VENDOR RATING FRAMEWORK – EXPERIENCE FROM THE PILOT

Prepared for:

United States Agency for International Development (USAID/India)
American Embassy
Shantipath, Chanakyapuri
New Delhi-110021, India

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This report is prepared for the M/s Tetra Tech ES, Inc. for the 'assessment of the Vendor Rating Framework (VRF)'. This report is prepared under the Contract Number AID-OAA-I-13-00019/AID-OAA-TO-17-00011.

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EXECUTIVE SUMMARY

The Vendor Rating Framework (VRF) is developed by the MNRE-USAID Partnership to Advance Clean Energy Deployment PACE-D 2.0 RE Program, along with CII- Godrej Green Business Center (CII-Godrej GBC) and the National Renewable Energy Lab (NREL). This framework will benchmark various rooftop solar (distributed solar) engineering, procurement and construction companies (EPCs or vendors) on a uniform set of parameters, which will provide a sense of the quality of the work carried out by these firms. The framework assesses companies on financial and technical capabilities and majorly on quality and safety of actual systems deployed on sites. The goal of developing this framework is to improve the quality of installations across the country and help customers and users make an informed choice of the vendors that they choose for their solar PV systems. Additionally, this framework will help identify improvement factors for various EPCs so that they may better the quality of their solar PV installations.

Before the implementation of the Vendor Rating Framework (VRF) on a national scale, there was a need to test and evaluate the framework itself. GERMI support the Program in implementing this pilot. This report provides details of the evaluation of the framework. The pilot test was carried out for 10 EPCs in the state of Gujarat. Five solar PV installations were selected for each EPC under the present assignment, bringing the total inspected sites to 50. The details of approach, methodology, sample selection method, data collection and analysis are described in this report.

For the pilot various sites and EPCs were selected based on the five parameters, i.e (i) Geographic distribution, (ii) Category of EPC (as per GEDA classification), (iii) Type of installation, (iv) System capacity (kWp), and (v) Overall experience in SPV installations. A total of 50 sites totaling to 2,120 kWp (1,890 kWp non-residential plus 230 kWp residential) of solar PV installations were inspected by thefive inspection teams, which completed all 50 site inspections in 15 days. There were other teams for the document collection and financial data evaluation as per the VRF requirement. Given the fact that most EPCs volunteered to be a part of this study, their names are anonymized in this report, and instead, they are referred to by placeholder names such as EPC-1, EPC-2 and so on.

The Vendor Rating Framework (VRF) collects information and document them through two checklists (i) site inspection checklist, and (ii) technical & financial evaluation checklist. The parameters included in the site inspection checklist has a total weightage of 70 marks and the parameters included in the technical & financial evaluation checklist has a total weightage of 30 marks. There are nine categories in the site inspection checklist. These parameters provide insights to the major quality and safety issues as revealed in the PACE-D 2.0 RE program's earlier report (report name and web link) from where this proposed VRF evolved. This report presents the assessment of marks obtained by the participating EPCs with respect to system size, district of installation, and categories of the evaluation checklist.

Some of the key learnings from this pilot are highlighted below:

- A deviation in the average ratings for residential and non-residential systems. Non-residential i.e., commercial and industrial (C&I) installations appear to be better engineered, hence were rating higher.
- Average rating is higher for the larger system capacities, than smaller systems.
- 50% of the selected EPCs have more than 5 years of experience in solar PV installations, while the remaining 50% EPCs have less than 5 years of experience

The experience and challenges while executing this pilot is also mentioned in this report to further refine the vendor rating process. The suggestions for the improvement of the VRF checklist, and for making it suitable for national applicability; are stated in this report. The used checklists are attached in the annexures for the completeness of the report.

Overall, the findings as a part of this pilot will contribute to informing a nation-wide VRF rollout.

INTRODUCTION

In India, the quality and safety of rooftop solar photovoltaic (PV) systems—and their installation—have become a concern for investors, regulators, customers, and distribution companies (DISCOMs). More and more engineering, procurement and construction contractors, installers and suppliers are cutting prices in order to be competitive and win jobs. As a result, contractors and installers often compromise on the quality of the components, the systems, and the workmanship. These inferior products deliver less energy than expected or have a lower overall lifespan—all of which are serious issues for developers and investors whose return on investment depends on the amount of power generated from these solar systems for the expected life of the project.

Policymakers and regulators in India have already developed and prescribed standards for solar PV projects. However, existing standards mainly describe component requirements. They do not address issues with workmanship, installation, and grid integration. These issues also create safety risks for the distribution network. Performance and safety concerns further lower investor and consumer confidence in solar products, threatening to slow market development. This is apparent in the slow growth of the rooftop photovoltaic (RTPV) segment in India, despite being economically viable to many conventional electricity consumers. These concerns are more prevalent with distributed solar systems where vendors and customers have limited knowledge and technical competence to judge the quality of equipment and installation, let alone the appropriateness of system design. Given the nature of these projects (small capacity and large numbers), Indian states, discoms, and lenders have limited capacity to monitor and enforce even existing standards and guidelines for equipment and installation. Also, most customers are unable to make informed decisions on the quality of solar PV rooftop installations. Customers aren't able to effectively evaluate vendors' work due to the complexity of the installation process and the large number of system components. Similarly, the grid engineer who inspects the installation, may not be well equipped to advise installers and customers on the quality of the system.

Given that 40 percent of India's national targets of 100 Gigawatt (GW) of grid connected solar power by 2022 is to be attained through solar rooftop deployment, this lack of customer confidence could derail India's path to achieving its goals. A single national standard that addresses PV components as well as their workmanship and installation are needed to achieve the quality and safety of solar PV systems. A rigorous system of testing, monitoring and performance mapping is also needed and could be achieved through the vendor rating framework.

UNDERSTANDING QUALITY ISSUES IN SOLAR PV ROOFTOP IN INDIA

During the stakeholder consultations, they raised key concerns around design and component quality across several stages of RTPV system life, including system design and installation phases. According to that study most of the quality and safety issues occur either at the component procurement stage (about 50% of quality and safety issues experienced) or the installation stage (about 35% of quality and safety issues experienced); the design stage contributes to the balance 15%. Within the different stages, some specific areas cause a high proportion of challenges. For example, in case of system design quality, almost half of the quality challenges stemmed from the wrong array layout, followed by string inverter mismatch and site access. In case of component quality, the major areas of concern were the modules and the module mounting structures, followed by junction boxes; in installation phase, the main quality issues were related to fasteners, handling of modules, and earthing.

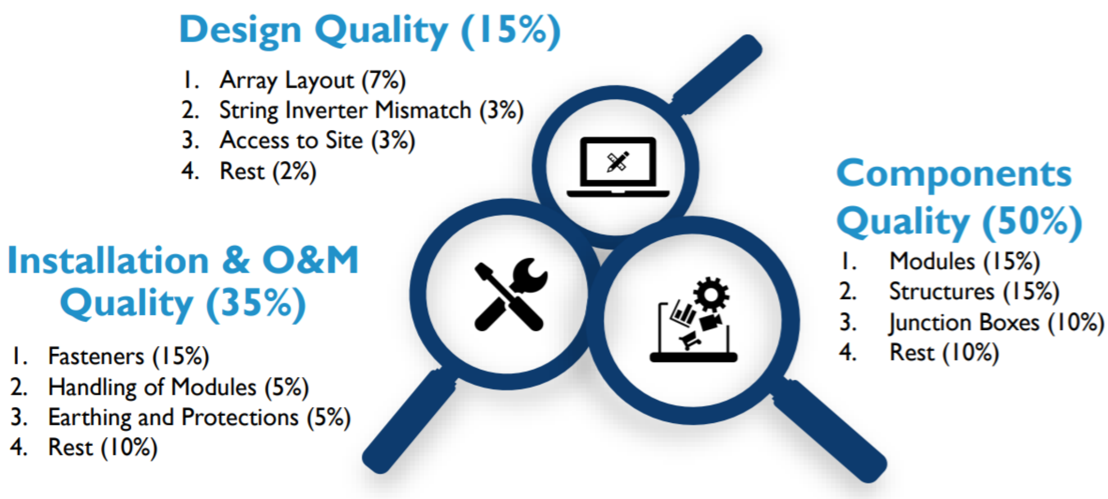

Figure 1: Quality and Safety Issues in Solar PV Rooftop in India

PACE – D 2.0 RE INTERVENTION

In addition to adhering to prescribed standards during the design, manufacturing, and installation of RTPV systems, there is a need for a framework that allows stakeholders to examine whether these standards have been followed, which should include a rigorous system of testing, monitoring, and performance mapping. With these principles in mind, a multipronged approach was suggested to address long-term quality and safety through the implementation of a Quality Assurance Framework (QAF). The Partnership to Advance Clean Energy Deployment (PACE-D 2.0 RE) program under the U.S. Agency for International Development (USAID) developed this Quality Assurance Framework, which has three recommendations to improve the quality of solar PV systems, their components, the installation, operations and maintenance during the life of the system, and the safety of the financed energy systems:

- **Module Quality Assurance Program**: This process would focus on the major component and help ensure module quality. It would also help small-capacity and dispersed systems to adhere to certain standards. It could be implemented by a Module Quality Certification Agency (to be established).
- **Electrical Safety Quality Assurance Program**: This process would certify for safety firstly during the design phase by ensuring adequate site access, provide design certification during the component stage, and then help ensure adequate electrical and lightning protection during the installation phase. Distribution utilities and Electrical Inspectors could play a role in ensuring that all safety standards for the RTPV system were followed.
- **Vendor Rating Framework (VRF):** Implementing a VRF would help evaluate the quality of work undertaken by EPC companies and installers. The ratings from this framework would allow the consumer, investor, or developer to identify the best providers and their capacity to install quality RTPV systems. This would require establishing a Vendor Rating Agency (VRA) to oversee the implementation of this process.

The Quality Assurance Framework recommendations were laid out in a report by USAID and the National Renewable Energy Laboratory, "Distributed Solar Quality and Safety in India," which was released in May 2020. Recommendations in the report were formed through extensive interviews and surveys with developers, engineering, procurement and construction contractors, installers, suppliers, bankers, consultants, and manufacturers in India. Emphasis was given to the VRF because stakeholders identified this concept as most useful and easier to implement in the short term. Currently, there is no mechanism in place to monitor, evaluate, and rate RTPV vendors in India. A VRF can help measure the quality of systems as well as ensure compliance of these systems to the established standards

WHAT IS VENDOR RATING FRAMEWORK?

Vendor rating is a procedure whereby a Vendor Rating Agency (VRA) provides solar EPC companies and installers a score, or a ranking based on factors such as the quality of onsite work (design, components, installation) and the performance of their systems. A VRF can be used as a single point of reference for all stakeholders, including customers, financial institutions, and developers, to identify top-quality vendors for future solar system installations, operations, and maintenance.

The USAID PACE-D 2.0 RE Program has designed and developed a rating methodology as well as the key parameters to be used as a part of that methodology to evaluate, rate, and certify vendors based on their track record of designing, developing, and deploying solar PV rooftop systems. The key objective is to help key stakeholders like investors, consumers, banks and NBFC's as well as developers identify the right vendor in the shortest possible time and at the least cost.

The Vendor Rating Framework is a procedure (using a set methodology and a set of accompanying parameters) where the solar EPC's will be provided a rating on a variety of factors like system design and its implementation at site, quality of modules and structures, proper installation of safety components, transport of modules, array layout and matching to name a few. Vendor Rating will provide a single point of reference for all stakeholders on how to identify top-rated quality vendors. The VRF can help measure the quality of the installed systems (where quality depends upon the quality of the procured components and the workmanship) as well as ensure compliance of these systems to certain established standards. It will allow consumers, developers and investors to compare and rank vendors on the quality of workmanship/ components procured and installation practices of EPC's as well as level of safety. Vendor rating will provide an incentive to Vendors to raise their game, offer better services and ensure delivery of quality systems.

An effective VRF may accelerate the adoption rate of RTPV by providing confidence to customers and discoms that reputed vendors sell high-quality solar products. An effective VRF would identify all relevant criteria for assessing vendors. It would also provide vendors with information about their performance weaknesses so they can take corrective action. A VRF could provide continuous review of standards for vendors, thus supporting continuous improvement of vendor performance.

DEMONSTRATING BENEFITS OF VENDOR RATING FRAMEWORK – PILOT IN GUJRAT

An important aspect of the designing the VRF was the verification and tuning of the Vendor Rating Framework through pilot assessments. This would cover all aspects including the design, installation and O&M of major components like modules, inverters, cable management and protection measures. The objective of performing a pilot assessment was to ensure that the VRF can be implemented successfully and incorporate the learnings and findings from the pilots to strengthen and make it more robust.

The methodology and sample selection were the prime factors for the effective assessment of the VRF in the pilot test. An online inquiry form was circulated to the Solar EPCs across Gujarat to seek participation in the Vendor Rating Framework. The form requested for required documents, EPC company profile and list of sites of installation of the selected EPCs. Based on categories such as type of installation (residential/non-residential), geographical spread of the site, system capacity (kWp), etc., the sites were shortlisted. For a diverse sample group, the team set a 'five-fold' criteria for the selection of different vendors (or EPCs) & site selections. These factors are shown in the figure below.

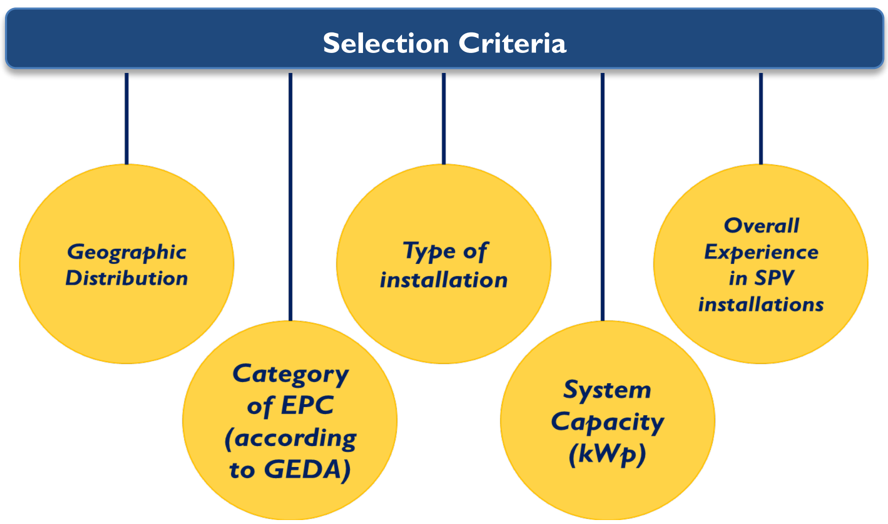

Figure 2 Selection Criteria of sites

A total of **50** **sites** were inspected across ten EPC companies, which means, for each vendor the team inspected and evaluated five sites. The sites were selected from six different districts, with major share from Ahmedabad (26%), followed by Surat (20%) and Anand (20%), Rajkot (18%), Vadodara (10%) and Gandhinagar (6%). Bifurcation based on the category of EPC is essential because not all companies can be evaluated on the same level. Some of the them have greater technical and financial capabilities, whereas the start-up companies have little to show in terms of both strengths. Therefore, treating both in separate categories prevents any bias towards the larger companies.

The Program inspected 76% residential sites and 24% non-residential sites. Out of 50 systems inspected, majority of them were of capacity range between 3-5 kWp, followed by systems with capacity in the range of 5 – 10 kWp. In addition, 50% of the selected EPCs have more than 5 years of experience in solar PV installations, while the remaining 50% EPCs have less than 5 years.

While rating EPCs, the Program used names such as EPC-1, EPC-2 to differentiate the companies. The capacity of inspections (in kWp) of different EPCs is shown in the table belowTable 1. Some of the EPCs (for example EPC-1, EPC-8) have executed major work in the residential solar PV sector, and therefore the numbers show up in this category. On the contrary, other EPCs (for example EPC-6, EPC-9, EPC-10) have predominantly larger commercial installations. The maximum inspection capacity for the single EPC is 1,078.91 kWp (for EPC-6) and the minimum inspection capacity for the single EPC is 13.20 kWp (for EPC-8).

Table 1 Inspected site capacity with respect to supplier

EPC Names	Non Residential (kWp)	Residential (kWp)	Total (kWp)
EPC-1		24.42	24.42
EPC-2	45.00	20.00	65.00
EPC-3	75.00	14.22	89.22
EPC-4		24.09	24.09
EPC-5	68.00	18.55	86.55
EPC-6	1,070.00	8.91	1,078.91
EPC-7		22.02	22.02
EPC-8		13.20	13.20
EPC-9	419.49	9.90	429.39
EPC-10	212.67	75.08	287.75
Total	**1,890.16**	**230.39**	**2,120.55**

The evaluation of the vendors was distributed in two checklists, namely:

1. Site inspection evaluation with **70% rating weightage**, and
2. Technical & Financial evaluation with **30% rating weightage**

The total marks for the evaluation stood at 100 for each EPC. The distribution of weightage, according to categories of both checklists, is shown in the Table 2.

Table 2 Marks distribution in various categories of checklists

Name of Checklist	Category	Total Marks
Site inspection checklist	Solar Modules	10
	Module mounting structure	9
	Accessibility and Safety	6
	Cable Management	10
	Protections and inverter/s	11
	Online monitoring and System Performance	8
	Operation & Maintenance	2
	Documentation	9
	Customer Interview	5
Technical & financial evaluation checklist	Technical capability	20
	Financial capability	10
Total Marks	**-**	**100**

KEY INSIGHTS FROM THE VENDOR RATING PILOT SURVEY AND RATING

The summary of the findings from site evaluation, as per the inspection checklist, is shown in the figure below:

Name of EPCs	Average Marks - Site inspection checklist		
	Non-Residential	Residential	Average
EPC-1		60	60
EPC-6	57	56	56
EPC-9	47	51	49
EPC-2	46	50	49
EPC-5	44	52	48
EPC-10	56	42	47
EPC-7		47	47
EPC-4		38	38
EPC-8		35	35
EPC-3	46	29	33
Average Marks	**50**	**45**	**46**

Figure 3 Summary marks out of 70 of the 'site inspection checklist'

The highest marks obtained were 60 out of 70, which is concerning and has adverse implications for the rooftop solar PV market in India. On-site inspections and subsequent assessments indicate apprehensions around quality and supports the importance of having VRF in place. In addition, there appears to be a divergence in the average ratings for residential and non-residential systems. Overall, non-residential i.e., commercial and industrial (C&I) installations appear to be better engineered. There are two possible reasons for this: one, since this is not a subsidized segment, EPCs are not exposed to rampant L1 bidding practices, which compromise on quality, and second, C&I establishments have their own in-house technical teams that carry out quality check and oversight.

The overall average rating is higher for the larger system capacities, as depicted in Figure 8. System sizes above 50 kWp system are non-residential solar installations. Similarly, for the lower system size (up to 3 kWp), the overall average rating is lower. The total marks of the site inspection checklist for these sites are comparatively higher. This can be on account of improved engineering drawing & practice by both EPC and customers, and the absence of a subsidy market.

System Capacity	Average Marks - Site inspection checklist		
	Non-Residential	Residential	Average
above 50 kWp	52		52
between 10 to 50 kWp	48	42	45
between 3 to 5 kWp		45	45
between 5 to 10 kWp		49	49
upto 3 kWp		43	43
Average Marks	**50**	**45**	**46**

Figure 4 Total marks of site inspection checklist with respect to system size categorization

As mentioned before, the site inspection checklist has a weightage of 70% in the VRF rating. Different sites have different installation and quality conditions in those nine categories in the checklist. This varies for each EPC. The average of site inspection checklist marks of the selected EPC, with respect to each category of marking, is shown in

Name of EPCs	Average of Solar Modules (out of 10)	Avg. of Module mounting structure (out of 9)	Avg. of Acceessibility and Safety (out of 6)	Avg. of Cable Management (out of 10)	Avg. of Protections and inverter/s (out of 11)	Avg. of Online monitoring and System Performance (out of 8)	Avg. of Operation & Maintenance (out of 2)	Avg. of Documentation (out of 9)	Avg. of Customer Interview (out of 5)	Sum of Technical Marks Obtained (out of 70)
EPC-1	8	5	6	10	11	3	2	9	6	**60**
EPC-2	7	3	5	7	11	2	2	7	5	**49**
EPC-3	6	4	3	9	8	0	1	-1	3	**33**
EPC-4	4	5	3	10	11	1	1	2	2	**38**
EPC-5	5	3	6	9	11	1	2	7	5	**48**
EPC-6	7	5	6	10	9	3	2	8	6	**56**
EPC-7	8	7	4	8	11	-1	1	5	3	**47**
EPC-8	4	3	4	7	6	1	1	5	5	**35**
EPC-9	9	5	3	8	9	2	1	9	3	**49**
EPC-10	7	4	4	9	10	2	1	4	5	**47**
Avg. Marks	**7**	**4**	**4**	**9**	**10**	**1**	**2**	**6**	**4**	**46**

Figure 5 Total marks of site inspection checklist with respect to category of the inspection checklist

A. Indicating good cable management practice

B. Demonstrating all-round easy access to the site

C. Inaccessible array. Notice how the lower end of the module tips dangerously into the slope

D. Improper cable management (no name tags to identify the cable)

COST IMPACT OF FIXING QUALITY FLAWS

From a detailed inspection study for the 50 sites under this pilot, there were several commonly occurring quality concerns. It becomes imperative to understand if these quality concerns can be fixed and at what cost. In the Table 3 below, category-wise cost implications to rectify the respective problems have been structured into three buckets.

Table 3 Tentative cost impact of fixing quality flaws

Sr. No.	Site inspection category	Particular Issue	Frequency of Occurrence		Possible Impact on system	Possible solution	Ease of possible solution	Cost of possible solution
	Evaluation section		Nos. of EPCs	Total Sites	High / Medium / Low		Easy / Medium / Difficult	Low / Medium / High
1.	Solar Modules	System design documents	5	19	Medium	Provision of Design documents	Easy	Low
2.	Solar Modules	String Voltage, orientation & tilt Mismatch	6	12	Medium	installation as per design. Design must be used as a reference for installation.	Easy	Low
3.	Solar Modules	Poor material for fasteners	5	14	Medium	Poor quality fastener can lead to corrosion and can possibly damage the fixing sufficiency of the module. Approved fasteners (SS/ or with proper coating) should be used.	Easy	Low
4.	Solar Modules	Usage of plastic ties instead of rust free metallic or UV resistant plastic	9	40	Low	UV resistant plastic ties or metallic ties can be used.	Easy	Low
5.	Module Mounting Structure	Poor attention on MMS, coating, and its certificate	9	45	High	Rust free (i.e. with proper coating or aluminum) structure can be used. The coating thickness	Easy	Medium to High

Sr. No.	Site inspection category	Particular Issue	Frequency of Occurrence		Possible Impact on system	Possible solution	Ease of possible solution	Cost of possible solution
						certificate record should be maintained.		
6.	Module Mounting Structure	Non-availability of STAAD Pro OR Structural strength Reports/certificates	9	45	High	STAAD Pro analysis report or assessment from chartered engineer can be carried out.	Medium	Medium
7.	Module Mounting Structure	Visible Rusting on MMS	5	10	High	Use of rust-free structure is essential for longer service life. Material selection should be proper. Proper Color or Zinc coating solution to be used for the prevention of rusting.	Easy	Low to Medium
8.	Accessibility and Safety	Poor accessibility for cleaning	6	9	High	Correcting the errors can have a significant cost impact. Preventing it through appropriate design depends on customer requirements (sometimes hard to convince)	Medium to Difficult	High
9.	Accessibility and Safety	Poor access for repair and lack of safety	7	15	High	Correcting the errors can have a significant cost impact. Preventing it through appropriate design depends on	Medium to Difficult	High

Sr. No.	Site inspection category	Particular Issue	Frequency of Occurrence		Possible Impact on system	Possible solution	Ease of possible solution	Cost of possible solution
						customer requirements (hard to convince)		
10.	Protections	Improper Earthing for 'module to module' and 'module to structure'	4	11	High	Considering the hazard, earthing should be properly done between module to module and module to structure.	Easy	Low to Medium
11.	System Performance	No generation data with vendor	10	50	Medium	Timely generation data should be recorded and maintained.	Easy	Low
12.	System Performance	No submission of simulation report by EPC	8	40	High	Simulation report enables comparison of actual generation with targeted generation. Benchmarking can help to improve the generation.	Easy	Low
13.	System Performance	Lack of average annual specific energy generation	10	48	Medium	Timely generation data should be recorded and maintained.	Easy	Low
14.	Documentation	Poor hand-over of documents to customer	7	24	High	Provision of warranty, as constructed drawings, and O&M documents are must require in case of any replacement and repairing.	Easy	Medium

As mentioned in the sections above, 'Technical & Financial evaluation carries a total of 30 marks out of 100. While performing the pilot, it was observed that some EPCs did not submit financial documents. The incomplete data provided by the EPCs can lead to a lower rating because the missing details & documents from the respective EPC is counted as absent (either rated zero or negative in the respective evaluation parameter).

The blend of marks for site inspection and technical & financial evaluation, provides the overall rating to each EPC. This summary is shown in Table 4. It displays that EPC-9 earned the highest marks, whereas EPC-1 got the lowest. However, the results are not 100 percent accurate due to lack of key documents submitted by few EPCs (such as financial documents, sales trends, coating certificate, generation data, sample copies of documents, etc.). However, it is perceived that with the formalization and launch of VRF, there would be a greater motivation for EPCs to furnish this information.

Table 4 Total marks of EPCs

EPC Names	Site inspection (out of 70)	Technical & Financial Evaluation (out of 30)	Total Marks (out of 100)
EPC-1	60	6	66
EPC-2	48.7	18	66.7
EPC-3	32.7	16	48.7
EPC-4	38.3	6	44.3
EPC-5	48.3	16	64.3
EPC-6	56.2	7	63.2
EPC-7	46.9	23	69.9
EPC-8	35.2	18	53.2
EPC-9	49.4	24	73.4
EPC-10	47.2	18	65.2
Average Evaluation Marks	**46.29**	**15.2**	**61.49**

VRF PILOT EXPERIENCE

The purpose of conducting this pilot was to identify areas of potential challenges during the rollout of the VRF, nationally. This section draws learnings from the Pilot experience and lists down suggestions and recommendation to help improve and enhance the VRF and its deployment.

Given the fact that this was a novel "first of its kind" exercise, several EPCs were skeptical and therefore showed limited interest in participating in the exercise. Additionally, some multiple documents and details are required from EPCs, to complete this exercise. Given that this was a voluntary exercise for the EPCs, it was cumbersome to collect information and needed several follow-ups.

Considering the participation from customers, PACE – D 2.0 RE observed that most of the customers were satisfied with the installation and with the EPC. There were no major complaints. However, this could also be since only the most responsive EPC companies participated in this test study. Some of the customers were also interested to increase the system performance based on these findings.

Also, most customers on their part lack awareness about the documentation requirements. This presents a significant challenge in the VRF.

It is therefore suggested to have a predefined documentation submission protocol for EPCs. For example, design documents, simulation reports, various proofs of purchase orders, certificates, and warranties. This protocol will help the VRA in easy and fast identification and assessment of the parameters from the submitted documents.

Additionally, after evaluating both checklists (i) site inspection checklist, and (ii) technical & financial evaluation checklist; the PACE – D 2.0 RE team observed few necessary changes that will help improve VRF. Such suggestions are given in this section.

Parameter	Suggested Actions	Remarks
Various parameters in 'solar PV module section' and 'Module Mounting Structure' (MMS)	Proper Sample Selection	These parameters are 'Age dependent parameters', which means that the rating can be different for the newly installed system and older systems. Hence, these parameters should be assessed with the consideration of the system installation date. One method is to sample systems according to different system ages.
Module fixing	Modification	Some sites were found with J-bolts of G.I used in MMS. This option should be added in the inspection checklist, with appropriate marks.
Structure material	Modification	Sites were also observed with mix structure (G.I. + Aluminum). This option should be added in the inspection checklist.

Coating	Modification	Many EPCs assured the inspectors that they will produce a certificate for the coating. This is another significant lacuna. To perform an accurate comparison as opposed to leaving the data blank, the coating robustness can be checked with instruments like a coat meter.
Accessibility and Safety parameters	Modification	For many sites, the team found elevated module mounting structures. These structures are risky for repairing, replacement and cleaning of the solar PV modules and other components. Such installations can be marked negatively and should have a separate row in the checklist.
Inverter display	Modification	During the site inspections, the team found certain installations that have inverters without built-in display (certain makes or models do not have this). This can be handled by recording inverter data from either the display or an online monitoring system. However, the absence of both such sources must be marked negatively.
Inverter installation	Modification	At certain sites the inverter was installed in A wooden box. This is a fire hazard. Hence, the marking option of 'inverter installation in card board & wooden box' should be added with negative marks.
Annual energy generation	Modification, Detailing required	Very few customers have annual energy generation data with them. Also, the team found, poor record of generation either by EPC or by customers. Hence, instead of depending on previous database, this parameter can be evaluated using instantaneous performance generation, where no data is available. A kWh/KW metric normalized against instantaneous irradiance can be suggested as an alternative.
Documentation	Modification, Follow-ups	Several customers do not show the documents given by EPCs while at the same time saying that all documents were given to them. Hence, an additional parameter might be added that shows customer said YES, but did not furnish the documents. This could be a mark of customer awareness.
Online monitoring	Modification	This parameter is dependent on the customer, whether they need this facility or not. Inverters are available with online monitoring with WiFi and SIM card-based internet. This can be linked with the visual display of

		power generation from the inverter or with online monitoring.

Figure 6 Suggested Actions based on common problems

As a conclusion, PACE-D 2.0 RE team feels that the pilot itself has again reestablished the need and the importance of Vendor Rating Framework and feels that early launch and all India adoption of this system would greatly contribute to enhancing quality and safety of the rooftop PV systems. This will also motivate vendors themselves to continually improve their systems as they themselves continue to learn through this rating system.

The team has carried out necessary improvements and modifications in the framework as revealed through this pilot test and the Vendor Rating Framework is now ready for national launch.

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