Green Growth and Energy Transformation

Solar for Education

Techno-Financial Training and Contract Evaluation Workshop

Monday, July 30, 2018, Kolkata

Report of Proceedings

1. Backgrounder and Overview

CUTS International in collaboration with Friedrich-Ebert-Stiftung (FES), Bask Research Foundation and Earth Day Network organized a Techo- Financial Training and Contract Evaluation Workshop as a part of the Green Growth and Energy Transformation (Grow GET) project on July 30th, 2018 in Kolkata.

Overall objective of the workshop was to capacitate the private educational institutions, financial institutions and Civil Society Organisations the various processes involved in installing Rooftop Solar PV (RTSPV), the technical and financial aspects involved in the RTSPV installation, how to monitor and evaluate the quality of RSTPV installation, and most importantly what should be the essential components of a contract to be signed between the potential consumers and the service provider (e.g. solar project developers in this case). These would not only help the potential consumers to better understand the nitty gritties involved in RSTPV installation. As far as the financial institutions are concerned, the workshop would help them make informed decisions while evaluating project proposals pertaining to installing RSTPV. The CSOs, as a medium of change makers, would be better placed in creating awareness on RTSPV among their target stakeholder groups. To this end, the workshop had participations from CSO, Financial Institutions, Solar Project Developers and Educational Institutions.

2. Proceedings

Abhishek Kumar, Director, CUTS International delivered his welcome remarks and flagged that solar for Education is a catalytic project which will gradually manifest itself in other domain such Healthcare, individual etc. This was followed by the training session where the key resource persons were Simran Grover, Fellow, CUTS International and Founder and CEO, Bask Research Foundation; and S P Chandak, Mentor and Professor Emeritus, Birla Institute of Management Technology. The workshop had a mix of both powerpoint presentations and some group activities to help the participants understand the theoretical as well as practical aspects of RTSPV.

3. Highlights from the presentation

Broadly the workshop covered the following key aspects pertaining to RSRTPV installation and contract evaluation:

A) Techno – Economic Feasibility

3.1 Available Solar technologies

Presently three type of technologies are available in the market –

- Grid Connected (On-Grid) systems
- Off Grid Systems; and
- Hybrid Systems

It was pointed out that the Grid Connected systems, in general are more cost effective as these systems do not require battery storage. The off-grid systems are relatively costlier owing to the storage components involved. The hybrid systems on the other hand Combines functionalities of both off-grid and on-grid inverters. Hybrid systems are more suited to areas where power disruptions are frequent. While hybrid systems combine the best of both the off-grid and on-grid technologies but it entails higher initial investment and cost of maintenance. It was highlighted that in Kolkata where the grid is stable and the DISCOM (i.e. CESC) is providing net meter free of cost, grid connected systems are appropriate.

3.2 Types of metering

There are two type of metering systems –

- Net Metering; and
- Gross Metering

Net metering is where the Units of energy generated debited against units of energy consumed. As per regulations issued by West Bengal Electricity Regulatory Commission (WBERC) in West Bengal a consumer having grid connected RTSPV can not sell more than 90 percent of the electricity it consumes from the grid. Gross metering is when 100% of energy generated is exported to the grid and value of energy generated is debited against utility bill. As mentioned earlier, in Kolkata, CESC, which is the largest DISCOM, is providing net meters to the consumers having grid connected RTSPV against payment of a nominal meter rent.

3.3 Available models for deploying RTSPV

There are three models involved in installation of RTSPV

- CAPEX Model – where the potential bears the entire cost of installation
- OPEX Model – where the solar project developer or a third party Finances the project. In such models the installation is entirely owned by the third party. The third party (project developer / investor) enters into a power purchase agreement with the facility owner usually for a period of 15-25 years to reap back the investment.
- Rooftop Leasing – In this model a rooftop owner leases his / her rooftop to a project developer against a fixed monthly compensation or a variable incentive based on electricity units generated.

The OPEX model and the rooftop leasing model were considered to be more suited to the Kolkata context. It was pointed out by the financial institutions that they would always prefer financing projects where the owner of the project belongs to the Private Sector and has good credit rating. The financial institutions are weary of giving loans to the educational institutions that are majorly run by Trusts. Under OPEX model, a Project Developer with good credit rating can install RTSPV with financial assistance from the Banks or other Financial Institutions. This will also benefit the educational institutions as they were not required to bear the initial capital investment. Further, the rooftop leasing model is also a viable alternative for the educational institutions as some of the institutions have large rooftops which remains unused. These institutions can lease out their rooftops to solar project developers in return of rent. However, the solar project developers were of the opinion that CAPEX models are more beneficial to the consumers since under this system they are able to sell electricity at a higher rate compared to that of OPEX models. This inturn reduces the payback period for the consumers.

In this regard, it was pointed out by the solar developers that owing to issues pertaining to ownership of rooftops, long term nature of the PPAs, etc., till date, OPEX model and rooftop leasing models have not been able to find takers.

3.4 Site assessment and understanding Technical Feasibility

Site assessment is the most important component that needs to be clearly understood by educational institutions and solar project developers before going for a competitive bidding. It not only helps the educational institutions in understanding the costs involved and estimated generation but also facilitates better evaluation of proposals/bids. For the solar project developers an effective site assessment will help them in drawing up realistic project estimates.

The key components of site assessment are:

- *Roof Assessment*
  This helps in understanding the orientation of the roof, the shadow free roof space, the load bearing capacity of the roof, neighbouring objects and building, plan the installation layout etc.

- *Electrical Assessment*
  This involves understanding the pattern of electricity usage by the institution, the existing electrical load, the electrical equipment being used by the institution, the quality of electricity, how the wiring needs to be done to reduce transmission losses, etc.

- *Risk Assessment*
  Assessing risks associated with a project include understanding how the materials will be transported to the roof, how the materials will be stored, whether the project involves handling any hazardous material and how to handle it, what are the security concerns involved etc.

- *Shadow Analysis*
  While shadow analysis is an obvious critical analysis for design of a SPV system, it is also easily over looked. Incompetent and non-trained personnel tend to designate shadow free area without giving due consideration to sun path throughout the year. Partial or complete shadow can have a significant impact on performance of the system, and accelerate degradation of modules. An effective shadow analysis can provide a good approximation of the estimated generation. It was highlighted that to get maximum exposure to sunlight the panels need to b kept such that they are always south facing. However, in case that is not possible the East – West alignment can also be considered.

- *Capacity Estimation*
  Capacity estimation depended on two critical factors
  - The available shadow free roof space; and
  - State Regulations

  As a thumb rule, for every 8-10 square meters of available shadow free space, 1kWp of solar modules can be installed. Other than the available shadow free roof space, policy also limits the capacity of the system that may be installed. Prevalent policy in most states limits the maximum solar capacity to 80% of the sanctioned load or 30% of the capacity of the distribution transformer, whichever is less. In case, when a facility does not have a dedicated distribution transformer, the rated capacity of the distribution transformer for the locality is considered by DISCOM to provide a *No Objection Certificate*.

A practical exercise was carried out among the participants that provided them with a real time case study. During the exercise, the participants were asked to state their electricity usage pattern, the shadow free roof space area, their time of operation etc. Based on these data the participants calculated how much capacity of solar installation they would need to do to suit their electricity usage pattern.

3.5 <u>Key Components and Quality Parameters</u>

- *Solar Modules*
  Solar modules are the most important component in the entire system, but unfortunately there are no standard mechanisms to understand whether a panel is good or not. Like ISI mark / FASSI mark, there are no standards and labels available to the consumers. Under these circumstances, the institutions were suggested to choose panels from the Tier I companies mentioned in the Bloomberg New Energy (BNE) Database. The institutions were suggested to consider renowned brands rather than going for cheaper options. Further, the institutions were advised to clearly understand whether the solar PVs are mono-crystalline or poly-crystalline. While price differential between the two is not significant, but the poly-crystalline technologies are considered to be better in terms of generation compared to mono-crystalline modules.

- *Inverters*
  Gauging a good quality inverter can be extremely tricky, especially since inverters also most prone to failures and faults in a solar PV system. Some standard parameters such IP protection, efficiency, number of available MPPT and wide operating range are good indicators of quality of the system. But most important, feedback by former customers can provide best inputs on quality of inverter and service support provided by the manufacturer. In the present market, very few companies are committed to providing timely and hassle-free service support to its customers.

- *Mounting Structures*
  SPV mounting systems are used to fix solar modules on surfaces such as roofs, building elevations, or ground. In case of solar rooftops, design of structures is dictated by the type of roof. While there are different types of mounting structure designs, the need to get the same checked by a structural design engineer is of utmost importance. This is because any design that does not consider the wind speed can have adverse effect during storms. Extrapolating wind speed corresponding to height of the building is also required before doing the installation. It was also underlined that while putting up mounting structures, the water proofing has to be done by the solar project developer.

- *Types of Cables to be used*
  There are two type of cables – DC and AC. The type of cables to be used in a solar installation is to be determined based on the electrical wiring plan of the RTSPV. There are both advantages and disadvantages of both type of cables, but AC cables offer more protection to the conductors

compared to the DC cables. However, in case fire breaks out, the AC cables emit harmful fumes compared to DC cables. Thus, when inhouse wiring is concerned, AC wiring should be avoided.

- *Protection Devices*
  Protection devices are needed for long term protection of the entire RTSPV system. Protection is generally required to protect the plant from any current or voltage surges, lightning damage and grid harmonics. Inclusion of the following protection devices prevents system downtime and keep the system running:
  - Miniature Circuit Breakers
  - Surge Protection devices
  - Earthing/Grounding to protect from lightning

  It was also pointed out that grounding of inverters is extremely important is a consumer is claim warranty for inverters.

3.6 Monitoring and Maintenance of the RTSPV System

Monitoring and maintenance of an RTSPV both before and after installation is important to understand *firstly*, whether the project developer can deliver the desired performance ration; and *secondly,* whether the installed system is generating electricity as desired. In this regard, the following two components are important –

- Weather Monitoring System (WMS) to get the weather data and take an informed decision on the actual generation by the RTSPV; and
- Remote Monitoring System (RMS) to track whether the installed RTSPV is generating or not, and how much it is generating.

Considering that weather data for a particular location is often not available with the Government, installing a WMS is advisable. However, installing WMS for a small RTSPV system (say, 10 – 15 KW capacity) may not be economically feasible owing to its cost, but it is imperative before installing large systems (say, 100 KW). This would help the institutions to understand whether the commitments on performance ratio made by a project developer is practical.

The RMS on the other hand is more of a post installation tool to understand whether the installed RTSPV is working properly. In general RMS comes as an inbuilt tool in OPEX models. The alert systems inbuilt inside RMS also helps generate alerts to the project developers in case generation gets disrupted. It is always advisable that institutions can install RMS so that they can better monitor the generation from the installed RTSPV systems.

It was emphasised that the institutions/potential consumers should regularly clean their modules regularly to prevent accumulation of dust on the panels, which inturn hampers generation.

3.7 Project Costing

While negotiating a contract price, it is important to understand project economics and boundary conditions. Contract price can vary based on final bill of material, quality of components to be used and scale of project. Figure 1 provides typical price range (computed on per watt basis) for various components and their variation with size of the project.

System Size / Component	5kWp	20kWp	50kWp	100kWp
PV module[1]	26 - 28	25 - 27	24.5 - 25.5	23 - 24.5
Grid-tied Inverter[2]	14 - 17	6.0 - 9.0	4.0 - 4.5	4.0 - 4.5
Module mounting structure[3]	5.5 - 6.5	5 - 6	3.5 - 4.5	3 - 3.5
DCDB / AJB (including fuses with optional DC disconnect and SPD - Type I + Type II)	0.8 - 1.0	0.25 - 0.3	0.20 - 0.3	0.20 - 0.30
ACDB (AC MCB, Solar PV Meter and optional SPD)	2.4 - 3.0	0.6 - 0.75	0.24 - 0.30	0.20 - 0.25
DC Cable[4]	0.3 - 0.4	0.3 - 0.35	0.39 - 0.41	0.38 - 0.4
AC Cable[5]	0.3 - 0.4	0.1 - 0.11	0.07 - 0.09	0.06 - 0.07
Lightning Arrestor	0.8 - 1.2	0.2 - 0.25	0.1 - 0.2	0.10 - 0.15
Earthing arrangement	1.4 - 1.6	0.35 - 0.40	0.2 - 0.3	0.2 - 0.25
Data logger	1.2 - 3.0	0.4 - 0.75	0.3 - 0.6	0.15 - 0.30
Weather Monitoring System[6]			0.7 - 2.0	0.35 - 1.0
Net Meter	2.0 - 2.4	0.5 - 0.6	0.25 - 0.35	0.20 - 0.25
Fire Protection System[7]	0.1 - 0.2	0.04 - 0.05	0.02 - 0.03	0.15 - 0.02
Installation and Commissioning	3.0 - 4.0	3.0 - 3.5	2.5 - 3.0	2.5 - 3.0
Engineering	2.0 - 2.5	0.5 - 0.6	0.3 - 0.4	0.20 - 0.25
Total[8]	59.8 - 71.2	42.2 - 49.7	37.3 - 42.5	34.7 - 38.7

Figure 1. Component wise breakup of price range (prices are indicative excluding the developer's margin)

The component wise breakup of prices are aimed at helping the potential consumers negotiate with the project developers before entering into a contract.

BOX 1. Remarks from financial institutions

Officials from financial institutions mentioned that mentioned that owing to the mounting Non-Performing Assets (NPA) and the ongoing reform process, the branch managers are often becoming sceptical to finance solar projects. This is because if the loan turns out to be NPA the liability comes on the branch manager.

It was suggested that RBI needs to introduce appropriate measures to make the Banks compliant with meeting their lending targets for the Renewable Energy sector. In this regard, it was mentioned that as per RBI guideline it is mandate for the banks to invest 40% of their credit on priority sectors under which financing renewable energy projects is an important component. In case any bank fails to meet the PSL target then the bank has to contribute the unspent amount to Rural Infrastructure Development Fund (RIDF) where the interest rate is significantly low compared to priority sectors. Thus, it was pointed out that even though there is no sub-target for banks in case of renewable energy sector; the aforementioned guideline is to indirectly motive banks, to lend more in priority sectors.

3.8 Engineering Deliverables

It was pointed out that the educational institutions / potential consumers need to ask the project developer to provide a detailed report on the following aspects:

- Single Line Diagram
- Module Layout

- Equipment Layout
- Cable and Conduit Laying Plan
- Cable Loss Calculations
- Performance Ratio and Yield Calculation
- Structure Mounting Layout
- Structure Shop Drawing
- **Structure STAAD Report**
- Structure Wind Loading Calculations

A **group exercise** was conducted with the participants to help them understand which type of conductor material is to used for wiring that best suits their needs. In general, two conductor materials are available in the market – Copper and Aluminium. While copper has a more tensile strength and a more efficient conductor than Aluminium, but copper wires are costly. Thus, while negotiating with the project developer, a potential consumer should check the wiring material to be used for the project. Additionally, the potential consumer also needs to decide on whether cost optimization or quality optimization should be the priority. It was also underline that since cabling pays an important role in the overall project cost, poor cabling can lead to higher operation and maintenance cost in the long run.

Table 1						
	Current	79Amps	Percentage Voltage Drop w.r.t. cable length			
S.No	Cable Size	Conductor	25m	50m	75m	100m
1	3.5C 25 sqmm	Cu	0.80	1.60	2.40	3.20
2	3.5C 35 sqmm	Cu	0.58	1.15	1.73	2.31
3	3.5C 50 sqmm	Cu	0.43	0.85	1.28	1.70
4	3.5C 35 sqmm	Al	0.95	1.91	2.86	3.82
5	3.5C 50 sqmm	Al	0.70	1.41	2.11	2.82
6	3.5C 70 sqmm	Al	0.49	0.97	1.46	1.95
Table 2						
	Cable Length	25 meter	Percentage Voltage Drop w.r.t. current			
S.No	Cable Size	Conductor	10 A	20 A	30 A	40 A
1	3.5C 06 sqmm	Cu	0.41	0.85	1.29	1.69
2	3.5 C 10 sqmm	Cu	0.24	0.50	0.76	1.01
3	3.5 C 16sqmm	Cu	0.15	0.32	0.48	0.63
4	3.5 C 10 sqmm	Al	0.41	0.85	1.29	1.69
5	3.5 C 16sqmm	Al	0.25	0.52	0.80	1.05
6	3.5C 25sqmm	Al	0.16	0.33	0.50	0.66

Figure 2. Voltage drop with respect to cable length (Table 1) and with respect to current (Table 2) across Copper and Aluminium conductors

3.9 Project Execution Plan

Project execution is an art which takes planning, foresight and intuition to ensure project are delivered on time and comply with the quality standards. This section discusses some of key deliverables which reflect project execution capacity of an EPC contractor / Project Developer. A good project design needs to have the clearly stated following components:

- *Project Execution Plan* - A good project execution plan should cover a clear timeline of the procurement of materials, resource mobilisation, equipment mobilization, and project milestones. Format for a sample project execution plan has been shared with the participants (Annexure – A). It was also highlighted that a good project developer would always record any deviations from the pre-approved plan and would get fresh approval from the client before implementing the plan.

- *Quality Plan* – Under quality plan, the project developer is expected to provide how the materials would be checked at stages, how the materials will be handled, detailed inspection plans, applicable standards, safety mechanisms etc. A list of relevant certificates, Standards & Guidelines has been shared with the participants (Annexure-B).

- *Safety Plan* – An effective safety plan needs to consider the risk assessments, equipment and tools to be used, the evacuation plan and processes in case of natural disasters etc.

- *Commissioning and Handover* – Getting handing over the commissioned RTSPV system is a very crucial part to be carefully done by the potential consumer / educational institution. It involves getting a detailed Commissioning Checklist from the developer, understanding the guaranteed performance parameters, getting the certificates and warranty documents. A sample commissioning checklist and Sample Project Handover List was shared with the participants (Annexure – C and D).

3.10 Operation and Maintenance

Operation and maintenance are also important part in the post-installation phase. In general, whether the project developer or the consumer will take care of O&M, that needs to be categorically mentioned in the Contract. The factors to be considered post commissioning of the project has been mentioned in Table 3.

Table 3. Operation & Maintenance Checklist

Component	O&M Activity	Period

Solar Module	• Cleaning of Solar Modules
	• Visual inspection of solar modules
	  o Inspection for any damage to module backsheet
	  o Visual inspection for discoloration, hot spots, micro-cracks in the module
	  o Inspection of module frame for damage or ingress of humidity
	  o Inspection of junction box on each panel for status of bypass diodes
		Quarterly or six monthly

String Inspection	• Electrical inspection of PV strings for output voltage and current • Visual inspection of inter-connectors and DC cable for damage	Quarterly or six monthly

Mounting Structure	• Visual inspection for corrosion and physical damage
	  o Tightening of nuts and bolts
	  o Inspection for evidence of erosion from water run-off for mechanical integrity
	  o Visual inspection of the foundations for critical damage, or separation from roof
	  o Inspection of roof for water seepage
		Quarterly or six monthly

DCDB	• Check if SPDs need to be replaced • Inspection of MCB / Fuses • Inspection of enclosure for ingress of humidity, pests and water	Quarterly or six monthly

	• Check electrical connections • Inspection of enclosure for degradation • Visual inspection of enclosure seal	
AC and DC Cable	• Visual inspection of conduit and cable tray for damage • Inspection of conduits for ingress of water • Inspect for any loose connection/ terminations • Visual inspection of cable for damage or degradation	Quarterly or six monthly
Component	**O&M Activity**	**Period**
Inverter	• Inspection of cable connections • Inspection of input and output voltage/ current range. Record and validate all voltages and production values from the human machine interface (HMI) display. • Check continuity of system ground and equipment grounding. • Look for signs of water, rodent, or dust intrusion into the inverter. • Functional inspection of the fan and cooling system, if applicable • Check fuses and SPD, if applicable • Look for discoloration from excessive heat buildup. • Check mechanical connection of the inverter to the wall or ground. • Check AC and DC disconnect (if applicable)	Quarterly or six Monthly
ACDB	• Check if SPDs need to be replaced • Inspection of MCB / Fuses • Inspection of enclosure for ingress of humidity, pests and water • Check electrical connections • Inspection of enclosure for degradation • Visual inspection of enclosure seal	Quarterly or six Monthly
LA	• Visual inspection of foundation for integrity • Confirm earthing strip continuity • Inspection for corrosion on LA and earthing strip • Ensure there is no short circuit between LA and balance of system	Quarterly or six Monthly
Earthing system	• Check continuity for earthing system • Inspect earthing cable (GI strips, if applicable) got corrosion or damage • Check for corrosion on earthing rods • Inspection of earthing pits for accumulation of water	Quarterly or six Monthly
Data logger	• Record voltage readings of power supplies, • Validate sensor reading by comparing to calibrated equipment	Quarterly or six Monthly
Safety	• Check for the fire extinguisher’s expiry • Check for any extinguisher nozzle damage • Check the fire bucket sand, if applicable	Quarterly or six Monthly
Miscellaneous	• Trimming of trees and vegetation in the surrounding to prevent shadow • Inspection of roof for any unaccounted shadow objects	Quarterly or six Monthly

B) Contract Evaluation

A project contract is a legal tool which lays out minimum deliverables and timelines, along with terms and conditions for financial transactions. A fair project contract shall safeguard interests of both parties, i.e. EPC Company / Project Developer and the client in a fair manner. The project contract, mainly safeguard payment for the EPC Company but it also plays a crucial role in safeguarding the clients against technical and performance risks, along with possible delays in project execution. It will act as a tool while filling litigation.

To this end, discussions that took place under the overall theme of Techno - Economic Feasibility were instrumental in understanding what are the technical and financial components that needs to be considered while preparing a contract with the project developer. It was mentioned that a comprehensive contract should include the following details

- Technologies, equipment and layouts to be used by the project developer;
- Project Costing;
- Project implementation plan; and
- O&M plan.

However, it was also underlined that for a good project, selection of the project developer is an imperative, and an informed decision needs to be taken to that end. This was considered important because of lack of standardisation of the solar panels. It is of utmost importance for the educational institutions / potential consumers should not be guided by simply cost optimisation, but rather maintain a balance between both cost optimization and quality optimization.

- Consideration of local data (West Bengal) rather than generalised data for training workshop would have been more beneficial for the participants.
- Simplified technical session or lesser technical coverage would have made it more interesting and understandable for the representatives from educational Institution as they lack technical background.

4. Conclusion

During the concluding session, a feedback was taken from the participants on what are the aspects they liked about the workshop and what are the areas of improvement. Their feedback has been presented in Table 4. While thanking the participants, it was mentioned that the workshop is not an end but a beginning in itself, and the educational institutions need to initiate the process of solarising their institutions. It was underlined that it is of utmost importance that learning from the workshop should translate in practical applications.

The participants were informed that after as a next step CUTS International alongwith Bask Research Foundation will undertake a practical exercise covering all steps, end to end, in implementing a project and will share the same with the participants in the next workshop.

Table 4. Feedback from the participants on the presentation	
Positive Feedback	**Areas of Improvement**
• The presentation delivered a good overview on installation of Solar PV system. • Information shared on techniques of cost estimation and cost optimization will be very helpful for installers. • The presentation had a very good coverage on type SPDs and cables to be used while installation of rooftop solar. • Capacitating the participants about load estimations with support of the hypothetical case study was a very good idea and will be very helpful for the institutions in making estimations for their own institutes.	• Introducing games to train the participants would have made the execution more interesting for the participants. • Sharing real and live case studies would have given the participants a better understanding about the real challenges. • Participation of officials from Energy Commission would have highlighted their perspective on installation of rooftop solar. • The presentation should have focused more on issues related to Net Metering. • Branding of Solar PV is required. • The presentation should have focused more on methodology and criteria required to get subsidy and loans.

Annexure – A: Sample Format for a Project Execution Plan

SNo	Activity			Timeline
1	**Project Creation**			
	1.1		Project PO / Contract	
	1.2		Advance payment reciept	
2	**Project Execution Plan**			
	2.1		Project Team List	
	2.2		Project Gantt Chart	
	2.3		Approval by Management	
3	**Design and Engineering**			
	3.1	Detailed Site Assessment		
		a.	Site Assessment Report	
		b.	Risk Assessment Report	
	3.2		Engineering Drawings	
		a.	Site plan	
		b.	Module layout	
		c.	Single Line Diagram	
		d.	String & equipment layout	
		e.	Earthing & LA layout	

SNo	Activity			Timeline
5	**Procurement**			
	5.1		Procurement Tracker	
		a.	Bill of materials	
		b.	Vendor	
		c.	Rate	
		d.	Warranties	
		e.	Expected date of delivery	
		f.	PO number / inventory	
6	**Delivery of Material**			
	6.1		Pre-Dispatch Inspection Report	
	6.2		Site Receipt	
	6.3		Site Inspection Report	
7	**Installation & Commissioning**			
	7.1		Resource allocation	
		a.	Finalizing accommodation	
		b.	Travel plan	
	7.2		Kick-off meeting	

<u>**Annexure – B: List of Certificates**</u>

SPV Modules	
IEC61215/IS 14286	Design Qualification and Type Approval for Crystalline Silicon Terrestrial Photovoltaic (PV) Modules
IEC61701	Salt Mist Corrosion Testing of Photovoltaic (PV) Modules
IEC61853- Part 1/ IS 16170: Part 1	Photovoltaic (PV) module performance testing and energy rating – Irradiance and temperature performance measurements, and power rating
IEC62716	Photovoltaic (PV) Modules – Ammonia (NH3) Corrosion Testing (As per the site condition like dairies, toilets)
IEC61730-1,2	Photovoltaic (PV) Module Safety Qualification – Part 1: Requirements for Construction, Part 2: Requirements for Testing
Solar Grid-Connected Inverter	
IEC62109-1, IEC 62109-2	Safety of power converters for use in photovoltaic power systems – Part 1: General requirements, and Safety of power converters for use in photovoltaic power systems Part 2: Particular requirements for inverters. Safety compliance (Protection degree IP 65 for outdoor mounting, IP 54 for indoor mounting)
IEC/IS 61683 (as applicable)	Photovoltaic Systems – Power conditioners: Procedure for Measuring Efficiency (10%, 25%, 50%, 75% & 90-100% Loading Conditions)
IEC62116/ UL1741/ IEEE 1547 (as applicable)	Utility-interconnected Photovoltaic Inverters - Test Procedure of Islanding Prevention Measures
IEC60255-27	Measuring relays and protection equipment – Part 27: Product safety requirements
IEC60068-2 / IEC 62093 (as applicable)	Environmental Testing of PV System – Power Conditioners and Inverters
PV Mounting Structure	
IS 2062/IS 4759	Material for the structure mounting
Cables	
IEC60227/IS 694, IEC 60502/IS 1554 (Part 1 & 2)/ IEC 69947 (as applicable)	General test and measuring method for PVC (Polyvinyl chloride) insulated cables (for working voltages up to and including 1100 V, and UV resistant for outdoor installation)
BS EN 50618	Electric cables for photovoltaic systems (BT(DE/NOT)258), mainly for DC Cables
Junction boxes	
IEC60529	Junction boxes and solar panel terminal boxes shall be of the thermo-plastic type with IP 65 protection for outdoor use, and

Annexure – C: Sample Commissioning Checklist

COMPANY LOGO	COMPANY NAME PRE-COMMISSIONING CHECKLIST AND COMMISSIONING REPORT		
Project Name		**Date:**	
Project Location		**Code:**	
	PHYSICAL INSPECTION	**STATUS**	**COMMENTS**
FOUNDATION and STRUCTURE	Foundation Alignment		
	Foundation Dimensions		
	Signs for damage to roof		
	Foundation Finishing		
	Structure assembly as per GA drawing		
	Damage to any structure member		
	Nuts and bolts are secured properly		
	Structure clamps are secured properly		
	Check structure BoM compliance		
	Check dimension of members		
	Check anti rust coating / galvanisation		
ARRAY INSPECTION	Orientation of the array as per drawing		
	Check module tilt		
	Check module alignment		
	Row spacing as per dwg		
EARTHING	Module earthing check		
	Structure earthing check		
	LA earthing check		
	Inverter earthing		
	LT panel earthing		
	Check location and marking of earthing pits		

Annexure – D: Sample Project Handover Checklist

PROJECT HANDOVER CHECKLIST		
Project Code:		
S.No.	**Documentation for Project Handover**	**Comments**
	Engineering drawings and documentation	
1	Shadow Analysis Report	
2	Performance ratio and yield estimation	
3	PV System design calculations	
4	Single and three (if required) line diagram of the plant	
5	Array layout drawings	
6	String Design	
7	Cable and Earthing layout	
8	Lightning arrestor layout	
9	DCDB and ACDB drawings and BoM	
10	Mounting Structure drawing	
11	Structure Analysis Report	
12	Foundation design and water-proofing plan	
13	Foundation layout drawing	
14	Bill of Material	
	Commissioning Documents	
15	Pre-Commissioning check and Commissioning Report	
16	Punch list and cleaning record	
17	Net Meter Acceptance	
	Warranty Documents	
18	Solar Module warranty	
19	Inverter Warranty	
20	Other electrical component warranty	
21	Civil Work Warranty	
	Other Documents	
22	Project Completion Certificate	
23	Operations and Maintenance Manual	