Phone :+91-512-597102(O)
+91-512-598772 (R)
Fax: +91-512-590063
e-mail: rsanand@iitk.ac.in
Home page: home.iitk.ac.in/~rsanand

Dr. RAGHUBIR SINGH ANAND
Principal Research Engineer

No.RSA/Aug 2013/1
Electrical Engineering Department
INDIAN INSTITUTE OF TECHNOLOGY
KANPUR 208016 INDIA

21 Aug 2013.

To,

Tender Enquiry

Subject: **Roof Top Solar Photovoltaic Power Plant at IITK**

We like to set up a 1744 KWp roof top solar photovoltaic (PV) power plant at our institute in two phases. In the first phase, a solar PV plant having a mix of 192 KWp high efficiency (=>20% efficiency) silicon solar cell modules and 152 KWp normal 14-15% mc-silicon/c-silicon solar cell modules will be implemented. Based on the user feedback on Levelized Cost of Electricity of high and low efficiency modules, a decision either to go for high efficiency or for normal 14-15% mc-silicon/c-silicon solar cell modules will be taken for IInd phase 1400 KWp.

In view of the above, Quotations for Ist Phase 344/353 KWp roof top internally IITK grid connected solar photovoltaic plants are invited. The material & system specifications are given below.

Option No.1 **High efficiency Silicon Module based 192 KWp Solar Power Plant**
Rooftop Locations: (a) Roof Top of Faculty Building & Part of Western Lab Building

I. PV Modules

(i) Silicon (=>20% efficiency) modules preferably 250 -300 Wp ratings.
(ii) Junction boxes for each panel and cable entry should be IP65 compatible.
(iii) RCD to prevent accidental live wiring of module casing and support structures must be present and must be tuned properly to avoid spurious trips.
(iv) Roof compatible galvanized structure in the layout shown in the drawing. It may vary as per rating & size of modules.

II. Power Electronic interface (Inverter)

(i) 4 x 50 kW, 3-phase grid connected inverters. Inverters should be nominally rated to inject full rated power into 415 V, 50 Hz, 3-phase, 4-wire AC grid. Inverters must incorporate all standard protection features including, but not limited to, overload, grid over/under voltage, incorrect phase sequence, frequency deviation, short-circuit, input dc over/under voltage, input cable disconnection, line surges etc.
(ii) Inverters should also be additionally capable of injecting full rated power under normal grid voltage fluctuations (400-460 V line-to-line, rms) and frequency variations (48.5 Hz – 51.5 Hz).
(iii) Harmonic injection under all operating conditions must adhere to IEEE-512, 1992 norms.

(iv) Insolation sensitive auto-startup (on availability of daylight) and auto-shutdown (in absence of daylight) features must be incorporated.

(v) Isolation between inverter and AC Distribution Board must be provided in case any PV array output terminal is earthed.

(vi) RCD installed for prevention of livewiring of cabinet and support must be present and must be tuned properly to avoid spurious trips.

(vii) RS485 LAN connectivity with each inverter to make available string DC voltage, currents, daily, weekly, monthly, yearly power & energy, AC voltage, current, phase, humidity, temperature and Sun Global Irradiance through a Pyranometer at the place.

(viii) 6mm core double insulated solar grade wires passing through good quality flexible plastic conduit pipe between panels and Combiner Box.

(ix) Combiner Boxes (CB) with proper fuses and surge protectors.

(x) 10mm core double insulated solar grade wires passing through good quality plastic conduit pipe between CB-inverter & inverter-ACDB.

(xi) AC Distribution Board with appropriately rated switchgear and energy meters between inverter and IITK 3-phase grid interface.

(xii) Anti-islanding feature to be incorporated. Hardware digital port to be provided for optionally disabling this feature. (default option: enabled through pull-up arrangement)

(xiii) *DC, AC grounding and lightning arrestors along with civil work as required*

AND

<u>Option No.2</u> **152 KWp Solar Power Plant**

<u>Rooftop locations:</u> (a) Western Lab (100 kWp), (b) Western Lab Extension (28 kWp), (c) Northern Lab II/Chemical Engineering Lab(24 kWp)

I. PV Modules

(i) 14-15% mc-silicon/c-silicon solar cell modules, preferably 250 (200 x4 panels) - 300 (160 x 4 panels) Wp ratings.

(ii) Junction boxes for each panel and cable entry should be IP65 compatible.

(iii) RCD to prevent accidental live wiring of module casing and support structures must be present and must be tuned properly to avoid spurious trips.

(iv) Roof compatible galvanized structure in the layout shown in the drawing. . It may vary as per rating & size of modules.

II. Power electronics (Inverter / charge controller)

(i) 2 x 50 kW, 3-phase, grid connected inverters for Western Lab installation. Inverters should be nominally rated to inject full rated power into 415 V, 50 Hz, 3-phase, 4-wire AC grid. Inverters must incorporate all standard protection features including, but not limited to, overload, grid over/under voltage, incorrect phase sequence, frequency deviation, short-circuit, input dc over/under voltage, input cable disconnection, line surges etc.

(ii) 3 x 10 kW, 3-phase grid connected inverters ***for each of*** the installations (total 6 x 10 kW) on Western Lab extension and Northern Lab II/ Chemical Engineering. Inverters should be nominally rated to inject full rated power into 415 V, 50 Hz, 3-phase, 4-wire AC grid. Inverters must incorporate all standard protection features including, but not limited to, overload, grid

over/under voltage, incorrect phase sequence, frequency deviation, short-circuit, input dc over/under voltage, input cable disconnection, line surges etc.

(iii) Inverters should also be additionally capable of injecting full rated power under normal grid voltage fluctuations (400-460 V line-to-line, rms) and frequency variations (48.5 Hz – 51.5 Hz).

(iv) Harmonic injection under all operating conditions must adhere to IEEE-512, 1992 norms.

(v) Insolation sensitive auto-startup (on availability of daylight) and auto-shutdown (in absence of daylight) features must be incorporated.

(vi) Isolation between inverter and AC Distribution Board must be provided in case any PV array output terminal is earthed.

(vii) RCD installed for prevention of livewiring of cabinet and support must be present and must be tuned properly to avoid spurious trips.

(viii) RS485 LAN connectivity with each inverter to make available string DC voltage, currents, daily, weekly, monthly, yearly power & energy, AC voltage, current, phase, humidity, temperature and Sun Global Irradiance through 3 Pyranometers at each of the three buildings.

(ix) 6mm core double insulated solar grade wires passing through good quality flexible plastic conduit pipe between panels and Combiner Boxes.

(x) Combiner Boxes with proper fuses and surge protectors.

(xi) 10mm core double insulated solar grade wires passing through good quality plastic conduit pipe between CB -inverter & inverter-ACDB.

(xii) AC Distribution Boards fitted with appropriately rated switchgear and energy meters between inverter and IITK 3-phase grid terminals.

(xiii) Anti-islanding feature to be incorporated. Hardware digital port to be provided for optionally disabling this feature. (default option: enabled through pull-up arrangement)

(xiv) *DC, AC grounding and lightning arrestors along with civil work as required across .*

OR

Option No.3 **353 KWp Solar Power Plant**

Rooftop Locations: Faculty Building (133 kWp), for Western Lab (100 kWp), Western Lab Extension (28 kWp), Northern Lab / Mech. Engg. (39 kWp), ACES building (29 kWp), Northern Lab II/Chemical Engineering Lab (24 KWp)

I. PV Modules

(i) 14-15% mc-silicon/c-silicon solar cell modules preferably 250(200 x4 panels) -300 (160 x 4 panels) Wp ratings.

(v) Junction boxes for each panel and cable entry should be IP65 compatible.

(vi) RCD to prevent accidental livewiring of module casing and support structures must be present and must be tuned properly to avoid spurious trips.

(vii) Roof compatible galvanized structure in the layout shown in the drawing. . It may vary as per rating & size of modules.

II. Power electronics (Inverter / charge controller)

(i) 3 x 50 kW, 3-phase, grid connected inverters for Faculty Building installation. Inverters should be nominally rated to inject full rated power into 415 V, 50 Hz, 3-phase, 4-wire AC grid. Inverters must incorporate all standard protection features including, but not limited to, overload, grid

over/under voltage, incorrect phase sequence, frequency deviation, short-circuit, input dc over/under voltage, input cable disconnection, line surges etc.

(ii) 2 x 50 kW, 3-phase, grid connected inverters for Western Lab installation. Inverters should be nominally rated to inject full rated power into 415 V, 50 Hz, 3-phase, 4-wire AC grid. Inverters must incorporate all standard protection features including, but not limited to, overload, grid over/under voltage, incorrect phase sequence, frequency deviation, short-circuit, input dc over/under voltage, input cable disconnection, line surges etc.

(iii) 4 x 10 kW, 3-phase grid connected inverter for Northern Lab / Mechanical Engineering. Inverters should be nominally rated to inject full rated power into 415 V, 50 Hz, 3-phase, 4-wire AC grid. Inverters must incorporate all standard protection features including, but not limited to, overload, grid over/under voltage, incorrect phase sequence, frequency deviation, short-circuit, input dc over/under voltage, input cable disconnection, line surges etc.

(iv) 3 x 10 kW, 3-phase grid connected inverters ***for each of*** the installations (total 9 x 10 kW) on Western Lab extension, ACES building and Northern Lab II/ Chemical Engineering. Inverters should be nominally rated to inject full rated power into 415 V, 50 Hz, 3-phase, 4-wire AC grid. Inverters must incorporate all standard protection features including, but not limited to, overload, grid over/under voltage, incorrect phase sequence, frequency deviation, short-circuit, input dc over/under voltage, input cable disconnection, line surges etc.

(v) Inverters should also be additionally capable of injecting full rated power under normal grid voltage fluctuations (400-460 V line-to-line, rms) and frequency variations (48.5 Hz – 51.5 Hz).

(vi) Harmonic injection under all operating conditions must adhere to IEEE-512, 1992 norms.

(vii) Insolation sensitive auto-startup (on availability of daylight) and auto-shutdown (in absence of daylight) features must be incorporated.

(viii) Isolation between inverter and AC Distribution Board must be provided in case any PV array output terminal is earthed.

(ix) RCD installed for prevention of live wiring of cabinet and support must be present and must be tuned properly to avoid spurious trips.

(x) RS485 LAN connectivity with each inverter to make available string DC voltage, currents, daily, weekly, monthly, yearly power & energy, AC voltage, current, phase, humidity, temperature and Sun Global Irradiance through 3 Pyranometers at each of the three buildings.

(xi) 6mm core double insulated solar grade wires passing through good quality flexible plastic conduit pipe between panels and Combiner Boxes.

(xii) Combiner Boxes with proper fuses and surge protectors.

(xiii) 10mm core double insulated solar grade wires passing through good quality plastic conduit pipe between CB -inverter & inverter-ACDB.

(xiv) AC Distribution Boards fitted with appropriately rated switchgear and energy meters between inverter and IITK 3-phase grid terminals.

(xv) Anti-islanding feature to be incorporated. Hardware digital port to be provided for optionally disabling this feature. (default option: enabled through pull-up arrangement)

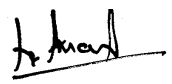
(xv) *DC, AC grounding and lightning arrestors along with civil work as required.*

Terms & Conditions:

1. Last date for submission of the Quotations is 10 Sep 2013, 1700 hrs.
2. Quotations are to be submitted in two parts, Technical and Financial bids in two separate sealed covers enclosed in other sealed cover. Technical bid containing material, system specifications, terms &

conditions as listed will be opened on 11 Sep 2013. Financial bids only of those meeting Technical and other terms conditions will be opened on 12/13 Sep 2013. Cover should be marked at its top with "Quotation for **Technical/Financial** bid for Roof Top Solar Photovoltaic Power Plant at IITK**".**

3. Our **preference** is to go for a mix of Option 1 & Option 2 in Phase I. Hence, separate Quotations for Option 1, Option 2 and Option 3 may be submitted. The final decision will be taken by the Purchase Committee.
4. Payment term, 50% on delivery of material and 50% on successful installation, commissioning & Inspection Report.
5. A template of modal Quotation is attached with this email.
6. Installation and commissioning to be completed within 6 months of placement of order. A fine of Rs.8000-00 per day, equivalent to expected electricity generation cost will be imposed after six months. It will be deducted from the final payment.
7. Modules, Inverters and other items should conform to the general guidelines and Specification, warranties as specified in Annexure -3 of MNRE letterNo.5/23/2009-P&C dated 16 Jun 2010. (copy attached) and other regulations on the subject.
8. All modules to be provided with its Flash Sheets giving test reports of all important parameters.
9. 20 (approximately 2% of the lot) randomly selected PV modules will be cross checked for efficiency & power at an authorized testing center. If 10% of these fail the tests, entire lot will be rejected. All panels have to be replaced by the concerned supplier within 15 days solely at their cost.
10. Warranties for modules, structure be given for 25 years and 5 years for inverters and other BOS items.
11. All civil, electrical installation & commissioning work should be carried by trained persons and as per best labor law practices with no possibility of any accidents. Any mis-happening will be the responsibility of the contractor and he will be responsible for due compensation as per law.
12. The open area & height of different building along with sample layout of panels in useable area is given the attached drawings.
13. Covered space for inverter near to solar panels and ACDB location on ground floor of the respective buildings will be provided by IITK.
14. We will like to avail the subsidy and other benefits available from the MNRE and other agencies under existing rules. Hence, authorized channel partners of MNRE need only submit the quotations.

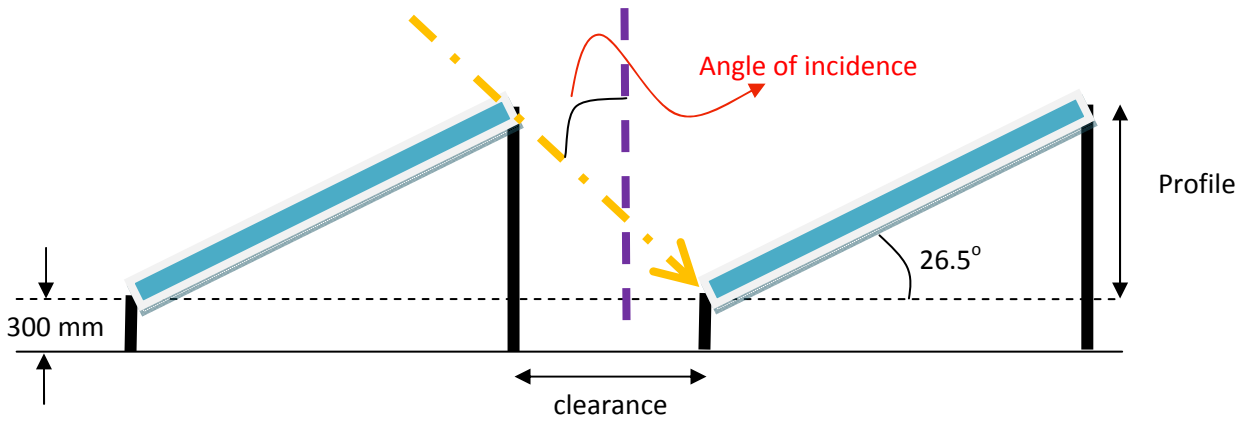


(RS Anand)

Annexure 1

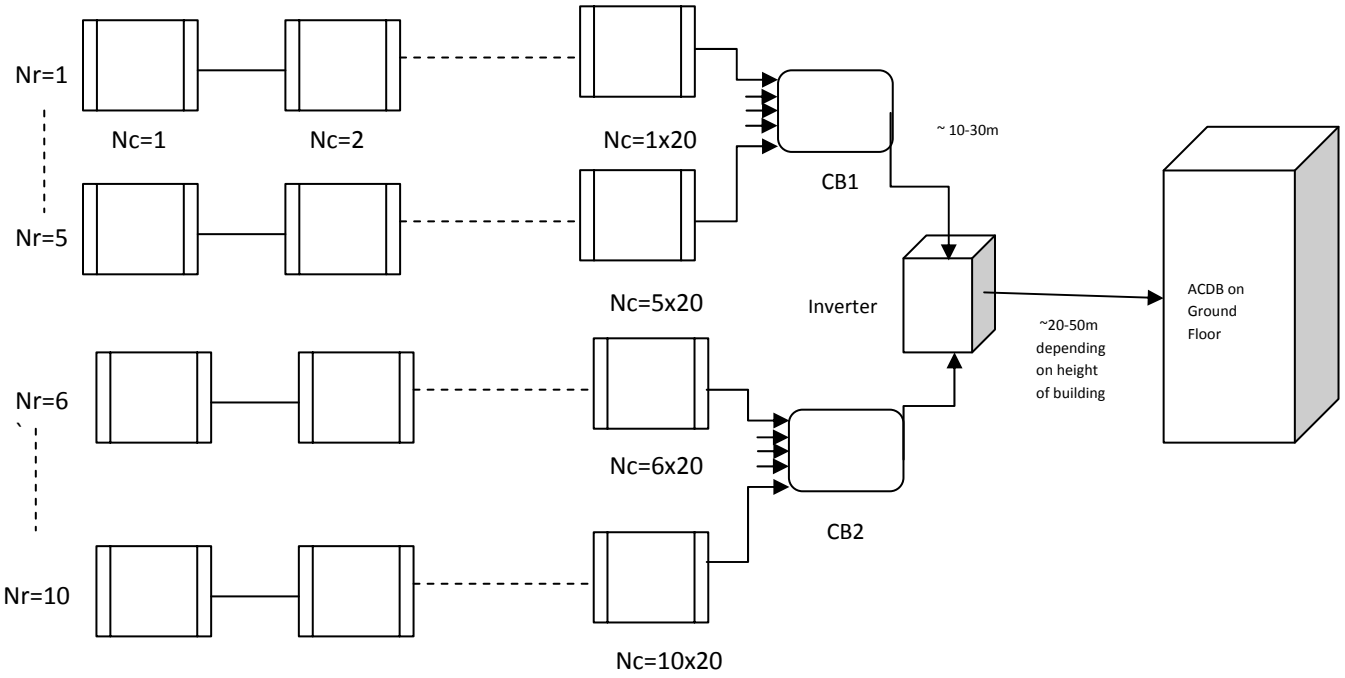
Area, Clearance, Angle of Tilt and String layout of modules

Required rooftop surface area (per kWp) is dependent on the maximum tilt of the sun as well as on the maintenance clearance between adjacent rows of panels. In winter, the maximum tilt angle at Kanpur (12 noon) is about 40°. Although this requires 0.5 m clearance, this is not sufficient for maintenance activities. Hence a clearance of 750 mm is proposed which results in rooftop surface requirement of 13.2 m^2/kWp. This factor has been used for estimating the generation potential for each building. With high efficiency modules, the minimum clearance required can be increased to 975 mm which allows a higher angle of incidence (64.5°).

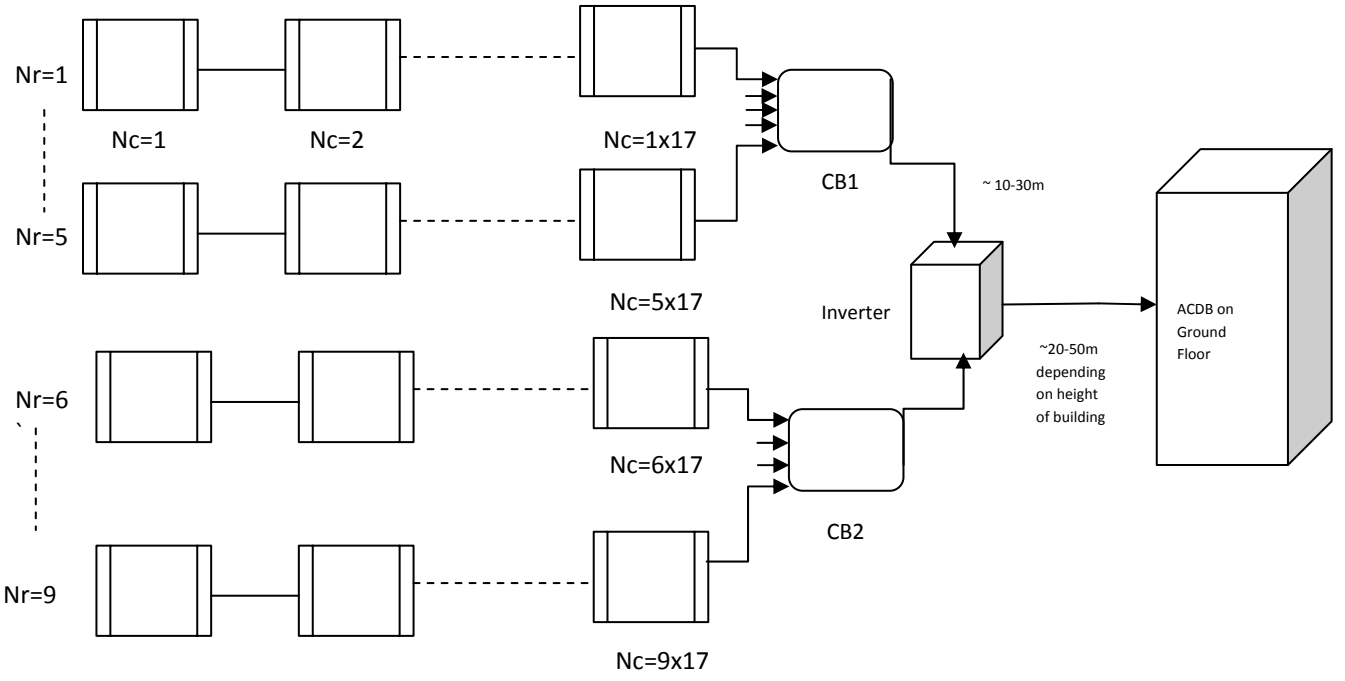


Side view of the proposed panel installation

Sample String layout of 200 x 250 Wp = 50 KWp Basic Unit for Vm = 35V, 14-15% efficiency solar modules. (It may change as per module ratings)



Sample string layout of 153x 327 Wp = 50.0KWp Basic Unit for Vm = 54.9V, 20.1% efficiency solar modules. (It may change as per module ratings)



Model Quotation for *Indigenous purchase*

Dated:

To
Dr./Prof.
Dept.
Indian Institute of Technology, Kanpur

Sub : Quotation for supply of :
Ref : Your enquiry letter no: & date:

Sir / Madam:

With reference to your enquiry letter on the subject mentioned above, the following quotation is hereby submitted for your consideration, in a sealed cover.

***

I Supplier Details : Agency / Vendor name: Local Agent:

1. Address :
2. Ph.No :
3. Mobile :
4. Email :
5. Bank A/c No :
6. Bank Name & Add :
7. RTGS / NEFT Code :
8. Registration Details like PAN / VAT / Service TAX etc:

II. Description & Costs of Material / Equipment :

Sl No.	**Complete description / specification of items required**	**Model No.**	**No of Units**	**Unit Price**	**Total Amount**
1	***Default Specs:***				

2	***Optional Specs:***				
3	**Total Cost in INR:** **a) Free on Rail** **b) Ex-Work**				
4	***Transportation charges***				
5	Packing & Forwarding charges				
6	Transit Insurance				
7	Other Charge, if any				
8	**Taxes**				
	• Excise Duty / Customs Duty, if applicable	Excise Duty Exemption Certificate will be provided.			
	• Sales Tax / CST / VAT • Octroi, if applicable • Service Tax				
	• Other Duties / taxes				
	Total Value of quotation				

IV. ***Terms & Conditions:***

	Particulars	Description
1	Guarantee/Warranty Yrs.	25 years for solar panel, 5 years for inverters & other items
2	AMC Value per annum	
3	Costs for additional warranty, if any	
4	No. of Preventive Maintenance Service visits per annum	3 visits per year for first five year
5	Validity of quotation (Min. 60 days)	60 days
6	Delivery Period	6 months.

7	Method of Payment: **(a)** ECS **(b)** Cheque **(c)** DD **(d)** CAD **(e)** TT **(f)** LC	
8	***Payment Terms***	
	• 90% on delivery & 10% after installation & approval of inspection report. • 50% on installation and 50% on inspection report submission. • 100% on installation and on inspection report submission • Advance payment up to 100 % against Bank guarantee • Any other Conditions	50% on installation and 50% on inspection report submission.
9	**Any other details**	

Encl: Literature

Signature of the authorized signatory

Date & Seal:

ANNEXURE-3

MINIMAL TECHNICAL REQUIREMENTS/ STANDARDS FOR OFF-GRID/ STAND-ALONE SOLAR PHOTOVOLTAIC (PV) POWER PLANTS/ SYSTEMS TO BE DEPLOYED UNDER THE NATIONAL SOLAR MISSION

1. PV MODULES:

1.1 The PV modules must conform to the latest edition of any of the following IEC / equivalent BIS Standards for PV module design qualification and type approval:

Crystalline Silicon Terrestrial PV Modules	IEC 61215 / IS14286
Thin Film Terrestrial PV Modules	IEC 61646
Concentrator PV Modules & Assemblies	IEC 62108

1.2 In addition, the modules must conform to IEC 61730 Part 1- requirements for construction & Part 2 - requirements for testing, for safety qualification.

1.3 PV modules to be used in a highly corrosive atmosphere (coastal areas, etc.) must qualify Salt Mist Corrosion Testing as per IEC 61701.

2. BALANCE OF SYSTEM (BoS) ITEMS/ COMPONENTS:

2.1 The BoS items / components of the SPV power plants/ systems deployed under the Mission must conform to the latest edition of IEC/ equivalent BIS Standards as specified below:**

BoS item/component	**Applicable IEC/equivalent BIS Standard**	
	Standard Description	**Standard Number**
Power Conditioners/Inverters*	Efficiency Measurements Environmental Testing	IEC 61683 IEC 60068 2 (6,21,27,30,75,78)
Charge controller/MPPT units*	Design Qualification Environmental Testing	IEC 62093 IEC 60068 2 (6,21,27,30,75,78)
Storage Batteries	General Requirements & Methods of Test Tubular Lead Acid	IEC 61427 IS 1651/IS 133369
Cables	General Test and Measuring Methods PVC insulated cables for working Voltages up to and including 1100 V-Do-, UV resistant for outdoor installation	IEC 60189 IS 694/ IS 1554 IS/IEC 69947
Switches/ Circuit Breakers/Connectors	General Requirements Connectors-safety	IS/IEC 60947 part I,II,III EN 50521
Junction Boxes/Enclosures	General Requirements	IP 65 (for outdoor)/IP 21 (for indoor) IEC 62208
SPV System Design	PV Stand-alone System design verification	IEC 62124
Installation Practices	Electrical installation of buildings Requirements for SPV power supply systems	IEC 60364-7-712

* Must additionally conform to the relevant national/international Electrical Safety Standards.

** **Also refer Addendum No. 32/49/2010-11-PVSE dated 19.08.2010 appearing at the end of this document.**

3. AUTHORIZED TESTING LABORATORIES/ CENTERS

3.1 The PV modules must be tested and approved by one of the IEC authorized test centers. Test certificates can be from any of the NABL/ BIS Accredited Testing / Calibration Laboratories. Qualification test certificate as per IEC standard, issued by the Solar Energy Centre for small capacity modules upto 37Wp capacity will also be valid.

3.2 Test certificates for the BoS items/ components can be from any of the NABL/ BIS Accredited Testing-Calibration Laboratories/ MNRE approved test centers. The list of MNRE approved test centers will be reviewed and updated from time to time.

4. WARRANTY

4.1 The mechanical structures, electrical works including power conditioners/inverters/charge controllers/ maximum power point tracker units/ distribution boards/digital meters/ switchgear/ storage batteries, etc. and overall workmanship of the SPV power plants/ systems must be warranted against any manufacturing/ design/ installation defects for a minimum period of 5 years.

4.2 PV modules used in solar power plants/ systems must be warranted for their output peak watt capacity, which should not be less than 90% at the end of 10 years and 80% at the end of 25 years.

5. IDENTIFICATION AND TRACEABILITY

5.1 Each PV module used in any solar power project must use a RF identification tag (RFID), which must contain the following information. The RFID can be inside or outside the module laminate, 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 manufacture (separately for solar cells and module)

(iv) Country of origin (separately for solar cells and module)

(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

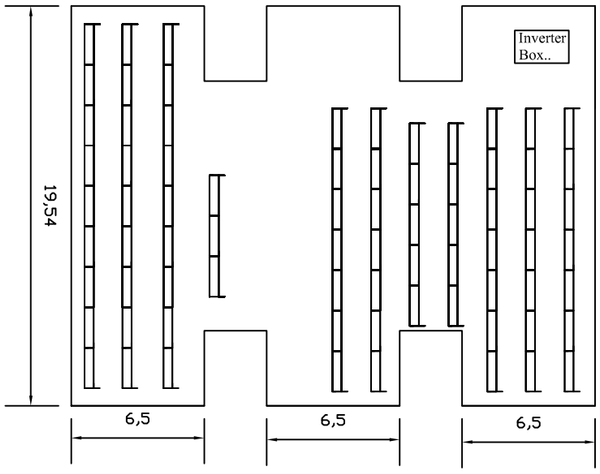
(ix) Name of the test lab issuing IEC certificate

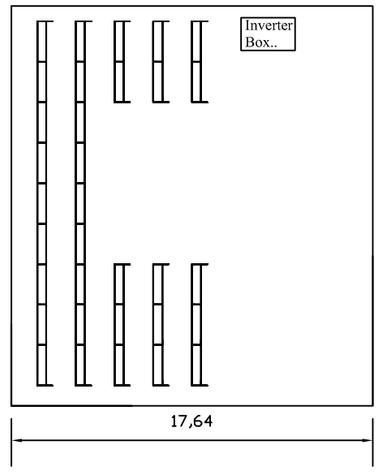
(x) Other relevant information on traceability of solar cells and module as per ISO 9000 series.

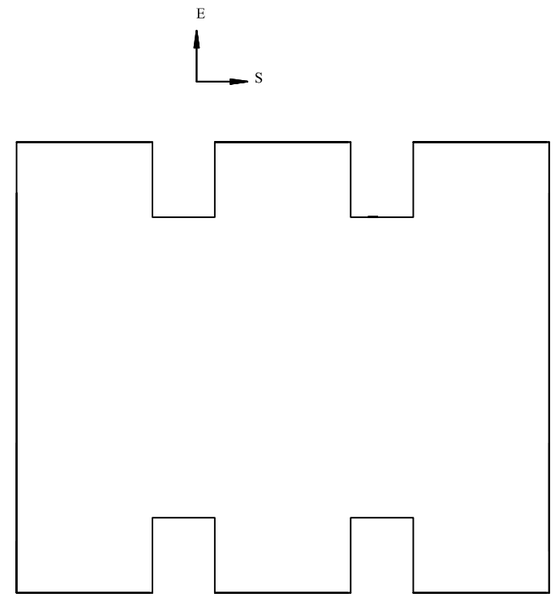
ACES Roof Top 29KWp.

Height of the building from ground about 15m

270Wp Module, Total Nos of Modules = 108.(1.975m x 0.995m)



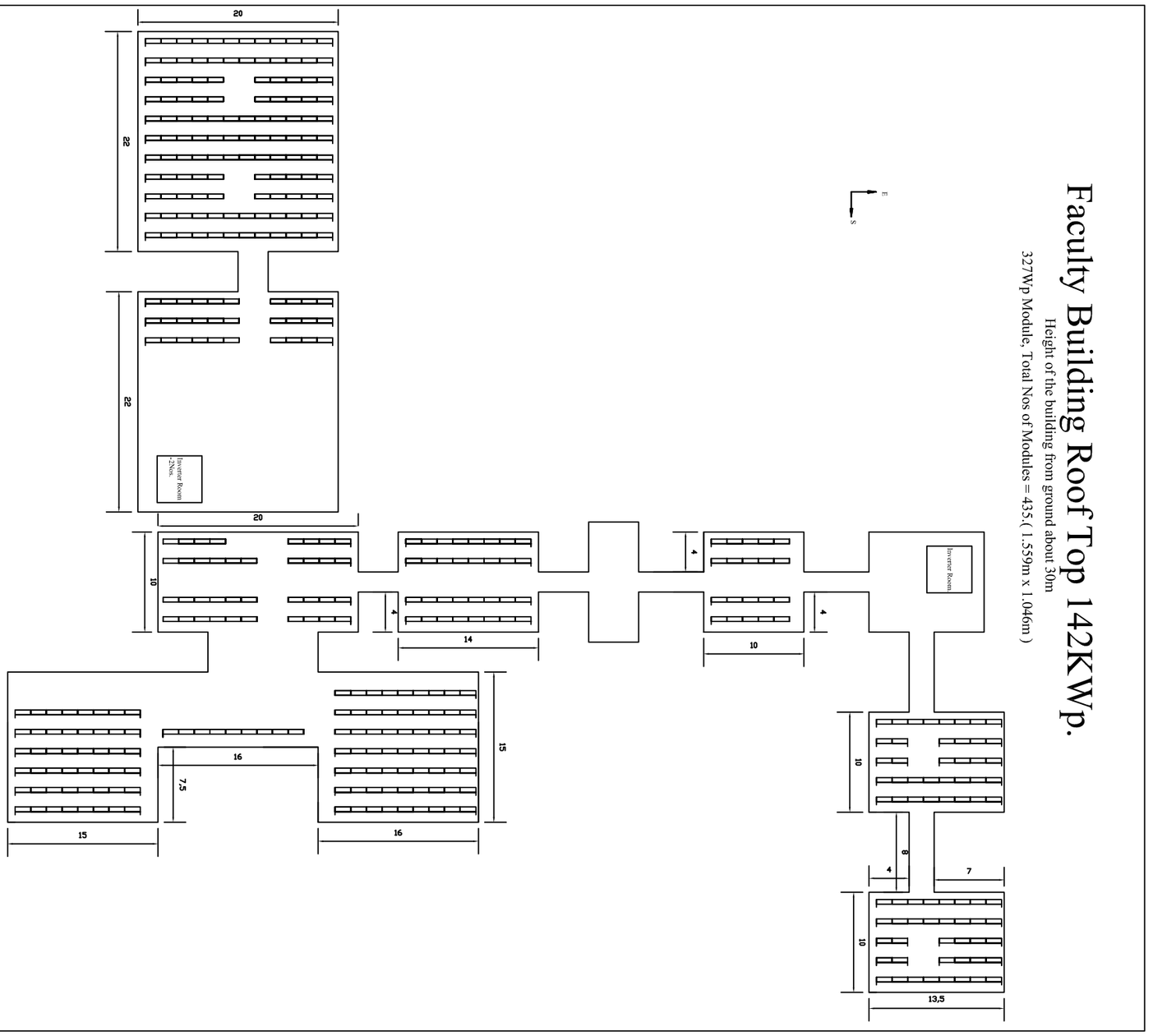




Faculty Building Roof Top 142KWp.

Height of the building from ground about 30m

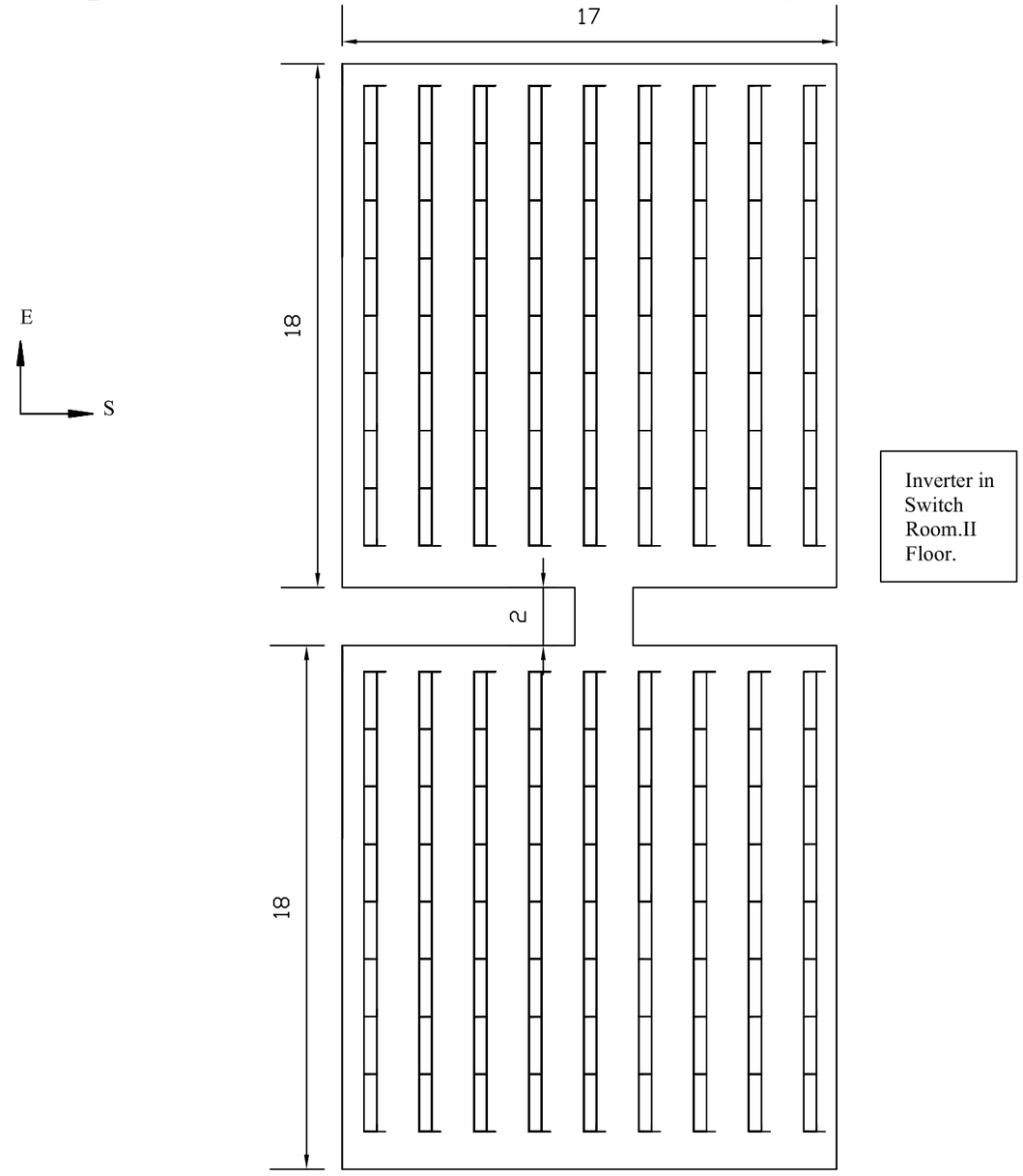
327Wp Module, Total Nos of Modules = 435.(1.559m x 1.046m)



NL-I Roof Top 39KWp.

Height of the building from ground about 15m

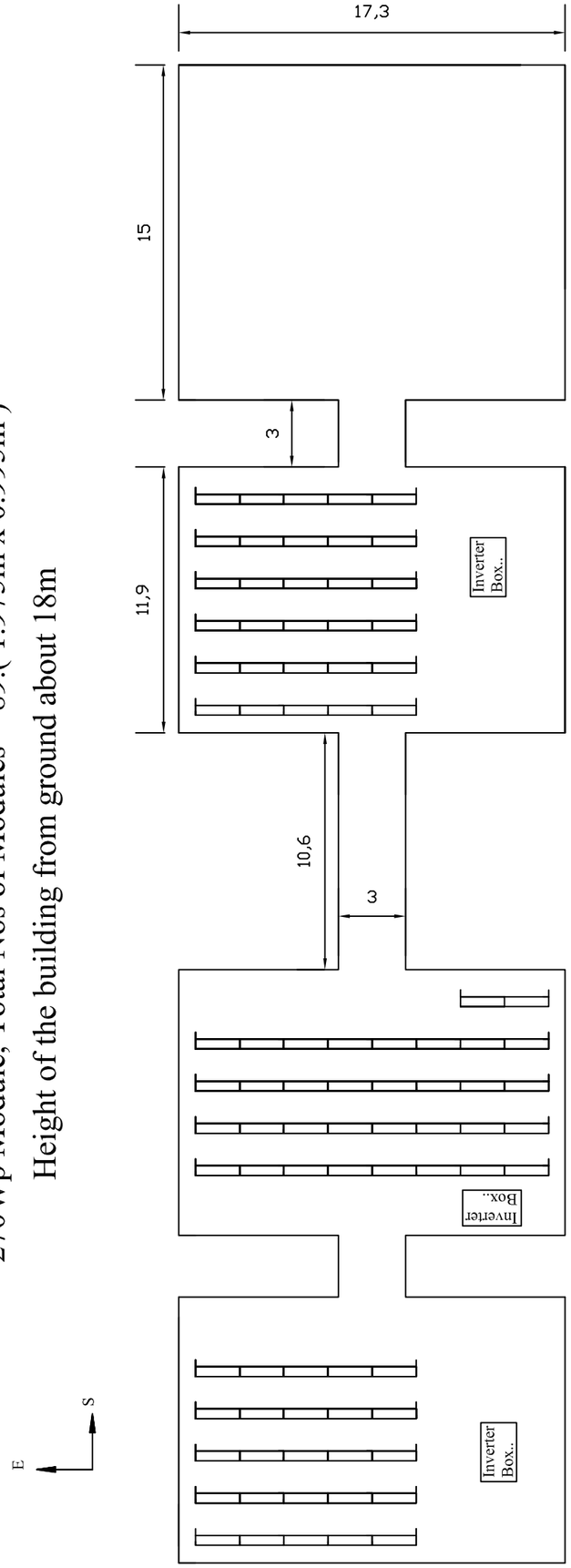
270Wp Module, Total Nos of Modules = 144.(1.975m x 0.995m)



NL-II Roof Top 24KWp.

270Wp Module, Total Nos of Modules = 89.(1.975m x 0.995m)

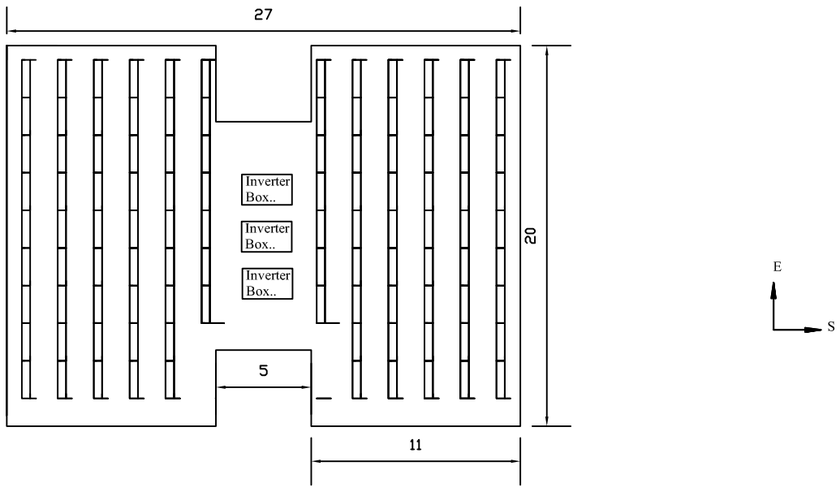
Height of the building from ground about 18m



Western Lab Extention Roof Top 28KWp.

Height of the building from ground about 15m

270Wp Module, Total Nos of Modules = 104.(1.975m x 0.995m)



Western lab Roof Top 150KWp.

Height of the building from ground max. 15m & min. 10m.

270Wp Module, Total Nos of Modules = 557.(1.975m x 0.995m)