Green Growth and Energy Transformation

Solar for Education

Workshop to Discuss Design Template of Project For Implementation

September 7th, 2018, Kolkata

Report of Proceedings

1. Overview and Purpose of the Activity

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).

This workshop gave a theoretical perspective of the factors to be considered while installing rooftop solar. The next set of activities were planned so as to impart a practical/operational knowledge about the rooftop solar installations. To this end, as a run up to the "Workshop to Discuss Design Template of Project For Implementation", CUTS and BASK selected one of the schools in Kolkata, assessed its roof space, developed a project proposal including the technical and financial components and presented that before the participants.

In this context, the present report has been divided into two broad parts –

- Activity I - It explains the roof assessment exercise; and
- Activity II – It explains proceedings of the workshop

2. Activity I: The exercise to understand the generation potential from the roof available for solar installation

Detailed site assessment was carried by the technical team of CUTS and BASK. The school had an RCC flat feasible for the solar system, one is a shed type and school possess the roof rights for the same. CESC Ltd., a private DISCOM provide electricity to the school and the sanctioned load is 100 KVA. A detailed 3D model of the site was created using SketchUp software and shadow simulation was carried out to identify the shadow-free area. It was found that the school has a shadow free roof space of 350 sq.m (approx.). The consequent generation capacity from solar was found to be 31.52 KWp. Detailed load consumption pattern of the school was studied from

the past electricity bills of the school. As per CESC norms, in a net-metering facility, injection from solar panel of Eligible Consumer can be adjusted with maximum 90% of the energy consumption of the consumer annually. The typical annual load consumption of the school was found to be 1,55,900 Units and the estimated generation from solar was found to be 32,424 Units (approx.). Hence, estimated capacity is complying with CESC's net metering policy. The total cost of installation and operationalisation of the project was INR 16.03 Lakh (apprx.). A detailed breakup of the cost has been given in Table 1.

Table 1. Cost of Commissioning the Project	
Cost per Wp (Excluding Taxes)	INR 50.85 / Wp
Material for 31.525 kWp Solar Grid Connected Solar Power Plant	INR 14,06,367.50
Erection, installation and commissioning of Solar Power Plant	INR 1,07,185.00
Taxes (GST on I @5% + GST on II @ 18%)	INR 89,611.68
TOTAL	**INR 16,03,164.18**

The proposal developed had details about the responsibilities of each of the stakeholders involved.

3. Activity II: Proceedings of the workshop

3.1. Backgrounder and Overview

CUTS International with the support of Friedrich-Ebert-Stiftung (FES), and in collaboration with BASK Research Foundation and Earth Day network organized the second Workshop on Sample Project Design for Solar PV System as a part of the Green Growth and Energy Transformation (Grow GET) project.

The first workshop on Sample Project Design for Solar PV system provided a theoretical base regarding the techno-commercial aspects of installing Rooftop Solar. After the first workshop, CUTS and BASK selected on the schools (name withheld as per request of the institution) and conducted a practical exercise to assess the roof space and the expected generation capacity; the cabling layout; the inverter capacity required; pattern of electricity consumption by the institution etc. Assessment of all these factors helped in understanding the actual cost of installation and the payback period. Further, detailed assessment of the factors also helped in documenting the components of a fair contract that the institution needs to have with the project developer. Based on the major outcomes and outputs of the exercise, a comprehensive case study was designed to help the educational institutions understand the practical aspects of rooftop solar installation.

The case study was presented before the participants at the second workshop on sample project design for solar PV systems.

The workshop registered participation from majority of the stakeholders from CSO, Financial Institutions, Solar Project Developers and Educational Institutions who participated at the first workshop.

3.2. Proceedings

Bratindra Bhattacharya, Director, CUTS International delivered the welcome remarks and provided an overview of objectives of the second workshop. He also mentioned the example of

Ramakrishna Mission Vivekananda Centenary College in Rahara, West Bengal which is saving around Rs. 2.5 Lakh annually on energy bills after installation of rooftop solar PVs, and further underlined the need to keep that as a case in point while discussing the benefits of RSPV. He also mentioned the exercise, jointly undertaken by CUTS and BAASK, pertaining to site assessment of one of the educational institutions in Kolkata and told that the workshop will present the major findings of the case study Simran Grover, Founder and CEO, BASK Research Foundation presented the case study and in that perspective discussed components for a fair contract. His presentation covered in details the techno-commercial analysis RSPV system that emerged from the case study.

3.3. Highlights from the presentation

Broadly the workshop covered the following key aspects pertaining to financial analysis, project design and contract evaluation :

3.3.1. A quick recap of the previous workshop

Simran started by showing a few pictures of solar panels which were adversely affected due to wrong assessment of wind speed, wrong laying out of cables, lack of proper maintenance etc. that were discussed in the previous workshop.

3.3.2. Financial analysis and Return on Investment (For grid connected system)

- **Cost of the RSPV system:** On an average the cost of installing RSPV is around INR 70 per watt peak for a 5 KW system and around INR 40 per watt peak for a 40 KW project without subsidy. Generally, a 5 KW system cost around INR 4 lakhs, but the cost depends on various factors such as type and quality of modules used, type of cables, capacity of the system etc. It was mentioned that oversizing the inverter will reduce cost per watt for any system but that should be done based on the datasheet of the inverter manufacturer, otherwise a consumer might miss out on the warranties offered by the inverter manufacturer. However, the present industry norm allows the inverter to be oversized only by 30 percent.

Box 1. Key technical components that should be kept in mind while installing RSPV system

- Remote monitoring system is very crucial for large systems to judge the performance of the system over time. It is also important to have a backup system for the remote monitoring system to back up data which is logged over time.
- If the system is installed using both RCC and Ballast type structures, then to ensure optimal performance multiple Maximum Power Point Tracking (MPPT) invertors should be used. But using these types of invertors will increase cost. For single structures single MPPT invertor is sufficient.
- Lightning arrestor should be installed in the buildings (if absent or not radius of the modules is not covered) to protect from lightning. It is of paramount importance for tall buildings.
- The type of the cable should be selected in such a way that AC loss is not more than 1% and DC loss is not more that 2%. The cables should be in line with the aesthetic beauty of the building. Performance loss increases with the increase in the length of the cables so if possible try to minimize the lengh.
- Earthing of the module is very crucial from safety angle. Two types of cables can be used for earthing, namely GI strips or copper PVC cables. Generally GI cables are used because they are comparatively cheaper. Note, that the variety of cable used has no impact on the performance of the system.

- **Internal Rate of Return (IRR):** Generally, for a 15KW RSPV system IRR is not that attractive (around 14%) but return for systems greater than 15 KW IRR is much higher. It ranges from 20% - 35% after incorporating subsidy. IRR could be higher if tariff rate increases.

- **Breakeven estimation:** Breakeven time decreases with increase in capacity of the system. For example, breakeven time is 10 years for a 5KW system whereas it is five years for a 50 KW system. The payback timeline is estimated with assumption of no subsidy and no debt. With subsidy breakeven period will be much less.

Box 1. Proposed design and layout of RSPV for the selected institution
No of modules: 97(maximum) Tilt – 20 Degree (RCC structure) Azimuth- 7 degree toward east DC Capacity : 31.525 KWP Inverter: 30 KW

3.3.3. Site assessment and Project Design

The key steps and findings/results that emerged from the site assessment exercise at one of the schools in Kolkata has been presented before the participants. The main points that emerged from the exercise are as follows:

Steps Followed while roof assessment

Step 1: As the first step, the team visited the school and took a detailed measurement of the available roof space. However, a developer might also consider the option of assessing the generation capacity from satellite images coupled with software such as such as Sketch –up, that can be used to estimate length and width of the free space available in the rooftop. However, accuracy of the dimension will be compromised as it doesn't estimate height of the elevated structures, load bearing capacity of the roof and other technical factors. The developer based on his technical knowledge need to assure that for mounted structures drilling work will not result in any water seepage issue. Thus, site visit by the project developer is an imperative to getting proper estimate of the generation capacity. Further, site visit also helped the team to understand the cable layout, existing backup systems and their capacity etc.

Step 2: Shadow analysis was performed to decide the optimal layout of the modules. 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. To get maximum exposure to sunlight the panels need to be aligned in such a way that they are always south facing. F**or the given** Institution, the orientation of the building is not south facing so due to little offset from the southern position the row spacing of the panels is little bit wider that was initially estimated based on the off-site assessment.

Step 3: The team collected past electricity bills from the school to estimate the total annual energy consumption by the school. The team had collected electricity bills for each of the seasons i.e. Summer, Monsoon, Winter and also during the vacations. This helped in estimating the total electricity the school will generate, consume and push to the grid.

Step 4: Based on step 1 and 2 the team chalked out what capacity of solar rooftop to be installed, and checked whether it is in parity with the DISCOM's policy. As per regulations laid out by the West Bengal Electricity Regulatory Commission, total generation of the system per year should be less than 90% of the total consumption per year.

On basis of off-site roof assessment, the estimated capacity for solar rooftop installation was found to be 40KW and which was in line with DISCOM's policy. However, the onsite assessment revealed that the maximum capacity that could actually be deployed is 30KW.

Based on the estimated capacity that can be deployed in an institution, it can float tender and it will also put them in a better position in order to compare different quotations.

Box 2. Proposed cost template for a 30 KW system

Cost per W_p - INR 50.85/W
Material Cost: INR 1406367.50
Service cost : INR 196797.34
Total cost : INR 1603164.84

Note:
#It is estimated after incorporating 5% GST on materials and 18% GST on services.
#The amount is estimated after adhering to certain quality standard so the rate may differ with other contractors.

Step 5: Potential clients may evaluate contractors on basis of their technical competency, good track record on quality and timely execution of the project and generation performance of the past projects. Credit ratings as well as medium and long term sustainability of the company can also be reviewed. If possible, interested clients

may also take feedback from previous clients. They can also choose one that has good service record dovetailed with good resources for operation and maintenance.

4. Contract Evaluation:

After an institution has received quotations from various project developers and evaluated them, it is essential for the institution to enter into a contract with the project developer. A project contract is a legal tool which lays out key 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. Broadly, it should cover scope of work, Rights and Responsibilities, hard deliverable, soft deliverables, standard and quality parameters, performance guaranties, penalties and incentives for client /developer as well as operation and maintenance liability.

A fair agreement contain following terms of agreement :

- **Scope of work:** Every nitty gritties regarding the model should be mentioned such as roof layout, capacity deployed, string designs showing equipment layout, type of module to be used, how modules will be connected among themselves as well as with the inverter, type and length of cables to be used, kind of protectors to be used. It should also state that whether backup system and remote monitoring system with be included in the model or not. Engineering details with appropriate graphs and picture should also be enclosed in the document.

- **Rights & Responsibilities:** The contract should clearly state the stakeholders involved and define the responsibilities of the owner of the facility, Project developer, EPC contractor, O&M contractor. The agreement should clearly as well as separately state the rates dedicated to EPC and O&M. Generally in CAPEX model the EPC contractor and ONM contractor is the same person. Whereas in OPEX model the project developer generally appoint separate EPC contractor and O&M contractor.

- **Performance Guaranty:** This states performance rate of the system guaranteed by the developer. This helps the client to judge the performance of the system against certain benchmark figures.

- **Risk mitigation tools:** Legal liability in case of any damage need to be defined. For example: In OPEX model the developer can dismantle the system after certain time period due to various reasons. This might cause some damage to the roof. So financial liability need to be predetermined and stated in the agreement.

- **Extension of agreements:** This defines what will happen to the system after termination of the contract period. This is mostly important for OPEX model as often after termination of contract period the ownership of the model get transferred to the rooftop owner.

- **Exit clause:** This is important mainly for the developer especially in OPEX model. The developer may decide to end the contract after a cooling period of 1-3 years. The legal exit rate need to be predefined based on the return of the developer, degradation rate of the system and legal cost of the developer.

5. Best practices for a fair contract between a Project Developer and a client

Permissions: To install RSPV system the client is required to seek NOC from the DISCOM. Prevalent policy in most of the state's limits the maximum solar capacity to 80% of the sanctioned load or 30% of the capacity of the distribution transformer, whichever is less. The liability of seeking NOC can be either on the client or developer; seemingly the task will be easier for the developer owing to his technical knowledge and past experiences in this field. Accountability to seek NOC should be mentioned in the document.

Project Execution:

- **Timeline for deliverables:** Under this, timeline for each deliverable (service as well as material) should be stated. Breakdown for each activity such as civil, mechanical and engineering should also be indicated in this section. Meeting deliverables on time is indication of a good developer.

- **Project Team & Execution Plan:** One-point service should be clearly mentioned in the document for better redressal of queries. This practice even simplifies monitoring by the client.

- **Quality Plan**

- **Engineering Quality:** Site inspection by both the parties is very crucial, otherwise installation of the system may cause damage to the building and system itself without notice of either the consumer or the project developer. Design/Structure analysis is essential especially where elevated structures are being set up on the rooftops. The accountability for accurate engineering should lie with the project developer.

- **Material Quality:** It need to be verified that the materials follow the submitted bill and are procured from the pre-decided manufacturer. Pre-dispatch inspections, onsite check, pre-commissioning check are some of the key guidelines.

- **Compliance with Standards:** It needs to be checked that the quality of the equipment and engineering follows the proposed one. Any deviation needs to be captured and approved by senior personnel (of the project developer company) as well as the client.

- **Commissioning & Execution plan:** Commissioning protocols need to be captured. Roles and responsibilities of the project team on both ends (Client & Developer) should be clearly defined. The parameters of checks, for both before and after making the system live, should be stated. Data sheets for all those checks should be documented. Record of all revision, as-built drawing and commissioning report (any issues raised during pre-commissioning check) should be handed over to the client.

- **Safety Plan:** Steps need to be taken to ensure that due safety measures are taken for both equipment and personnel. Such as appointment of duly safety officers conducting proper risk assessment before initiating the project. Project team should be well trained and equipped to handle things efficiently. Moreover, there should be proper evacuation plan in case of any emergency.

- **Access rights:** Certain rights need to be given to the developer to facilitate installation of the system and they should be clearly stated in the document to avoid any future conflict or confusion. For example; access of their cars and their timings, availability of parking space, availability of storage facility, limit on water and electricity usage for O&M activities and etc. It should be clearly mentioned whether these facilities will be provided by the client or the developer have to make their own arrangements.

- **Performance Guaranties and Penalties:** Performance guarantee basically ensure certain level of minimum generation from the system. The contractor can be held liable and penalized if the guaranteed level is not achieved. Performance can be analyses with help of data loggers and weather monitoring systems but they does not make sense for small systems (5-10KW) as they are generally very costly and cheaper one does not reflect accurate data. However, for smaller systems Solar PV meter can be used to capture generation. Unfortunately, using Solar PV meters data cannot be stored for long duration (more than few months). It is advisable to opt for minimum yield guarantees in case of smaller system over performance ratio to judge the performance of the system. The contractor may assure certain yield per year. In the contract, duration of this guarantee should be captured and penalties in case of non-compliance to the guaranteed yield should be stated.

- **Commercial date of operation:** The commercial date of operation is the date when the system will be made live. It can be either soon after the installation of the system following full payment or after the net meter is installed. It should be predetermined and stated in the contract.

6. Floor Discussion

- **What are the factors affecting optimal performance of rooftop solar PV in West Bengal?**

Performance ratio depends on various factors such as temperature, humidity, wind and light intensity. Given the climatic condition of West Bengal 73 percent Performance Ratio (PR) is good enough (as a thumb rule). But estimated performance ratio may differ based on the technique used for calculating it. One technique is based on optimal tilt and orientation thus estimated PR will always vary from site to site with change in tilt even though the ambient condition remains same. Other technique is independent of the tilt and it gives estimation based on internal ambient of the system. Moreover, higher PR can be achieved by oversizing DC but it is not advisable.

- **How can the customer measure efficiency of the panels?**

From weather monitoring system one can estimate potential generation for given ambient. Data logger gives the estimate of power generated by the system. Comparing this data one can analyse whether he/she is getting the desired generation or not. But efficiency of the modules cannot be tested by the customer by himself/ herself. They can only be tested at laboratory at time of procuring. The thumb rule is, the output of a system should be 3.8 KW per day on an average. If aforementioned output is not received then there might be some quality issue with modules or other components of the system. The client can held the contractor liable if the guaranteed level is not attained.

- **How much Carbon content mitigation is possible through installation of RSPV system?**

About 0.7-0.8 ton carbon foot print can be mitigated per KW per year. This is almost equivalent to plantation of 60 trees.

- **What is the average load on the roof for a RSPV system and how to understand that the roof the building will be able to handle it or not?**

The structure of the system plays a dominant role in terms of load. The average load will vary depending on the structure of the system. It is higher for elevated structure over flat ones. On an average the dead load is 50-60 kg per square metre. Proper engineering analysis is compulsory before installation of the system to mitigate any risk.

- **What is the level of generation drop in monsoon?**

The generation reduces by 2.5- 3 unit per day/kW or even less. However, the quality of the module plays a key role in this context. Generation loss is least from good quality modules.

- **What will happen if the contactor becomes insolvent on case of OPEX model?**

A. Ownership of the system will get transferred to the institution that had lent its roof for the installation of the RSPV system. In some cases the institute might have to pay nominal charges to gain the owner of the system.

Table 3: Feedback from the participants on the presentation

Positive Feedback	Areas of Improvement
• The presentation delivered is very interesting and informative and gave a good overview on installation of Solar PV system. • Information shared on financial analysis and analysis on technical aspects will be very helpful for installers. • Participations from developers and implementers have made the workshop more fruitful. • These series of workshop may lead to some implementation on ground.	• Sharing case studies of failed projects (where things went wrong) along with their reasons would have given the participants a better understanding about the real challenges. • The presentation should have focussed more on accountability of the developers • Branding of Solar PV is required. • Participation of officials from Energy Commission would have highlighted their perspective on installation of rooftop solar. • Should involve educational institutions and students in these workshops to sensitize the issue among larger group and involve mass in this noble agenda. • Should sensitize mass about usefulness of RSPV and should involve government organizations in this initiative. • Involving educational institutions in this workshop and keeping a discussion round where they could have flagged their needs would have made the workshop more practical. • The module should be prepared in a lucid manner • Can incentivise installation of RSPV by highlighting associated as well as alternative benefits of the same.