to earth on inverter and DC inputs</td>
<td></td>
</tr>
<tr>
<td><strong>ENVIRONMENTAL</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>5-50 degrees Celsius</td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>0-90% non condensing</td>
<td></td>
</tr>
<tr>
<td>Enclosure</td>
<td>Rated for IP30 (indoor application)</td>
<td></td>
</tr>
</tbody>
</table>

**ENCLOSURE**
<table>
<thead>
<tr>
<th>Dimensions</th>
<th>To be mentioned</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight</td>
<td>To be mentioned</td>
</tr>
</tbody>
</table>

**GRID SPECIFICATIONS**

| Nominal Voltage & Frequency | 230/400 volts 50Hz, 3 phase, 4 wire. Typical voltage tolerance: +15% and -90% for any two of the 3 phases, +15% and -20% for the remaining phase. Typical frequency tolerance +/- 3Hz |

**DATA LOGGING**

<table>
<thead>
<tr>
<th>Communication Interface</th>
<th>RS232/RS485, Modbus/Profibus/Telephone Modem</th>
</tr>
</thead>
</table>
| System Features         | - Adjustable logging repetition from 1 sec to 900 seconds  
                          - Storage capacity of up to 3 year with 10 min logs  
                          - Time and date stamped log entries  
                          - Time and date annotated fault log, holding the fault description and operating statistics  
                          - View and change system set point configurations remotely  
                          - Bulk log download for data importation into a spreadsheet where applicable |

**Logging Attributes**

A summary of the data logging abilities to be supplied with the control system for instantaneous viewing and periodic logging are listed below:

**SYSTEM SUMMATIONS**
- Inverter import and export kWh
- Solar kWh
- Hours run

**SYSTEM PARAMETERS**
- Inverter volts, amps, kW, kVA, frequency
- Grid volts and frequency
- Solar panel temperature
- Ambient temperature
- PV panel voltage
- Solar charge current
- Heat sink & cabinet temperatures
- Solar radiation (with external pyranometer)
## Annexure D: Evaluation Parameters

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Description</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Technical</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Guaranteed energy generation for sale per annum (kWh) over a 25 year period.</td>
<td>Please give the figure in KWH &amp; Mus</td>
</tr>
<tr>
<td>1.1</td>
<td>Sub Total</td>
<td>10</td>
</tr>
</tbody>
</table>