MINISTRY OF NEW AND RENEWABLE ENERGY

Best Practices Guide Implementation of State-Level Solar Rooftop Photovoltaic Programs in India, Dated: June, 2016

Sl. No.	Description	Summary
1.	**Objective**	• GoI has announced an ambitious solar target of 100,000 megawatts (MW) installed capacity by 2022, of which 40,000 MW of solar photovoltaic (PV) systems are to be installed on rooftops. • With dramatic reduction in PV prices over the last couple of years, we are entering an era of 'grid-parity', where the cost of solar electricity is competitive with retail electricity tariffs in many cases. • This Guide captures global and national best practices and learnings. The Guide primarily addresses grid-connected rooftop PV systems, under both net metering and gross metering connectivity.
2.	**Customization, Compliance and Revisions**	1 The Guide addresses all necessary concerns, whether administrative or technical, to realize a simple, efficient and scalable solar PV rooftop programme. While it discusses many topics in detail, readers are suggested to ensure their applicability before directly applying them. 2 In case of any conflict between the provisions of the Guide with statutory provisions in the current scenario or in the future, the statutory provisions shall overrule the provisions of the Guide.
3.	**Business Models**	Components and Design of Solar Business Model: **1 Building Blocks for a Solar Rooftop Business Model:** The ownership structure or the revenue model are identified based on a number of factors such as the policy and the regulatory framework in the market, the electricity market structure and tax policies. Revenue models depends on the manner in which the energy is generated and used/sold. **2 Evolution of Solar Rooftop Business Models:** • The first generation model is the most commonly found model globally. • The second generation model evolved based on packaging a large number of smaller solar rooftop projects by a single project developer known as a "third party". • At present, the first two generation models dominate the market but a small shift can be seen in the way utilities are entering this market.
4.	**Types of Solar Rooftop Business Models**	**1 Self owned Business Models:** promote investment in solar rooftop systems by the consumers to either generate electricity for self-consumption or for export to the grid. (a) **Captive-captive (off-grid)** models are prevalent in the places where the grid is either absent or has very poor reliability. (b) **Gross Feed:** These models consists of grid-connected solar rooftop systems which feed all the energy generated to the grid. In lieu of the energy fed to the grid, they are paid feed-in-tariff (FiT). (c) **Net Metering:**- Under this, solar energy is first consumed by the consumer0020for meeting the internal/captive requirement and the rest (surplus) is exported to the grid, where it is banked with the utility, and subsequently when the consumer imports power from the grid, the banked energy is adjusted against the imports from the grid, leading to a lower bill

		for the consumer for grid based electricity services. **2 Third Party Owned Business Models** - Under the third party-owned model, a third party (separate from the consumer [rooftop owner] and the utility) is the owner of the rooftop systems. (a) **Solar Leasing/Leasing of solar Systems** - The third party investor earns steady cash flows in the form of lease rental payments while also benefiting from tax credits and depreciation benefits available to investors of solar rooftop equipment. (b) **Solar Power Purchase Agreements** - The third party developer invests in solar rooftop asset, and the electricity is sold either to the building owner (also the utility consumer) or fed into the grid. • **Individual Rooftops With Third Party - Owned Systems With Grid Feed:** Under this arrangement, the third party developer leases a rooftop and pays a rooftop lease/rental for the rooftop space. • **Combined Rooftop Leased by Third Party with Grid Feed (Gross Metering):** Under this model, a project developer identifies and leases (through a lease agreement) a number of rooftops in an area and develops these together in the form of a single project. **3 Utility-Based Business Models:** Utility involvement in the solar rooftop market was initially limited to being a facilitator through a broad framework for interconnection. However, a growing number of investor-owned utilities have recently taken up a more pro-active stance in encouraging the development of solar rooftop projects. The utilities involvement in the solar PV rooftop business model space has been limited to four broad areas (a) **Utility Ownership:-** it allows them to claim tax credits, earn a healthy rate of return on the power generated from these installations while also ensuring that consumers with rooftops do not transit out of the utility's ecosystem. (b) **Utility Financing:** Another route in which utilities are encouraging the deployment of solar rooftop installations is by financing consumers. wo types of loans are typically available through utility-based financing: (c) **Utility Loans:** These are loans which are targeted at utility customers and administered by the utility at the local, municipal or the State level. Utility loans are either linked to the consumer (bill financing) or linked to the property (meter secured financing). • **Revolving Loans:** Revolving loans finance rooftop owners directly through public sources such as public benefit funds, environmental non-compliance penalties, bond sales or tax revenues. • **Community-Shared or Customer Programmes:** Community-shared solar programmes provide energy consumers the option of utilizing the benefits of solar generation (through proportional benefits via virtual net metering) without actually installing on-site solar PV or making high upfront payments required for such projects. (d) **Energy Purchases:** A number of utilities are also entering the market with the objective of procuring energy directly from third party or rooftop owners by offering FiTs which allow utilities to buy all the energy generated by the rooftop at a flat price under a long term PPA, the cost of which is passed onto the consumers as part of its ARR, while at the same time retaining the customers on whose rooftops these systems have been set up.
5.	**Key Challenges and Considerations**	Solar rooftop projects suffer from a number of commercial, policy and regulatory, technical and financing challenges which need to be addressed as the market grows through a concerted effort from policy makers, regulators, financers and above all the

		utilities. Some of these challenges have been highlighted below: 1. **Contract Sanctity:** For long-term sustainability and investor confidence in the market, the contracts need to be easily enforceable, provide remedies for payment defaults, and buy out clauses/appropriate compensation framework in case of building redevelopment or relocation of projects. 2. **Availability of Financing and Capacity of FIs to Evaluate Rooftop Projects:** Banks and FIs are still in the process of putting in place consumer financing products (loans) and guidelines which allow access to debt for rooftop owners. 3. **Solar Equipment Leasing:** One of the key fiscal incentives used to bring down the cost of solar in markets like the U.S. is depreciation or accelerated depreciation (AD) in the case of India. The key challenge here is that service tax is levied on the leased equipment which erodes most of the benefits that investors may have attained from AD. 4. **Rooftop Leasing:** Access to rooftops for the life of the solar rooftop project remains another key challenge due to issues such as reconstruction of the building or expiry of the lease of tenets. Most private sector companies lease buildings (along with rooftops) for up to 10 years. 5. **Role of Utilities – Challenges and Facilitation Required:** There is a need to streamline the interconnection process, making it time bound and transparent with a focus on achieving the required performance standards and quality standards. 6. **Match between Incentive Mechanisms and Needs of the Market:** There is a need to evaluate a regulatory framework which targets rooftop utilization and penetration of solar rooftop systems on a large number of consumers such as schools, hospitals, and storage facilities, etc. which have huge rooftop space but do not have the financial justification for adopting net metered solar rooftop business models.
6.	**Policy Objective**	• Give clarity to various departments within the Government on the action plan and direction of the Government. • Give clarity to the general public, investors, developers and other public and private stakeholders on the intention of the Government in a particular field.
7.	**Goals/Targets**	The targets specified by the MNRE may be escalated slowly over time, reflecting three important facts: • **Falling Costs of PV:** As PV prices fall over the target period, affordability of these systems increases, thereby increasing the uptake of these systems. • **Increasing Power Tariffs:** As power prices increase steadily over time, many more consumers will begin to augment their current grid consumption with solar PV rooftop. • **Maturity in Ecosystems:** As time progresses and various stakeholders in the solar PV rooftop value chain begin to get familiar with the technology and its risks, the ease of transactions and marginal risk costs begin to decrease. • **Subsidy:** Currently, there is a 30 percent capital subsidy from the MNRE for solar rooftop systems on homes, educational institutions, hospitals, etc. States might choose to provide an additional subsidy if required, especially for marginal groups and economically weaker sections of society. The risk to State and Central Governments is that people may get used to the subsidy and demand entitlements.
8.	**Operative Period**	Most policies are extant for a period of three to five years. The following considerations must be kept in mind while determining the tenure of the policy: • Changing Governments, and subsequent drastic changes in policy, are not good

<table>
<tr><td></td><td></td><td>for the business environment as a whole. Governments must ensure that electoral transitions coincide with defined end-dates to policies.
Drastically falling prices of solar PV have ensured that most of the earlier plans and policy direction have turned void. This has necessitated a revision in the policy and corresponding schemes under the policy.</td></tr>
<tr><td>9.</td><td>Nodal Agency</td><td>A nodal agency is the Government department that is responsible for the promotion of the policy.
Most States strive to adopt a single window clearance that helps investors obtain all clearances at a single office. This must be implemented in true spirit and a dedicated team may be constituted for the rapid approvals and addressing of investor’s grievances. The State energy development agency/authority is best suited for such a role.</td></tr>
<tr><td>10.</td><td>Implementing Agency</td><td>It is the implementing agency that is responsible for implementing the solar rooftop programme.
As grid-connected solar rooftop plants have an implication on utility billing, grid safety and power quality, the DISCOM becomes the de facto implementing agency. While on the other hand, the SNA can become the implementing agency for stand-alone solar projects.</td></tr>
<tr><td>11.</td><td>Eligible Entities</td><td>Eligible entities are usually the different categories of electricity consumers mentioned in the SERC orders. A good example of this is incentives such as banking or net metering schemes.
Financial implications may be considered while setting the targets of the policy.
An eligible entity may be an owner of the building, a tenant or even a third party investor.</td></tr>
<tr><td>12.</td><td>Schemes/Applicable Business Models</td><td>A solar rooftop policy is implemented through various schemes. Schemes provide the necessary implementing framework for the policy and may change from time to time within the tenure of the policy. They may also include specific subsidies and incentives that are also time-bound, and may be applicable to a certain eligible entities and types of systems (e.g., off-grid versus on-grid).</td></tr>
<tr><td>13.</td><td></td><td><table>
<tr><th rowspan="2">Type of Incentive/Exemption/ Parameter</th><th colspan="2">Sale to Distribution Licensee</th><th>Sale to Third Party</th></tr>
<tr><th>Net Metering</th><th>Gross Metering</th><th>Open Access</th></tr>
<tr><td>PV System Capacity</td><td>Limited to consumer’s contract demand/sanctioned load.</td><td>Limited by the available rooftop area (or related to associated distribution transformer capacity) or as per the relevant terms of RFP, if applicable.</td><td>Based on mutual agreement between developer and offtaker.</td></tr>
<tr><td>Ownership</td><td>Self-owned.</td><td>Self-owned or thirdparty owned.</td><td>Third-party owned.</td></tr>
<tr><td>Demand Cut</td><td>50 percent of the consumer’s current billing demand</td><td>Not applicable</td><td>50 percent of the consumer’s current billing</td></tr>
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					demand.
		Billing Cycle	As per consumer's current billing cycle.	Monthly	Solar energy to be adjusted on a 15 minute-basis.
		Banking	Excess energy allowed to be banked during a financial year, at the end of which excess generation will be paid at an appropriate tariff determined by concerned SERC.	Not applicable as complete energy is sold to the distribution licensee at the tariff determined by concerned SERC.	No banking allowed for third party sale of power. Any excess, unadjusted energy shall be purchased by the distribution licensee at the tariff determined by concerned SERC.
		Tariff	As determined by SERC from time to time.	As determined by SERC from time to time or based on competitive bidding using SERC's tariff as benchmark.	Mutually agreed between developer and consumer.
		Wheeling Charges	Not applicable	Not applicable	As per concerned SERC order
		Transmission Charges	Not applicable	Not applicable	As per concerned SERC order
		Wheeling Losses	Not applicable	Not applicable	As per concerned SERC order
		Transmission Losses	Not applicable	Not applicable	As per concerned SERC order
		Cross Subsidy Surcharge (CSS)	Not applicable	Not applicable	Exempted as a promotional measure
		Electricity Duty	Not applicable	Exempted	Exempted
		Renewable Energy Certificate (REC)	Consumer can claim REC for solar energy consumed by self and energy sold to distribution licensee at Average Power	Developer can claim REC if selling power to Distribution Licensee at APPC. (In addition, the	Developer can claim REC based on the provisions of relevant REC regulations.

			Procurement Cost (APPC). (In addition, the developer shall abide by all other provision as per the relevant REC regulations.)	developer shall abide by all other provision as per the relevant REC regulations.)	
		Renewable Purchase Obligation (RPO)	Distribution licensee can claim RPO if (i) consumed solar energy is not credited towards the consumer's RPO and (ii) no REC is claimed for the generated solar energy.	Distribution Licensee can claim RPO if no REC is claimed for the generated solar energy.	Distribution Licensee can claim RPO if (i) consumed solar energy is not credited towards the consumer's RPO and (ii) no REC is claimed for the generated solar energy.
		Clean Development Mechanism (CDM)	CDM is retained by the consumer.	CDM is retained by the developer.	CDM sharing is left to the developer and off taker.
14.	**Procedures**	It is important that the procedures are framed by respective DISCOMs and publicized upon notification of the policy.			
15.	**Technical Requirements**	1. Technical requirements such as metering and issues concerning grid integration are covered by the Central Electricity Authority (CEA) standards. 2. Regulations for solar rooftop systems are only applicable in case of grid-connected systems. The regulations may be either net/gross metering. 3. The Central and State regulators are guided by the National Tariff Plan, National Electricity Policy and Tariff Policy. 4. Any net/gross metering regulation should ideally consider the following clauses: • **Title, Scope and Application:** The regulation should clearly indicate the eligible consumer to whom and under what instances do the regulations apply. • **Applicable Models:** Gross Metering/Net metering/REC/Ownership Model. • **Capacity Limits and Interconnection Voltages** • **Procedure and Process:** Regulations do not need to contain a detailed process flow pertaining to application and approval process. • **Grid Connectivity, Standards and Safety:** Refer to CEA Grid connectivity Regulations • **Metering:** CEA Metering Regulations, 2010 • **Energy Accounting, Billing and Banking** • **Renewable Purchase Obligation (RPO), REC and other Green Attributes** • **Powers to Direct/Relax/Amend**			
16.	**Technical Standards and**	Rooftop PV systems are classified based on the following parameters: **1. Connectivity to the Grid:**			

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<td>Specifications</td>
<td>
Stand-alone PV systems are isolated from the distribution grid, and usually use standalone inverters with batteries.
Grid-connected PV systems (also known as grid-tied systems) are directly connected to the distribution grid, use grid-connected inverters, and usually do not use batteries.
Hybrid PV systems are connected to the grid and also have a battery backup.
Other grid-interactive PV systems are also evolving in India wherein PV systems are directly connected with uninterruptible power supply systems.

Metering Arrangement: Net Metering/Gross Metering
Interconnection Voltage: In case of direct interconnection with the grid, the following interconnection voltages are applicable:

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<tr><td>< 4 kW (or 5/6/7/10 kW in some States)</td><td>connected to the distribution grid at 240 VAC, 1φ, 50 Hz.</td></tr>
<tr><td>> 4 kW (or 5/6/7/10 kW in some States) but < 50 kW (or 75/100/112 kW in some States)</td><td>connected at 415 VAC, 3φ, 50 Hz.</td></tr>
<tr><td>> 50 kW (or 75/100/112 kW in some States) but < 1 MW (or 2/3/ 4/5 MW in some States)</td><td>connected at 11 kVAC, 3φ, 50 Hz.</td></tr>
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2. Capacity Limitations

Limited requirement of energy or the lack of shadow-free rooftop area.
Lack of a higher interconnection voltage (this can be enhanced through regulatory and/or DISCOM’s intervention).
Capacity of the PV system limited to connected or sanctioned load of consumer.
Capacity of the PV system designed to meet a particular RPO or SPO.

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<td>17.</td>
<td>Key Technical Considerations, Standards and Specifications</td>
<td>
CEA’s (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations, 2013 primarily govern the standards and guidelines.
These regulations refer to relevant IS issued by the Bureau of Indian Standards (BIS).
In case of absence of relevant IS, equivalent international standard should be followed in the following order: (a) International Electro-technical Commission (IEC), (b) British Standard (BS), (c) American National Standard Institute (ANSI), or (d) any other equivalent international standard.
IEC 60364, 1st Ed. (2002-05), “Electrical installations of buildings – Part 7-712: Requirements for special installations or locations – PV power supply systems,” is the primary standard for PV installations, safety and fault protection , common rules regarding wiring, isolation etc.
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<td>Electrical safety</td>
<td>
1. General: All PV systems should comply with the CEA’s (Measures Relating to Safety and Electric Supply) Regulations, 2010.
2. Anti-Islanding:

IEC 61727, 2nd Ed. (2004), “Photovoltaic (PV) systems –Characteristics of the utility interface” is a standard for PV systems rated for 10 kVA or less.
In case the system should ceases to energize the grid within 0.2 second if the grid frequency deviates beyond ±1 Hz of nominal frequency.
IEC 62116, 2nd Ed. (2014-02), “Utility-interconnected photovoltaic inverters – Test procedure for islanding prevention measures,” provides a test procedure to evaluate the performance of islanding prevention measures for inverters that are connected to the utility grid.

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		3. Earthing (or Grounding): • IS 3043-1987 (Reaffirmed 2006), “Code of practice for earthing,” governs the earthing practices of a PV system. • IEC 62109-1, 1st Ed. (2010-04), “Safety of power converters for use in photovoltaic power • systems – Part 1: General requirements,” defines the minimum requirements for the design and manufacture of Power Conversion Equipment (PCE) for protection against electric shock, energy, fire, mechanical and other hazards. • IEC 62109-2, 1st Ed. (2011-06), “Safety of power converters for use in photovoltaic power systems – Part 2: Particular requirements for inverters,” defines the particular safety requirements relevant to DC to AC inverter products as well as products that have or perform inverter functions in addition to other functions, where the inverter is intended for use in PV power systems. • The earthing conductor should be rated for 1.56 times the maximum short circuit current of the PV array. • In any case, the cross-section area or the earthing conductor for PV equipment should not be less than 6 mm2 if copper, 10 mm2 if aluminium or 70 mm2 if hot-dipped galvanized iron. • For the earthing of lightning arrestor, cross-section of the earthing conductor should not be less than 16 mm2 of copper or 70 mm2 if hot-dipped galvanized iron. • Resistance between any point of the PV system and earth should not be greater than 5 Ω at any time. **4. DC Overcurrent Protection:** The PV system is protected from overcurrent from the PV modules with the help of fuses at the string junction box. **5. DC Surge Protection:** The surge arrestors should be of Type 2 (with reference to Standard IEC 61643-1, “Low Voltage Surge Protective Devices”), rated at a continuous operating voltage of at least 125 percent of the open-circuit voltage of the PV string, and a flash current of more than 5 A. **6. Lightning Protection:** • Lightning protection installations should follow IS 2309-1989 (Reaffirmed 2010). • IS 2309-1989 (Reaffirmed 2010), “Code of practice for the protection of buildings and allied structures against lightning” govern all lightning protection-related practices of a PV system. **7. Ingress Protection:** All PV equipment, if installed outdoors, should have an ingress protection rating of at least IP65. **8. Labelling of PV System Equipment:** The labelling of a PV system should conform to IEC 62446 standard. **9.** IEC 62446, 1st Ed. (2009-05), “Grid-connected photovoltaic systems – Minimum requirements for system documentation, commissioning tests and inspection,” defines the minimal information and documentation required to be handed over to a customer following the installation of a grid-connected PV system.
	Electrical Quality	**1. DC Power Injection:** CEA’s (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations, 2010, stipulates that the distributed generating resource shall not inject DC greater than 0.5 percent of the full rated output at the interconnection point. **2. Harmonic Injection:** CEA’s (Technical Standards for Connectivity of the Distributed Generation Resources) Regulations, 2010, stipulate that harmonic current injections from a generating station shall not exceed the limits specified in

(Standard) IEEE 519.

Voltage Distortion Limits as per IEEE 519

Bus Voltage (V) at PCC	Individual Harmonic	Total Harmonic Distortion (THD)
V< 1.0 kV	**5 %**	**8 %**
1 kV <V< 69 kV	**3 %**	**5 %**
69 kV <V< 161 kV	**1.5 %**	**2.5 %**
161 kV <V	**1 %**	**1.5 %**

3. Phase Imbalance (or Unbalance): The DISCOM should always limit its voltage imbalance to less than 3 percent. It is recommended that DISCOMs should keep track of the PV capacity connected to each phase for troubleshooting any extreme cases.

4. Flicker: IEC 61000 is a set of standards on electromagnetic compatibility, which are subdivided into sections below:

- The environment from the EMC viewpoint and establish the compatibility levels that the distributors must guarantee.
- The emission levels into the networks and immunity levels of the appliances.
- IEC 61727, 2nd Ed. (2004), “Photovoltaic (PV) systems – characteristics of the utility interface,” stipulates that the operation of the PV system should not cause voltage flicker in excess of limits stated in the relevant sections of IEC 61000-3-3 for systems less than 16 A or IEC 61000-3-5 for systems with the current of 16 A and above.
- Power Factor:
- IEC 61215, 2nd Ed. (2005-04), “Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval,” outlines all the procedures for sampling, marking and testing of mono- and multi-crystalline silicon PV modules.
- IEC 61646, 2nd Ed. (2008-05), “Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval,” outlines all the procedures for sampling, marking and testing of thin-film PV modules such as amorphous silicon, cadmium telluride (CdTe), copper indium gallium selenide (CIGS), micromorph and similar technologies.
- IEC 62108, 1st Ed. (2007-12), “Concentrator photovoltaic (CPV) modules and assemblies – Design qualification and type approval,” outlines all the procedures for sampling, marking and testing of concentrator cell technologies and assemblies.
- In addition to one of the above-mentioned three IEC certifications, all PV modules should also be certified for IEC 61730 as a part of their safety qualification.

5. Performance Warranty: The globally accepted performance warranty commits less than 10 percent performance degradation in power output during the first 10 years and less than 20 percent performance degradation during the subsequent 15 years.

6. Workmanship Warranty: The typical workmanship warranty on a PV module is five years.

<table>
<tr><td></td><td>Mechanical and Workmanship Considerations</td><td>1. Inclination of PV Modules: The optimal angle of inclination of a flat plate solar collector (which also includes a fixed PV module) is very close to the latitude of the location of installation facing south for India.
2. Area of a Rooftop PV System: A rooftop PV system can take anywhere from 10 to 15 m^2 of area per kilowatt of installation depending on the angle of inclination of the PV modules.
3. Weight of the Rooftop PV System: The weight of a PV system (including the PV module and structure) does not exceed 30 kg per m^2.
4. Wind Loads: All MMS should be designed taking into consideration the wind loads at the location of installation and should consider the ‘wind speed zone’ of the location as per Indian Standard IS 875 (Part 3)-1987.
5. Material of Mounting Structure: Galvanized iron (GI) or aluminium is the most common material used for module mounting structures. In case of GI structures, the quality of galvanization becomes very critical to ensure a rust-free life of at least 25 years.
6. Penetration and Puncturing of Roof or Terrace: Penetration into or puncturing the roof or terrace for anchoring of MMS should be avoided as far as possible to avoid any water leakage-related issues.</td></tr>
<tr><td></td><td>Other Considerations</td><td>• Performance of a PV System
• Generation Guarantee
• Monitoring of a Rooftop PV System: This is generally done at the following levels- At PV Module-Level, At String-Level, At Inverter-Level, At Meter-Level.</td></tr>
<tr><td>18.</td><td>Technical Documentation, Drawings and Inspection</td><td>1. Technical Documents of the Rooftop PV System
• The inspection of a PV system may be guided by the IEC 62446 standard.
• The critical documents of the rooftop PV system include: Contact information of various stakeholders such as PV system owner, project developer, EPC contractor, designer, lending agency, etc, Datasheets of PV System, IEC certifications, Warranty documents, Design document of the module mounting structure, Warranty document of the entire rooftop PV system, Generation estimation report, Operation and maintenance manual, Test results, commissioning certificate, Purchase bills and contracting documents.
2. Drawings of a Rooftop PV System
The critical drawings of the rooftop PV system include:
• Single Line Diagram (SLD);
• Equipment layout diagram; and
• Wire and earthing layout diagram.
3. Inspection and Testing of a Rooftop PV System
• The inspection of a PV system may be guided by the IEC 62446 standard.
• The overall inspection activity of the rooftop PV system is divided into two parts: visual inspection and testing.
• It is also highly recommended to undertake such inspections via third-party inspection and testing agencies that specialize in such work.</td></tr>
<tr><td>19.</td><td colspan="2">Roles and Responsibilities of Key Stakeholders</td></tr>
<tr><td></td><td>The Policy-maker: State’s Energy (or Power) Department</td><td>The State’s Energy (or Power) Department is the proponent of the solar rooftop policy. Once the policy is launched, the Energy (or Power) Department should notify the other stakeholders including the SERC and the DISCOMs on their roles and responsibilities as well as the necessary action to be undertaken to implement the policy.</td></tr>
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	The Regulator: SERC	The regulator develops the necessary regulation addressing various provisions of the solar rooftop policy. Such a regulation would typically guide the interconnection process, tariff, banking, safety and similar concerns. The regulation may be developed *Suo Moto* or through the petition by any stakeholder.
	DISCOM	• The DISCOM interprets and implements the provisions of the policy and regulation, thereby allowing consumers to interconnect their rooftop PV systems to the grid. It should also be clarified here that the role of DISCOMs is only limited to PV systems interconnected to the grid (i.e. grid-connected and hybrid PV systems), and not stand-alone systems. The role of the DISCOM can be segregated based on the three phases of the overall solar PV rooftop programme implementation: • Preparatory phase of the programme: Budgetary approvals, Regulatory approval of process, systems and formats, Empanelment and procurement etc. • Application and approval phase of individual rooftop PV system: Screening of application, and preliminary technical and commercial approval by DISCOM, Inspection, meter replacement and commissioning of the PV system by DISCOM etc. • Operation and billing of individual rooftop PV system: Ensuring safety of the distribution network, Data Collection etc.
	SNA	Traditionally, SNAs have been the flag bearers of solar rooftop initiatives in India. Therefore, they have already developed: Technical capacities for solar rooftop PV systems, and Channels for promoting solar rooftop programmes through funds and subsidies.
	The Chief Electrical Inspector (CEI)	Main functions of the CEI: • Inspection and issue of statutory approvals for generator installations more than 10 kW and others under Rule 47-A of Indian Electricity Rules, 1956. • Inspection and approval of electrical installation in high rise buildings (of more than 15 meters height) under Rule, 50-A of Indian Electricity Rules, 1956. Hence, the CEI's involvement with respect to process is on two counts: • First, during approvals of drawing and design documents, and • Second, pre-commissioning inspection of the installed PV system for issue of the 'Charging Certificate'.
	The Consumer, Investor and Developer	The consumer would be responsible for the administrative paperwork for establishing and running the PV system including investment, availing loans, application to DISCOM, availing subsidies (if any), call for commissioning, operation, maintenance and other administrative and technical compliances.
	The System Installer	The system installer is appointed by the consumer or the developer to design, procure and construct the rooftop PV system.
20.	**The Interconnection Process**	• The interconnection process forms the heart of the engagement between the DISCOM and the consumer (or the solar rooftop PV developer). • A effective interconnection process is recommended, which is broadly divided into the following four steps and can be directly adopted by DISCOMs: **1. Application Submission by Consumer:** necessary details- ➢ Name and type of applicant, along with identity proof. ➢ Type of consumer, along with copy of latest electricity bill. ➢ Capacity of the intended solar rooftop PV system. ➢ The application fee, openly publicized by the DISCOM should ideally be a

nominal flat fee.

2. **Screening of Application and Preliminary Approval by DISCOM:**
   The DISCOM should undertake the preliminary screening based on the following:
   - **General Screening**
     - Verification of consumer details provided in the application form, and
     - Receipt of application fee.
   - Technical Feasibility:
     - Confirmation of the proposed capacity of the rooftop PV system based on the existing sanctioned load of the consumer and relevant regulatory guidelines.
     - Verification of technical feasibility of the proposed rooftop PV system based on the capacity of the relevant distribution transformer.
   - Upon successful screening, the DISCOM should intimate the consumer of Preliminary Approval within 7 (seven) days of acceptance of the application.
3. **Installation of PV System and Call for Inspection and Interconnection:**
   Once the consumer receives the Preliminary Approval, it can commence all its activities in a full fledged manner including:
   - Selection of a rooftop PV system installer (or developer), if not already selected, and awarding them the contract for installation (or project development);
   - Application for bank loans; and
   - Application for subsidies, which is usually through the system installer as they are also MNRE Channel Partners.

   Additionally, when the construction of the rooftop PV system is completed, then the consumer, with the help of the system installer (or developer) should undertake the following activities:
   - (If the PV system falls under the purview of the CEI, typically for capacities greater than 10 kW, then) Intimation to the Chief Electrical Inspector as per stipulated format for safety inspection and obtain a ‘Charging Certificate’ for the PV system.
   - (Once the Charging Certificate is obtained from the CEI, wherever applicable, then) Application to the DISCOM for interconnection and replacement from existing unidirectional meter to a bi-directional net-meter, i.e. commissioning.
   - This application should also consist of the necessary technical and administrative documents required by the DISCOM, such as: Covering letter, Drawings, Datasheets/specification, Certificates, Installer (or developer) information, (Optional) Bank loan information etc.
4. **Inspection and Commissioning of the PV System by DISCOM:**
   - Site visit and inspection to verify the installed PV system as per documents submitted; and
   - Replacement of the existing unidirectional meter with a bi-directional net-meter.
5. **Operation and Billing of Individual Rooftop PV System:**
   Once the rooftop PV system is successfully commissioned, the development phase of the rooftop PV system is complete.
   The DISCOM now has to focus on the following key activities:
   - Billing to the consumer as per the DISCOM’s net-metering terms, conditions and regulations;
   - It is also recommended for the DISCOM to observe and gather data on the performance (generation) of the PV systems, as this data would be very useful for future technocommercial planning as well as verification of the system data provided by the consumer.

<table>
<tr><td>21.</td><td>DISCOM’s Preparatory Processes</td><td>1. Delegation of Powers and Empowerment of Committee:
As rooftop PV systems are decentralized in nature, it is very important to delegate appropriate powers to nodal offices (Central as well as Sub-Division Level) in order to avoid any congestion in the administrative processes.
2. Budgetary Approvals:
Although any cost incurred by the DISCOM due to a solar rooftop programme can be passed through and loaded on the consumer, there will often be instances when it may cause a burden on DISCOM’s balance sheet and also on the State’s Exchequer. Hence, it is important to understand the financial implication of a solar rooftop programme on the DISCOM.
3. Regulatory Approval of Process and Formats:
Although the state may have a solar rooftop policy and regulation, the DISCOM should still get its administrative interconnection process, terms and conditions, schedules and formats approved by the SERC.
4. Integration with Existing Processes and Changes to Billing Software:
• There would be some new process and some modification in existing processes within the DISCOM, which should be defined prior to the launch of the rooftop PV programme. The new processes to be established within the DISCOM include:
• Keeping record of consumer applications for interconnection and its status up to commissioning,
• Keeping record of rooftop PV capacity allotted to (and commissioned at) each distribution transformer and overall PV capacity within the DISCOM’s network, and
• Accepting calls for inspection and interconnection, and assigning a team for the same.
5. Empanelment and Procurements:
• It is recommended for the DISCOM to have some control over safety, quality and economics of the rooftop PV system though such empanelment.
• Certain aspects and components, which may be empanelled based upon the DISCOM’s involvement and comfort level with the solar technology.</td></tr>
<tr><td></td><td>System Installers</td><td>• Install technically compliant and safe PV systems,
• Offer PV systems and services at a reasonable price and terms to the consumer,
• Follow all compliance norms of the DISCOM, and
• Educate and assist consumer with appropriate administrative processes.</td></tr>
<tr><td></td><td>Inverters</td><td>There are several technical considerations for the interconnection of a PV system, including safety (e.g. anti-islanding) and power injection quality (e.g. harmonic distortion, surge protection, DC injection, etc.), which are taken care of through the inverter.</td></tr>
<tr><td></td><td>Net-meters</td><td>• The DISCOM needs to ensure purchase of appropriate bi-directional net-meters for different capacities.
• It is also recommended to procure meters with communication ports such as RS-232/ 485 and standard protocols such as IEC 62056 or DLMS), so that such meters are also ready for functionalities that may be required in the near future such as remote meter reading and communication, energy prediction, energy audit, ToD tariff, etc.</td></tr>
<tr><td>22.</td><td>Capacity Building</td><td>The DISCOM engineers should be trained on:
➢ Solar technology, safety, standards and performance,
➢ Administrative processes for interconnection and reporting issues, and</td></tr>
</table>

		➢ Soft skills and customer relations. The system installers should be trained on: ➢ Technical requirements of the DISCOM, ➢ Compliance with administrative processes of the DISCOM, and ➢ Providing honest and reliable services to the consumer.
23.	**Information Dissipation and Publicity**	As a solar rooftop programme is also social in nature, it is equally important to educate the consumer regarding: • The solar technology, its possibilities and its limitation, • Investing in a rooftop PV system and its payback, • Selecting the right system installer, and with appropriate terms and conditions, • Administrative processes for establishing a rooftop PV system, and • Encouragement by the DISCOM to adopt rooftop PV systems.