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Workshop on

Renewable Energy Integration and Procurement

March 18 -19, 2024

South Asia Regional Energy Partnership (SAREP) and Sri Lanka Energy Program

Session 6B: Overcoming Challenges and Scaling Rooftop Solar Deployment

CONTENT

1. **Generation data monitoring and performance management framework**

2. **Performance monitoring of RTS plants**

3. **Rating program to ensure quality, safety, and performance of rooftop solar installations.**

Rooftop Solar Policy Outlook in Sri Lanka

Installed RTS Capacity in Sri Lanka is ~ 816 MW

Target Solar Capacity is 5GW by 2030

Net Metering	• Credits Prosumer for the electricity they add to the grid • Banking facility to prosumers for 10 years
Net Accounting	• The Prosumer is paid for excess generation at the end of the month at Feed-in-tariff
Net Plus	• Two separate meters are installed for grid consumption and PV • Prosumers is paid for the complete (gross) solar energy injected in the grid.
Net Plus Plus	• Similar to net plus, but there are not sanction capacity based restriction on the prosumers and could utilize roof space to the full extent.

Why should a consumer do RTS generation data monitoring?

Asset Performance Evaluation	Assessment of how well the system is performing, by comparing actual generation data with expected or predicted values, one can determine if the system is meeting its intended output levels.
Identifying Issues and Faults	Continuous monitoring helps in early detection of any issues or faults in the system. Prompt identification allows for timely maintenance or repairs, minimizing downtime and maximizing energy production
System Optimization	Analyzing generation data over time can reveal patterns and trends in energy production. This information can be used to optimize the system for better performance.
Energy Management	Generation data can be integrated with energy consumption data to provide insights into overall energy usage patterns and enables better energy management decisions by consumer

Benefits to utilities from RTS generation data monitoring?

Demand Forecasting	Forecast future electricity demand more accurately. By analyzing historical solar generation patterns, predict how much energy will be available from rooftop solar sources at different times of the day and under different weather conditions.
Resource Planning	Inform long-term resource planning efforts by understanding the potential for distributed solar generation in their service territories and taking informed decisions on where to invest in grid infrastructure, and other technologies
Grid Management and Integration	Identify areas with high levels of RTS penetration and proactively address any challenges related to grid stability, voltage regulation, or power quality.
Policy Compliance	In many jurisdictions, utilities are required to meet RPO targets. Monitoring RTS generation can help utilities demonstrate compliance.

General Conditions - Guidelines for PV System Monitoring*

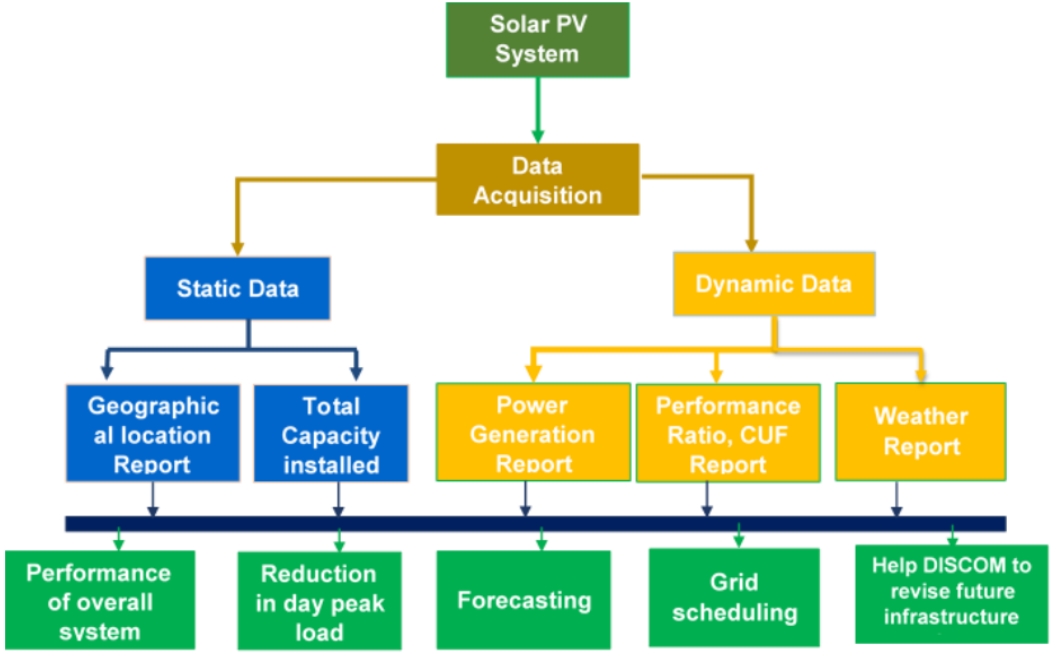
- The **installer shall provide a performance monitoring system** for the overall solar PV system.
- The monitoring system **shall include the instantaneous power output** from the inverter, cumulative energy generation, string parameters and **any other parameters** chosen by the manufacturer.
- The installer may provide **remote monitoring system** via internet or personal area network as well.
- The monitoring system shall be either proprietary **software issued by the inverter manufacturer.**

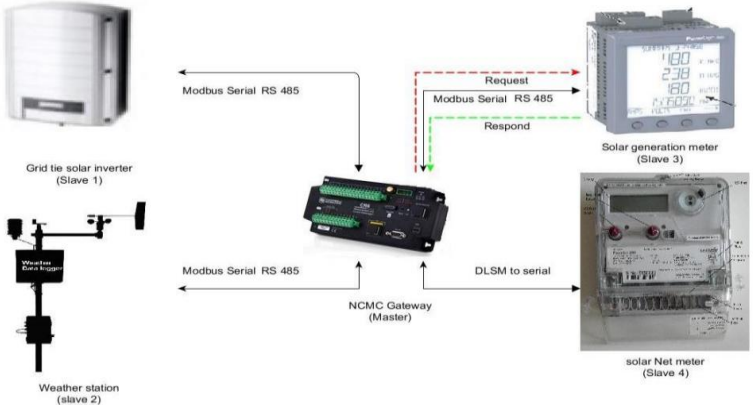
*September 2022: Guidelines on Rooftop Solar PV Installation for Solar Service Providers - https://www.energy.gov.lk/images/energy-management/guideline-for-solar-pv-system-installation-for-solar-providers.pdf

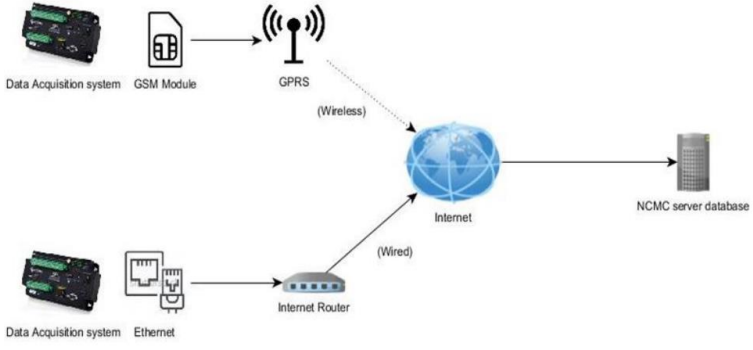
Key concerns in RTS generation data monitoring?

- Data Accessibility – Spread over multiple assets
- Data Quality and Accuracy
- Standardization of data requirements
- Security and Privacy Concerns
- Resource Constraints- Infrastructure; HR?
- Data Consistency

Centralized framework for RTS generation data and performance monitoring

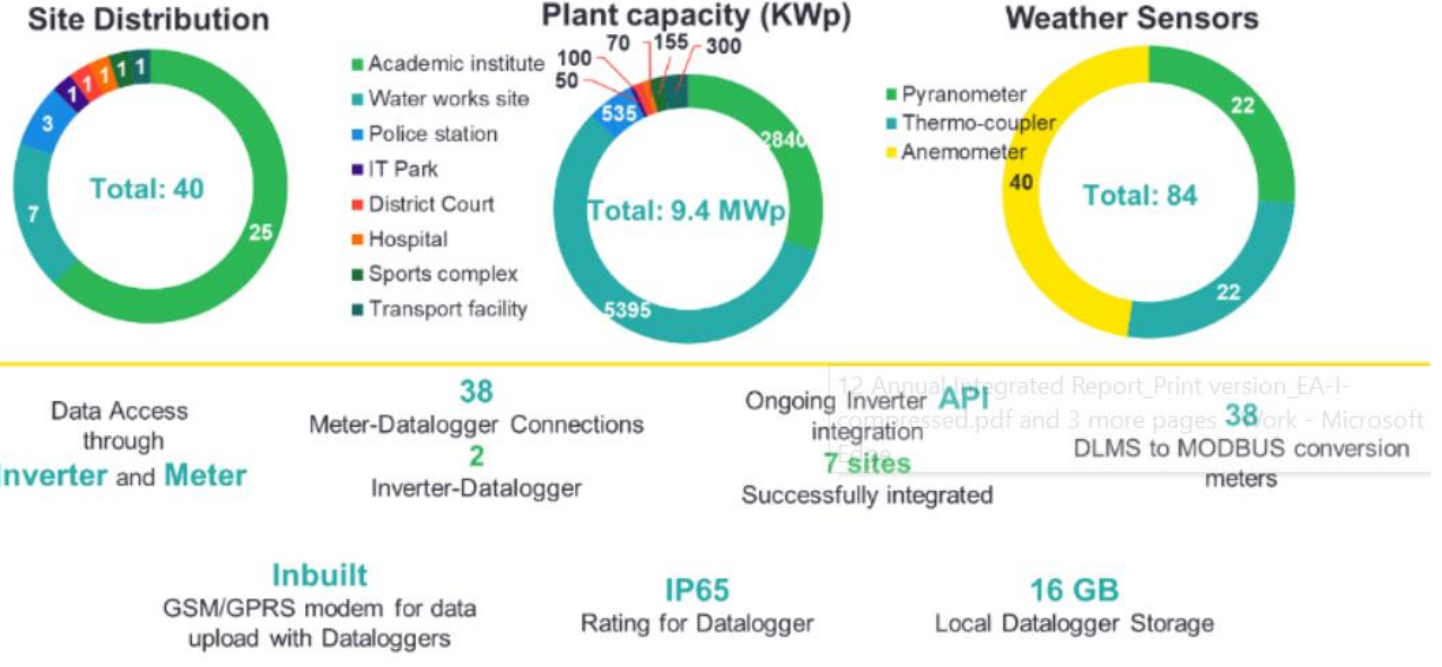






Central Rooftop Solar Data Monitoring Centre

Access & Capture data | Compatibility | User Friendly Format | Data Analytics & Dashboard | Scalability & Integration



* *Source: National Institute of Solar Energy (NISE), Pilot on National Online Rooftop Solar Data Monitoring Centre (For Ref. only)*

Which of these is this the correct way of cleaning a solar modules?

Picture-1

Picture-2

Picture Source: Google and Scroll.in

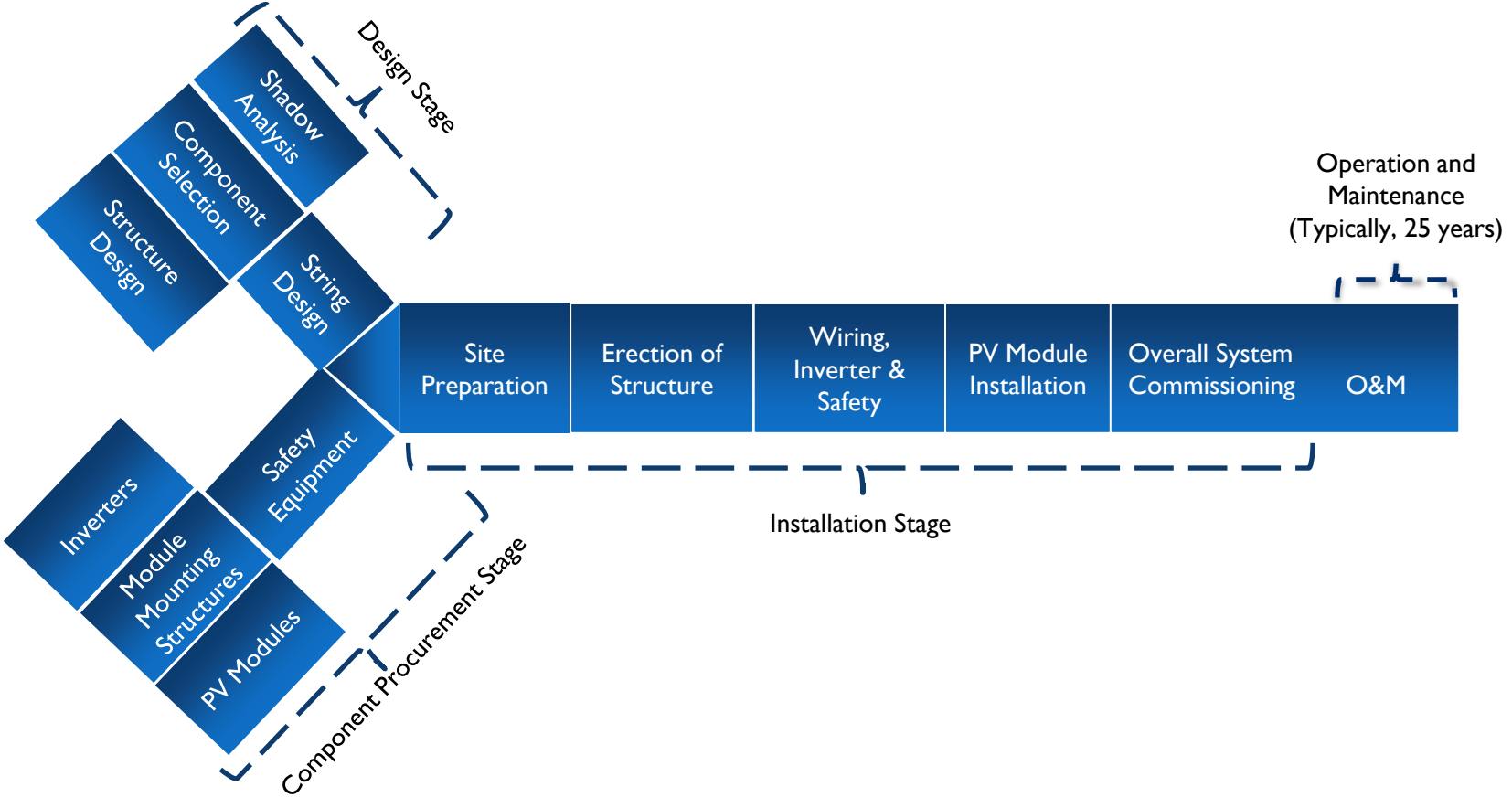
Understanding the Problem Statement of RTS Quality

- It is certain that **rooftop solar installation is gaining traction** across geographies
- **Quality and safety of rooftop solar installations** is becoming a big concern for investors, customers and policy makers.
- It is often seen that vendors try to increase their competitiveness and win contracts by **compromising on quality, safety and performance** of the system to cut costs; and some installers simply lack capacity.

How it can be addressed?

- Establish a **market-based vendor rating program** that require installers to be rated based on a system's compliance with standards determined by central and state government ensuring the **vendor is capable of quality work**.
- The rating system will **incentivize vendors** to participate and continually improve the quality of their installation services, which will also increase the generation efficiency of RTS plants expected to be installed in the coming years.

Rooftop Solar (RTS) project development steps

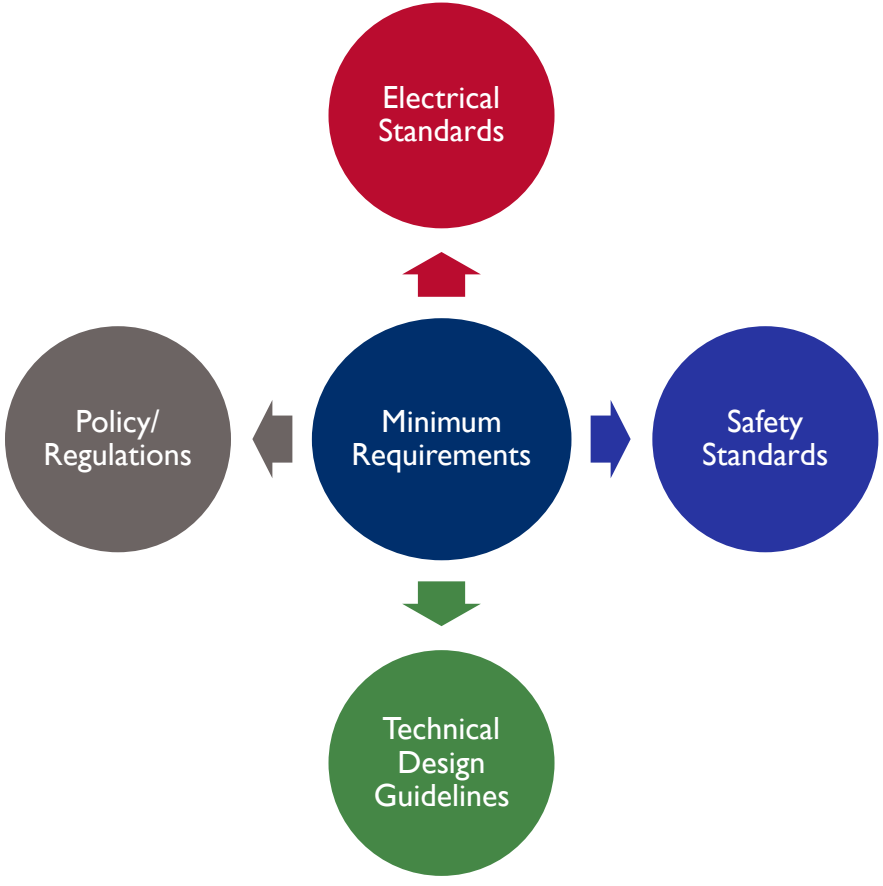


Minimum technical standards for RTS installations

Technical Standards:

1. PV Modules
2. Solar Inverter
3. PV Module Mounting Structure
4. Cables and Connectors
5. Safety and Protection
6. Civil Structure
7. Data Communication
8. Grid Interconnection

OFTEN MISSED -
Standards for Workmanship?
Standards for O&M?
Standards for Technical Documentation?



Common Findings at Various Stages of RTS Installation

Particular	Issue / Challenge / Concern
PV module issues	Early degradation, microcracks, in-transit damages
Safety and protections	Incorrect earthing, insufficient safety equipment's - lightning protection systems; underrated circuit brakers; surge-protection devices; and disregard for fire-handling provisions
Workmanship and Installation methods	Partial shadows on PV array, incorrect design, loose connections, wear and tear of cables, corrosion in mounting structures, weak civil work
System Commissioning	Absence of independent inspection, lack of commissioning tests, improper site verifications
Operations & Maintenance	Inadequate maintenance, no schedule for preventive maintenance
System performance	Lower energy generation, intermittent monitoring of systems, slow or no follow up on corrective actions prompted by monitoring
Documentation	Absence of proper documents with customers
Customer feedback	Absence of onsite customer feedback identification

RTS Installation Quality & Safety gaps

No.	Parameter	Impact
1	**PV Module Orientation:** 1) Angle – Generally, equal to the latitude of the location 2) Direction – South Facing	Generation loss
2	**Shadow Analysis:** Proper shadow analysis using S/W like Google Sketchup, PVSyst etc.	Generation loss, damage to solar cells/ modules
3	**PV Modules:** 1) Check for snail trails, hot spots, back sheet discolouration 2) **Proper Matching of Modules/ Solar Array** with Inverter	Module/ cell damage, generation loss, inverter damage, system tripping/ availability issues (increased downtime)

RTS Installation Quality & Safety gaps

No.	Parameter	Impact
4	**Module Mounting Structures:** 1) Material: Galvanised Iron (GI), Aluminium 2) Proper foundation & Structural analysis 3) Fixing of modules with proper fasteners	Rusting, stability, fatal accidents (modules/ structures can fly at high wind speeds)
5	**Cables:** 1) DC cables: Proper sizing & material (copper) 2) AC cables: Proper sizing & material (aluminium/ copper) 3) Cable Routing & Enclosures 4) Joints/ Connectors/ Cable Radius/ Insulation	Fatal accidents, voltage drop, generation loss
6	**Safety Devices/ Breakers:** 1) Surge Protection Devices 2) Over Current Protection Devices 3) Proper Earthing 4) Lightning Arrestors	Fatal accidents, increased system downtime

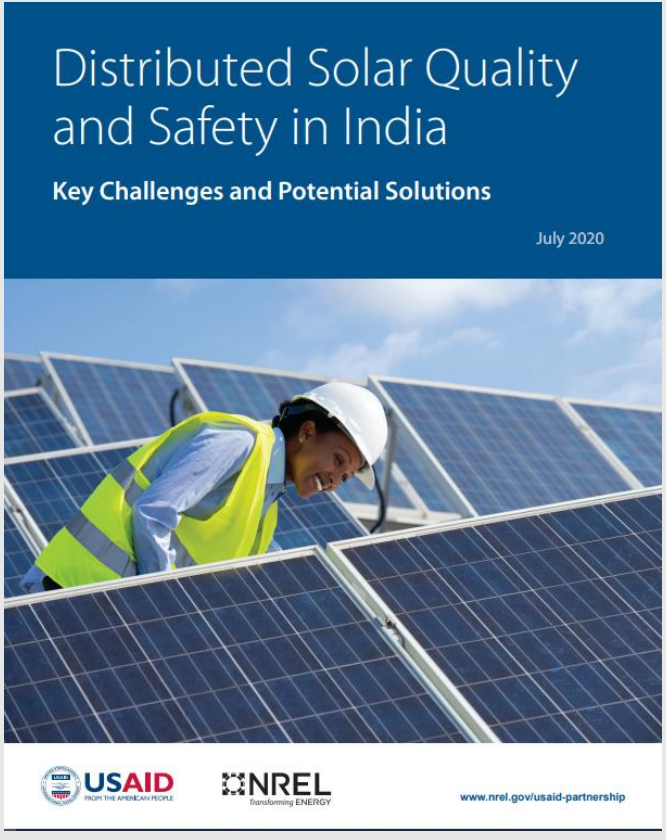
Results- Incidents due to poor Quality & Safety gaps

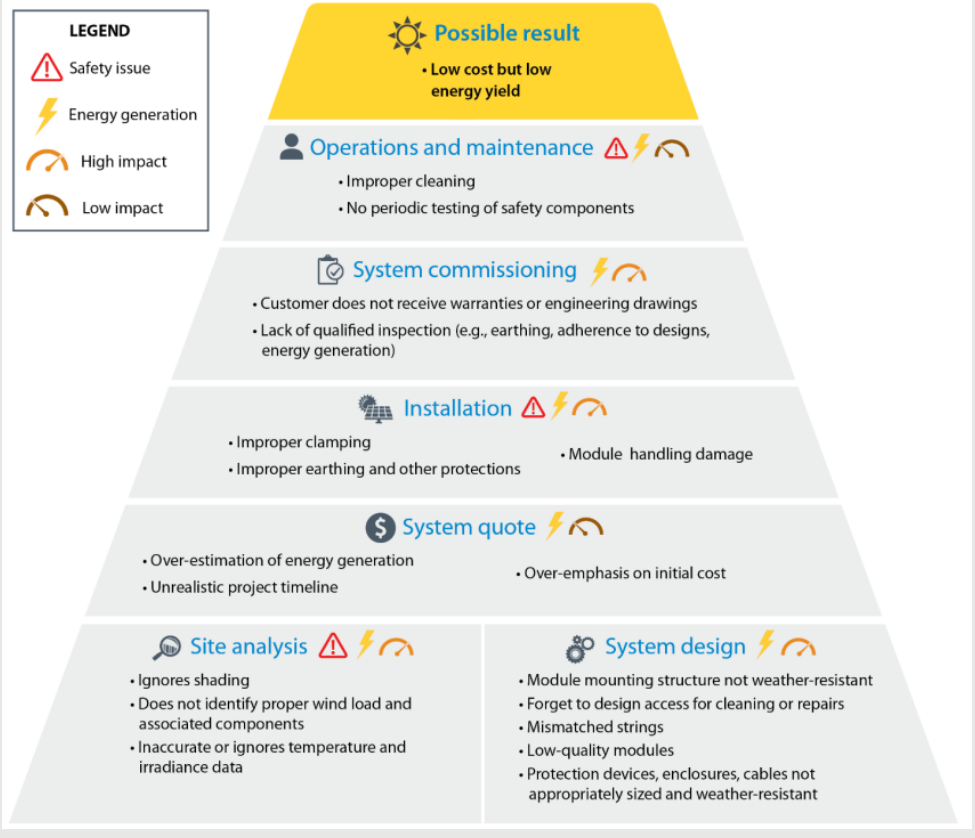
- Location: Jaipur, Rajasthan
- Impacted: 300 rooftop and ground-mounted plants
- Trigger: Rainstorm and Gusty winds
- Poteantial Reason: Poor workmanship (Major reason)

Reference video of the potential consequences

News Source: https://m.timesofindia.com/city/jaipur/rain-hit-rooftop-projects-raise-quality-issues/amp_articleshow/100541504.cms
Video Source: Unknown/Online

Study: Key Challenges for RTS Quality and Safety (1/2)





Source: https://www.nrel.gov/docs/fy20osti/74833.pdf

Study: Key Challenges for RTS Quality and Safety (2/2)

Design Quality (15%)

1. Array Layout (7%)
2. String Inverter Mismatch (3%)
3. Access to Site (3%)
4. Rest (2%)

Installation & O&M Quality (35%)

1. Fasteners (15%)
2. Handling of Modules (5%)
3. Earthing and Protections (5%)
4. Rest (10%)

Components Quality (50%)

1. Modules (15%)
2. Structures (15%)
3. Junction Boxes (10%)
4. Rest (10%)

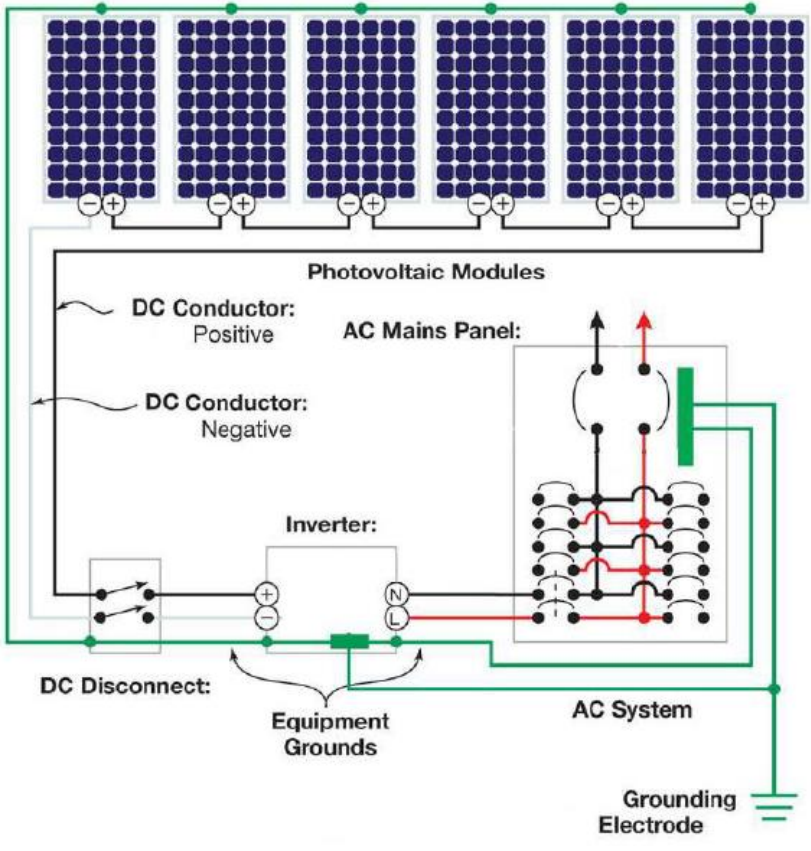
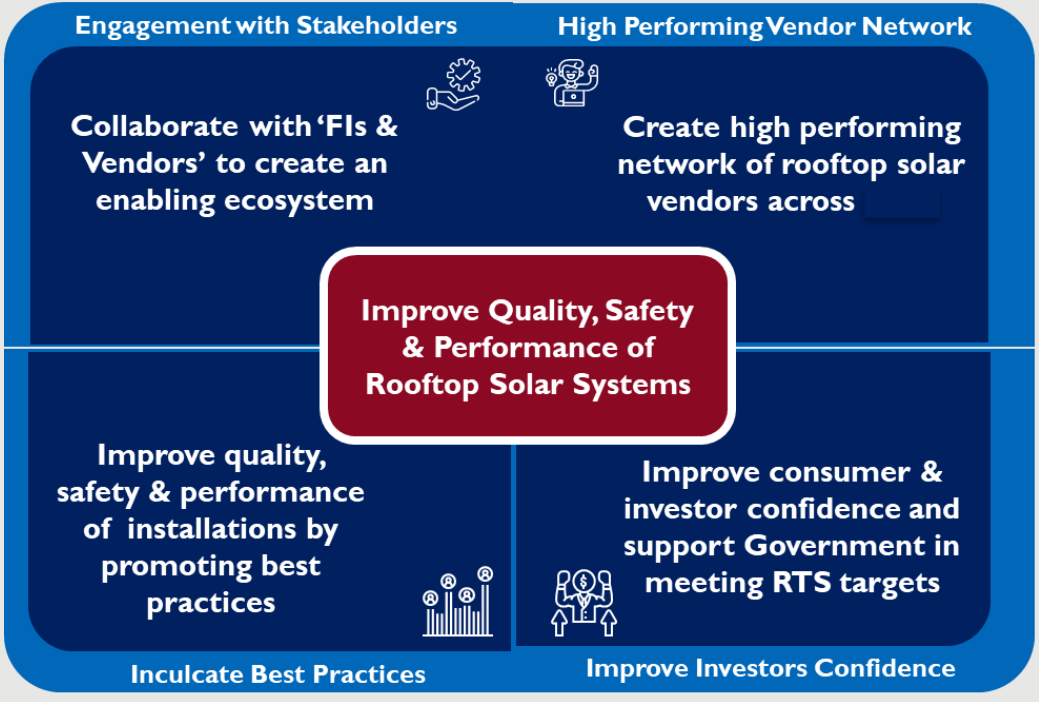


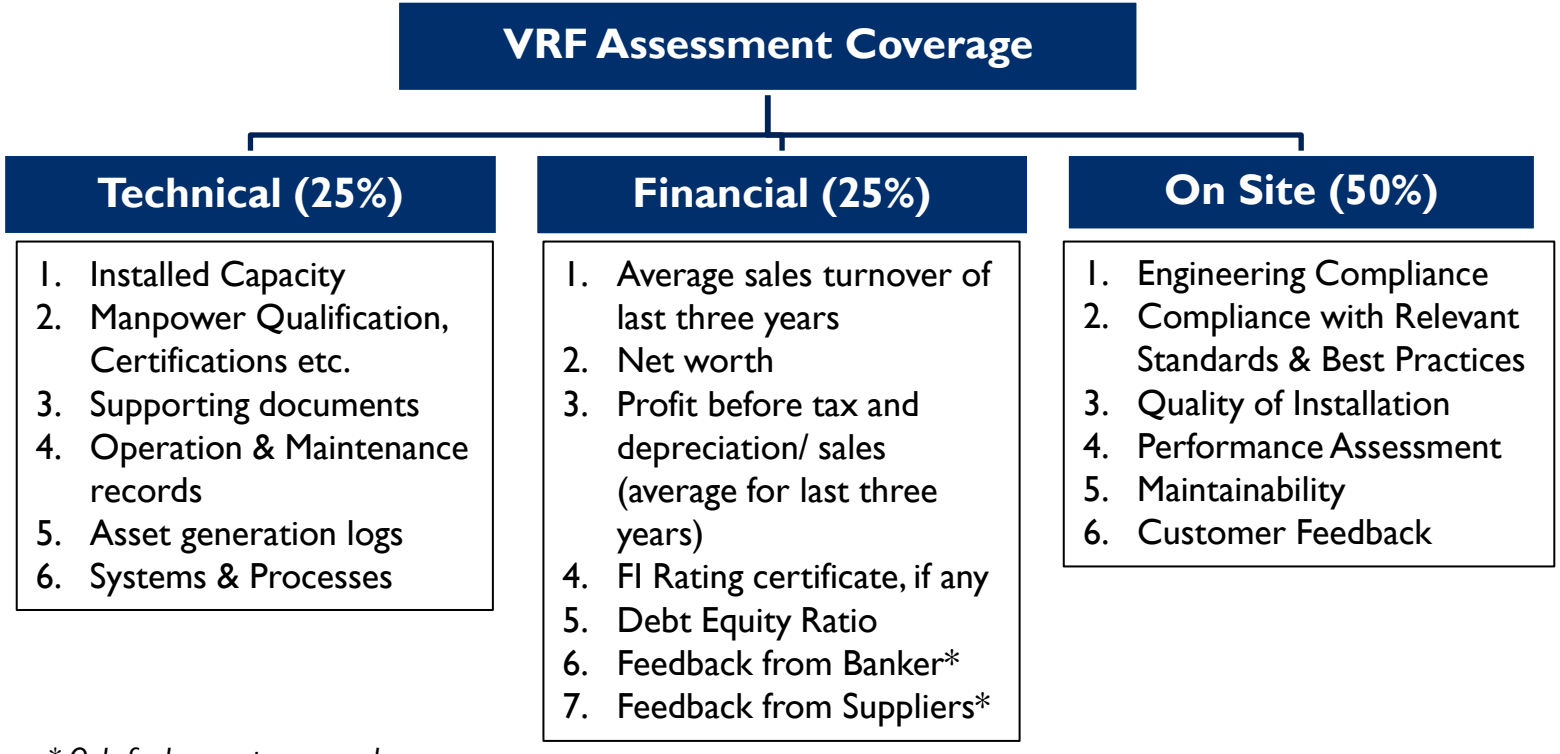
Image Ref: Guidelines on Rooftop Solar PV Installation for Solar Service Providers

What is a Vendor Rating Framework (VRF) ?

- A **procedure** to rate RTS vendors **on a variety of factors** related to the **design, installation, workmanship and financial health**
- Provide a **single point of reference** for all stakeholders – to identify top-rated quality vendors
- Allow consumers, developers and investors to **compare and rank vendors** on the quality of workmanship/ procured components, installation practices and level of safety
- Encouraging **Vendors to raise their standards** and offer better services and delivery of quality systems



VRF - Methodology



** Only for large category vendors*

Benchmarks set separately for small, medium and large segments for the above criteria

VRF - Rating Process

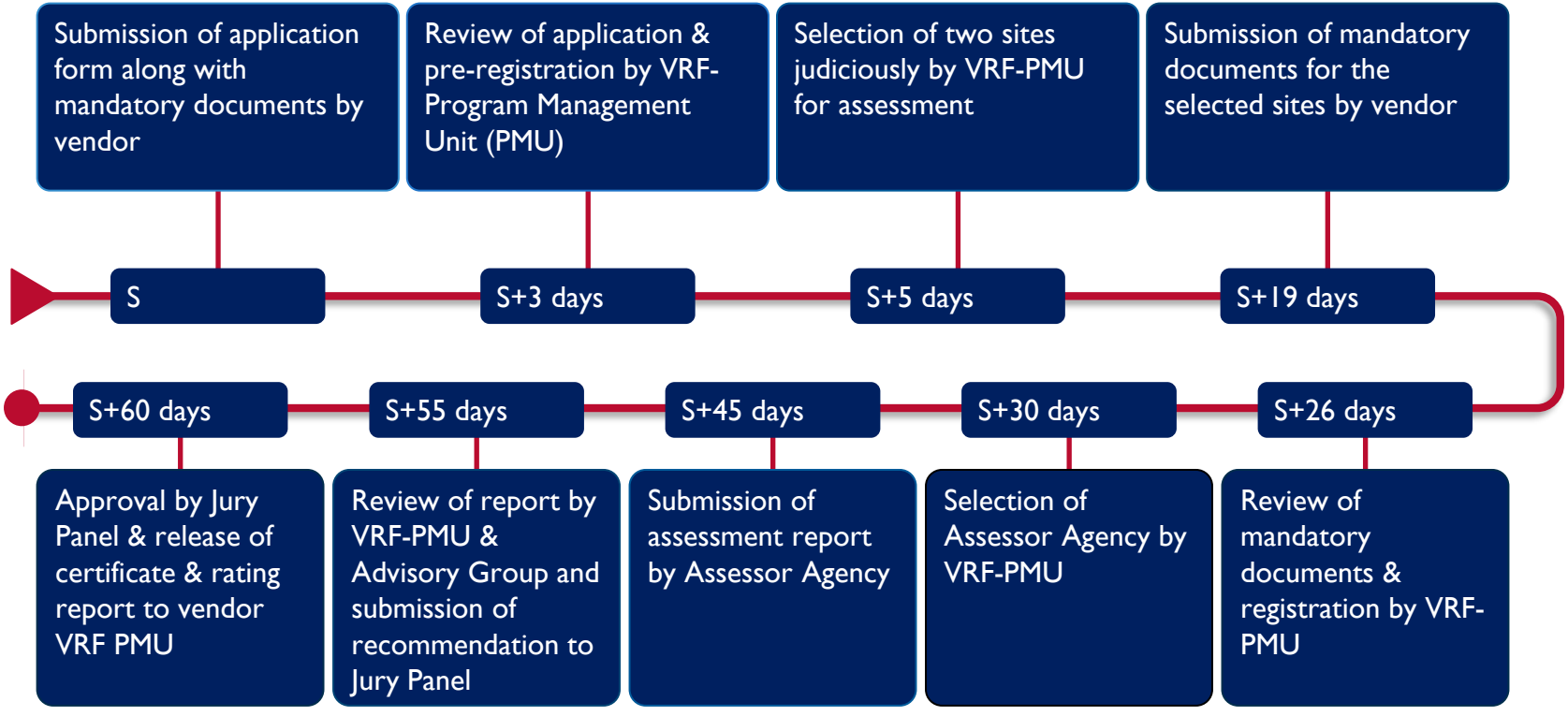


Illustration provided above is for a 'Small Category' Vendor
For medium & large category vendors, rating process would take 15 more days for completion

VRP - Rating Matrix

Suggested Vendor Ratings			
Overall Technical assessment points (75)	Technical Rating	Financial assessment points(25)	Financial Rating
≥ 68	A	≥ 23	1
59 to 67.5	B	20 to 22.5	2
50 to 58.5	C	17 to 19.5	3
41 to 49.5	D	14 to 16.5	4
≤ 40.5	E	≤ 13.5	5

	The Rating Matrix	Excellent	Good	Fair	Weak	Vulnerable
		Financial Strength 1 to 5 ----> High to Low				
Excellent	Technical Competence A to E -----> High to Low	A1	A2	A3	A4	A5
High		B1	B2	B3	B4	B5
Fair		C1	C2	C3	C4	C5
Low		D1	D2	D3	D4	D5
Very Low		E1	E2	E3	E4	E5

- Vendors securing a minimum cumulative score of 60% are recognised as Certified Rooftop Solar Vendor.
- The rating as per the current Rating Matrix is confidential and is only shared with the assessed vendor for helping to improve upon the low scoring parameters.

VRP - Benefits to Stakeholders

Developers

- Identify quality vendors (EPC/installers)
- Increase / enhance returns through improved performance
- Reduce transaction costs

Customers

- Identify high quality vendor
- Compare vendors based on rating
- Enhanced system performance
- Increased reliability

Bankers

- Record of quality of vendors & systems
- Assurance of performance of systems on the ground and return
- Potential reduction in interest rates
- Increase the confidence in RTS

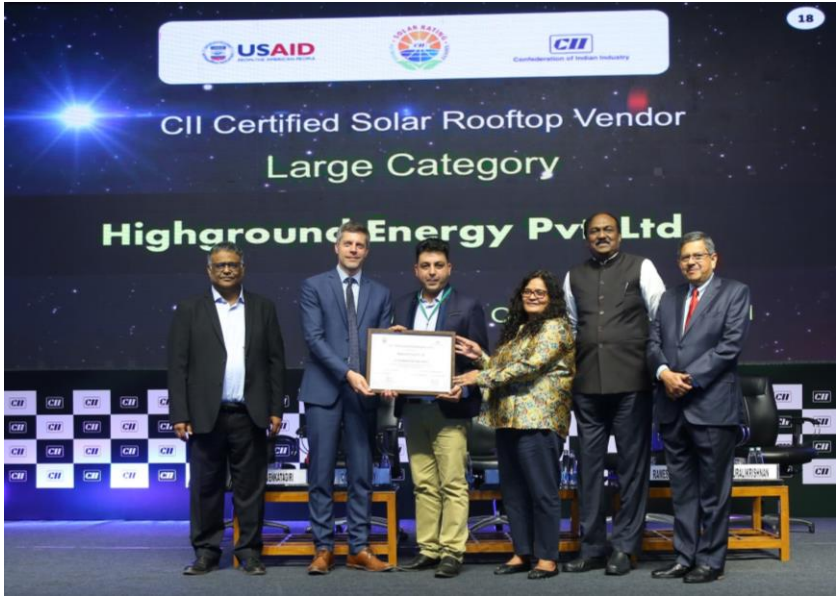
Utilities

- Enhanced safety due to improved compliance by installers
- Improved quality resulting in increased predictable generation, allowing better demand/grid management

EPC Companies

- Enhanced visibility and business promotion
- Access to information & feedback on benchmarking & process improvement
- Increased chances to access lower interest debt

Conferring Certificates to Rated RTS Vendors



~ 100 Rooftop Solar Vendors Rated as of March, 2024

VRP Web Portal: www.ciisolarrating.com

85 vendors certified, 15 vendors on last stages of certificate issuance

People forget how fast you did a job-but they remember how well you did it

- Howard Newton

Thank You

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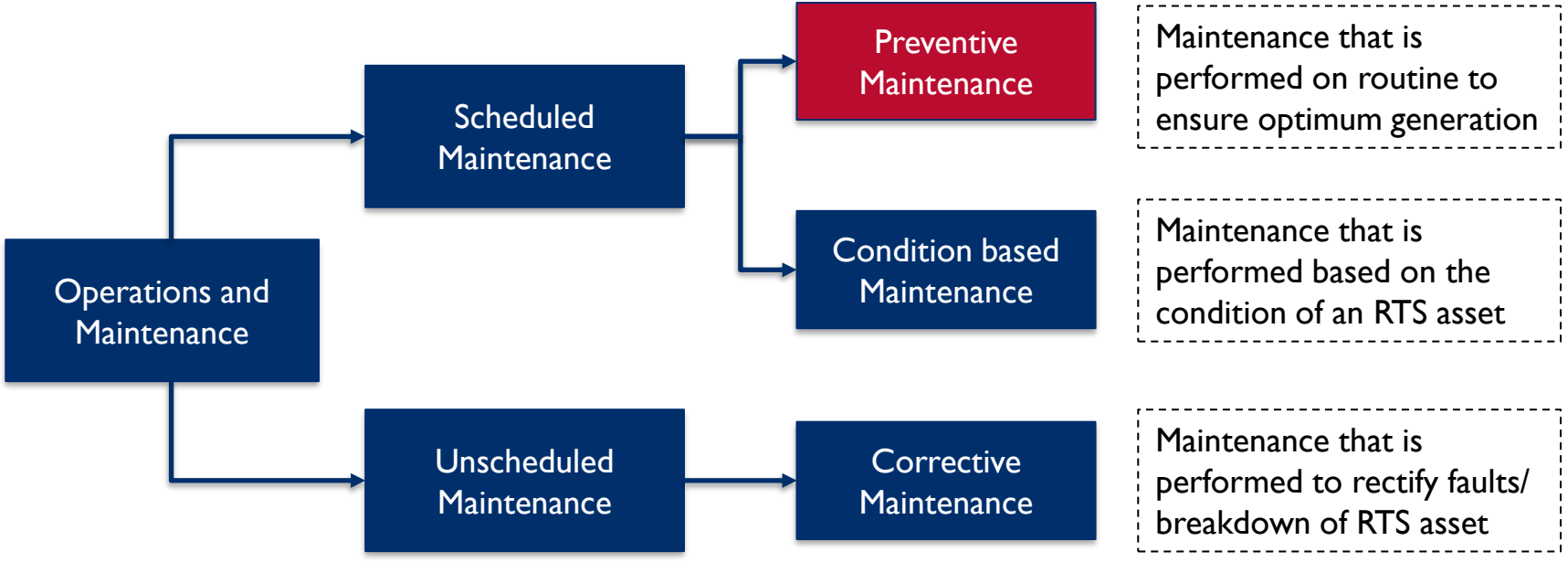
Pilot: Assessment of the Vendor Rating Framework (VRF)

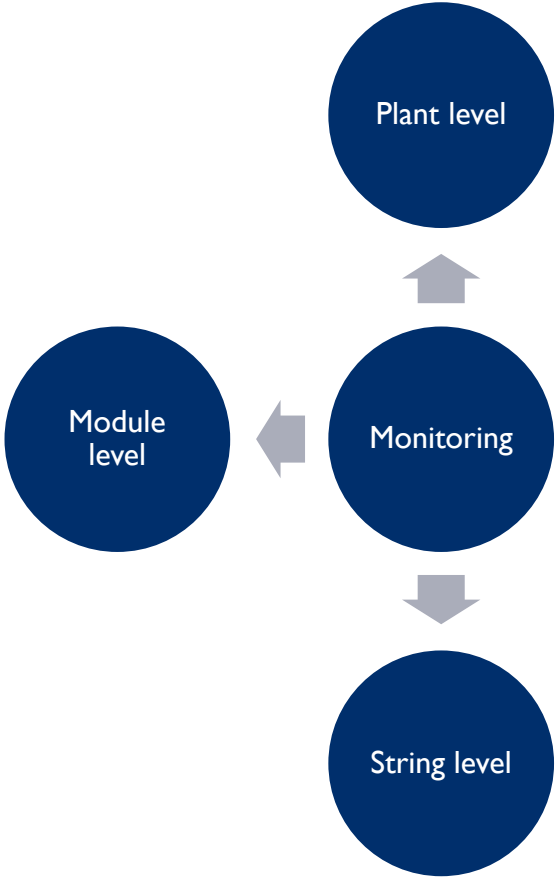
February 2021

- Vendor Rating Framework (VRF) developed under the MNRE-USAID Partnership to Advance Clean Energy Deployment PACE-D 2.0 RE Program
- Pilot conducted to test the VRF and its acceptance before national rollout as a vendor rating program
- The pilot test was carried out for 10 EPCs in the state of Gujarat
- Five solar PV installations were selected for each participating vendor with a total of 50 RTS projects sites inspected during the pilot
- To inspected capacity was 2.12 MWp (1,890
- kWp non-residential and 230 kWp residential)

Various O&M Approaches



Role of Preventive Maintenance for RTS systems (1/2)



Generation of each plant

Monitoring at module level parameters

Yield of each inverter

Monitoring at string level by checking output of each string

Prerequisites for successful RTS O&M

- Select **low- or no-maintenance alternatives** when available (for example plastic wire ties would require replacement whereas coated metal ones may not);
- **Track the performance of fielded equipment** and identify and specify the ones that have low failure rates, and which have the best OEM warranty service; standardize on preferred products to avoid mis-match of parts and expertise in a fleet;
- **Make use of network-connected inverters** for remote testing, software configurations and/or updates, and remote resets
- Provide required access to and **clearance around equipment** for maintenance

Capacity Utilization Factor (CUF)

- CUF means the ratio of the annual output of the plant versus installed plant capacity for number of days.

CUF = plant output in kWh / (installed plant capacity in kW * 365X24)

Example:

RTS Plant: 5 kWp
Annual Generation: 7200 kWh

CUF= 7200/(5*8760) = 16.43%

Performance Ration (PR)

- Performance Ratio means the ratio of plant output versus installed plant capacity at any instance with respect to the radiation measured.

PR= (Measured output in kW /Plant capacity in kW * (1000 W/m2 /Measured radiation intensity in W/m2)

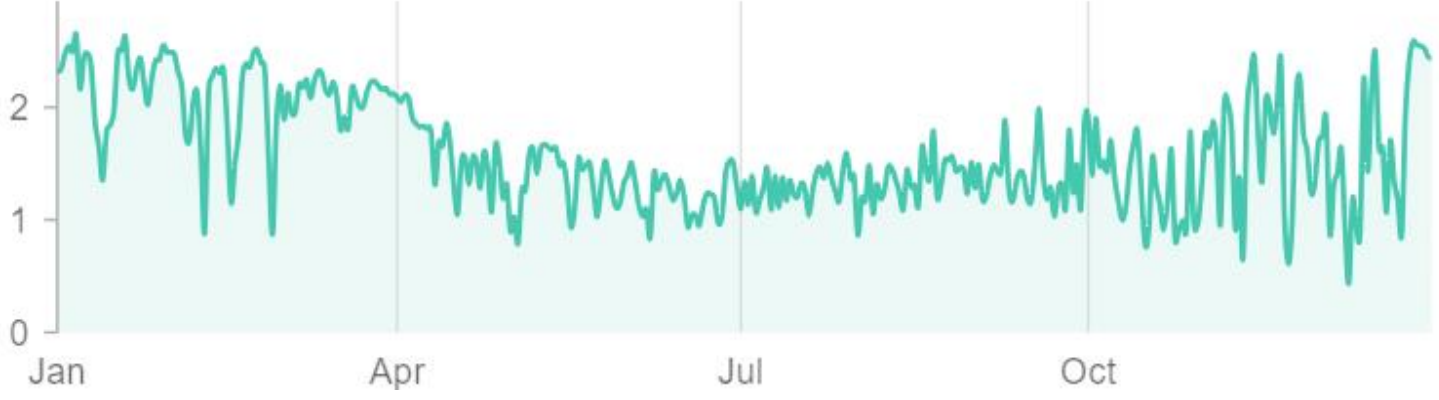
Example:

Measure capacity: 5.1 kWp
RTS Plant: 5 kWp
Measure radiation intensity: 950W/m2

PR= (5.1/5)*(1000/950) = 94.7 %

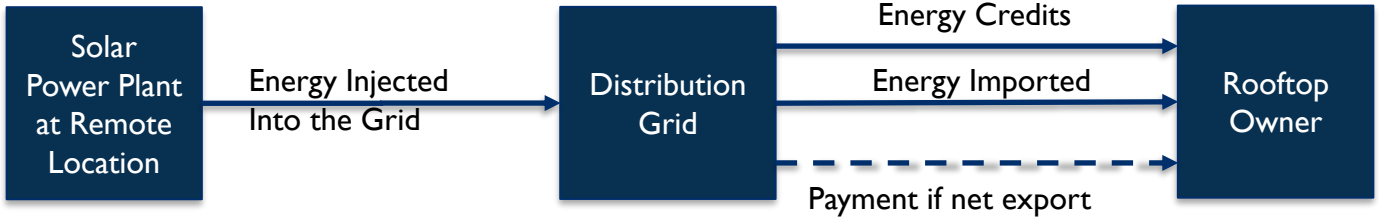
Intermittent Nature of Solar Power

- Solar PV systems are dependent on the clear sky for optimum generation
- The variation in irradiance leads to reduced generation and swift change in o/p of the system
- Such an example is shown in figure below (7.4222N, 81.1118E):



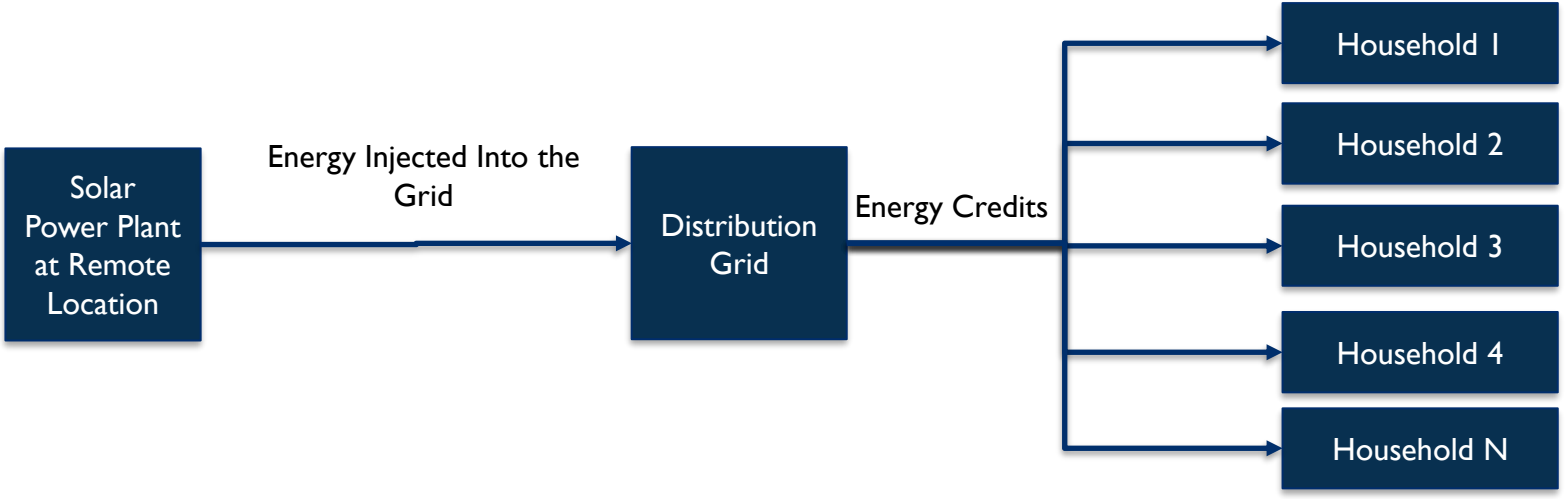
The variation in generation may lead to various technical challenges, if not monitored or managed efficiently

Virtual Net-Metering



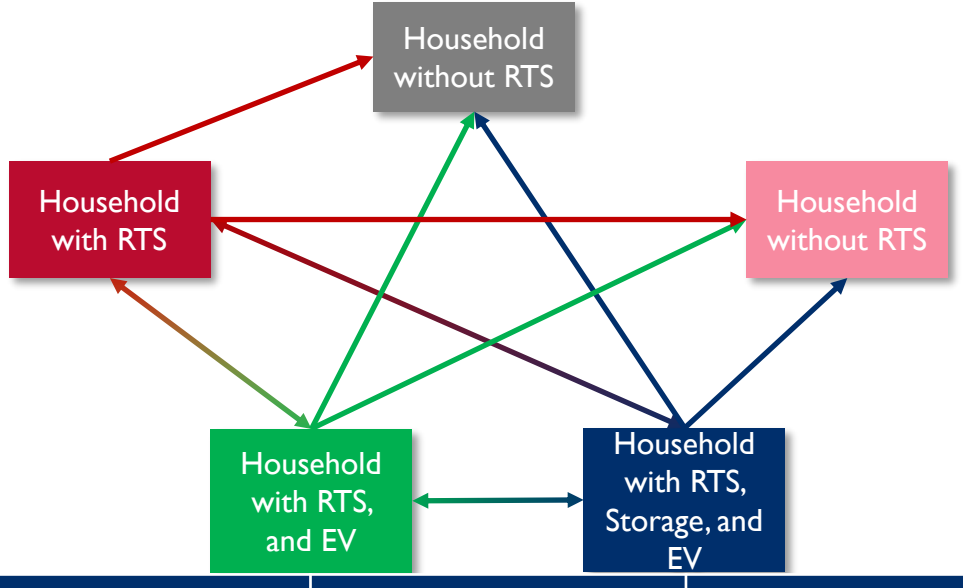
Consumers	Benefits	Challenges	Tariff	Evolve
• Residential and C&I • Single Family house with shadows • Tenants • EV Charging Stations	• 3 Phase generation I phase consumption • Use of Roof potential in cities • Inclusive opportunity in RE Investment	The cost could be higher than tariff in certain conditions Energy accounting if the generation and consumption are in different DISCOMs	APPC or as determined by the regulator	This business model could act as a gateway for the cities, where roofs are congested and covered with shadow.

Group Net-Metering



Consumers	Benefits	Challenges	Tariff	Evolve
• Residential • C&I • EV Charging Stations	• Community level solar benefits • Benefits can be availed by owners without roof	• Need of regulatory intervention	• APPC or determined by the regulator	• This business model could act as a gateway for the cities, where roofs are congested and covered with shadow.

Peer-to-Peer Trading



- P2P trading enables direct electricity transactions connecting consumers and prosumers and facilitates the transition to a decentralized retail renewable energy market
- P2P trading incentivises and automates the balancing of electricity supply and demand in close proximity by providing price signals connected to available solar surplus energy within the decentralized retail renewable energy market.
- This provides alternatives for conventional Net Metering (NM) or Gross Metering (GM) subsidies and increased returns for rooftop solar (RTS) or battery owners hence incentivising more end-customers to install RTS in a market-based approach.

Consumers	Benefits	Challenges	Tariff	Evolve
• Residential • C&I • EV Charging Stations • DISCOM	• Reduced Tariffs • Peak load shaving	• High implementation cost • Complex trading regulations	• The tariff is market driven	• This business model could become the future of distributed RE trading, which could be implemented throughout the country.