Journal of Energy Research and Environmental Technology (JERET)
p-ISSN: 2394-1561; e-ISSN: 2394-157X; Volume 8, Issue 1; January-March, 2021; pp. 1-5

Solar PV Policy: Overview, Policies, Challenges

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Abstract: *Current commercialized solar cells possess the disadvantages of being harmful to the environment, lower efficiency and high maintenance problems, which has lead us to the possibility of utilizing organic photovoltaic cells that manage to curb all the mentioned problems. Solar photovoltaic rooftop has emerged as a potential green technology to address climate change issues by reducing reliance on conventional fossil fuel based energy. With a strong commitment to increase the renewable sources based energy capacity to 175 GW by 2022, India has a target to install 100 GW of solar energy capacity. Of this 40 GW would be the share of grid connected solar PV rooftop. These RTS systems are currently experiencing sluggish growth due to multiple technical, policy and regulatory, and financial hurdles encountered by them. The present study focuses on RTPV system development in India: it comprehensively maps and measures policy strengths at the sub-national scale.*

Keywords: *rooftop solar PV systems, policy strength, Solar energy, India, Rooftop PV, Policies.*

India is blessed with tremendous potential for PV energy production, however, tapping it is possible with meticulous planning and defining a policy framework. In the last five years, the solar industries in the country have started blooming rapidly with the implementation of solar policy by sixteen states. Revision of the state policies is needed as the country aims to achieve 100 GWp of solar capacity by the year 2022. Improving the state policy depends mostly on factors such as estimated PV energy potential of the region, availability of useful wasteland, and implementation cost. The study reviews and discusses the pitfalls of the current solar policy framework of sixteen states and identifies the challenges of the sector for achieving the targets.

1. INTRODUCTION

It is an established fact that utilization of renewable energies and resources such as wind, hydroelectricity, biomass, and solar is being encouraged globally as a quintessential priority. Currently, 75% of the total fossil fuels utilization is for heat and power production, while other 25% for transportation and fuel, and a very small proportion for chemicals and materials. In 2015, the PV market, with a 25% growth, broke numerous records and continued its worldwide expansion at 50 GW installation. After a limited development in 2014, the market restarted its evolution, throughout the world, with all regions of the world simultaneously contributing to PV growth for the first time. The total installed capacity at the end of 2015 globally amounted to at least 227 GW, which is ten times higher than in 2009. Currently out of the total electricity generation, approximately 3% is produced by solar PV power plants [1].

Looking inwards, India is having fourth largest electricity generation capacity in the world after the US, China and Russia. Its Renewable Energy (RE) share increased to 13.16% in 2015 with solar energy having a share of 11.62% in it. Between 2005 and 2015 the renewable grid connectivity has increased from 6.2 GW to around 36 GW for both solar and wind. As on June 2016 renewable based capacity became 43,727 MW in the total installed capacity of 303,100 MW [4]. In today's world, the topmost leaders of solar PV capacity are China, Germany, Japan, USA, and Italy with the total cumulative PV capacity of 43 GW, 39.6 GW, 33.3 GW, 27.3 GW, and 18.9 GW respectively [2].

India ambitiously targets to install 23 GW of solar capacity by 2016 on the background of slow PV growth seen in the last four years [4].

Being near the tropic of cancer, India possesses the vast potential for renewables like solar energy. Figure 1 shows the distribution of grid-interactive renewable power capacity in India. The installed capacity of wind power (62.6%) is highest followed by solar power (15.82%), biopower (11.3%), small hydropower (10%), and waste to power (0.27%). The Ministry of New and Renewable Energy (MNRE) decided to increase the total cumulative renewable power installed capacity in India to 175 GW by the end of 2022 [5]. By the end of March 2016, the total installed capacity of grid-connected renewable power in India reached 42.72 GW [6].

1.1 Development of solar energy in india

Rooftop PV systems are promising energy ventures for countries like India and possess huge future potential. A study by TERI (2016) revealed that the market potential of Rooftop PV systems in India stands at 124 GW. However, potential estimates by the National Institute of Solar Energy (NISE) indicate that the potential for Rooftop PV systems in India is around 42.8 GW, which was perhaps the basis for setting the target of 40 GW to be achieved by 2022.Year-wise targets as well as state-wise targets have been set by the Government of India for Rooftop PV systems.

While the year-wise targets (Figure 1) are set considering the current financial resource constraints and the ability to deploy Rooftop PV systems, the state-level Rooftop PV systems potential appears to have been apportioned based on the solar energy potential of the state as well as the proactive policy and regulatory framework that governs the sector.

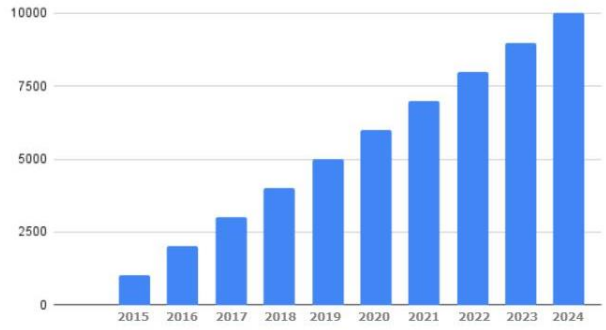

Figure 1: Year-wise Roof-top Solar Photovoltaic Target (in MW)
Source: Author's construct (Data collated MNRE).

Deployment statistics for Rooftop PV systems show that in fiscal year 2018–2019, a capacity of

1836 MW had been added to the Rooftop PV systems segment. Total cumulative capacity of about 4375 MW had been deployed by the end of March 2019 (Bridge to India 2019), of which 3066 MW was installed in the commercial and industrial Rooftop PV systems segment and 690 MW in the residential sector, while the remaining 619 MW was installed by government agencies. These interventions appear to be more suitable for commercial and industrial consumers, which prefer larger size systems, so, over time, the average size of Rooftop PV systems has increased, with close to 30% having a capacity of more than 1 MW. Within the industrial sector, the manufacturing sector is emerging as the biggest consumer constituting about 14% of the total share, followed by infrastructure and real estate at 9%, education at 8%, and automotive at 7%, while textiles 7% and other sectors constitute the rest of the market share (Bridge to India 2019).

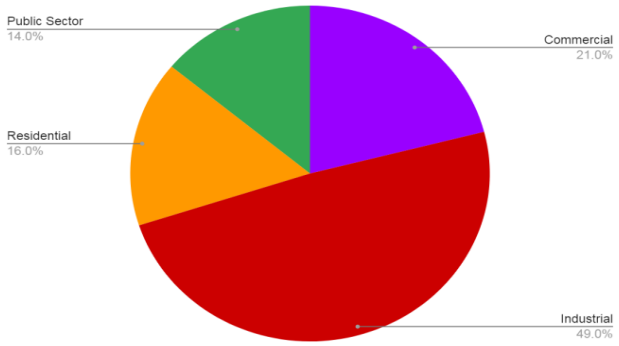

Figure 2: Total Installed Roof-top Solar Photovoltaic Capacity Deployed as of 31 March 2019
(Data Source: Bridge to India).

1.2 Development of Policies about Rooftop PV System in India

The origin of rooftop PV system development in India can be traced back to the declaration of the Jawaharlal Nehru National Solar Mission (JNNSM) in 2010; the initial target was to deploy 2,000 MW of rooftop PV system by 2022. The target as revised in 2015, and a new target of installing 40,000 MW was set to be achieved by 2022. The emphasis was set on demonstrating the relevance and importance of rooftop PV system projects for meeting the country's energy needs. The first set of rooftop PV system incentives, structured around 2010, was to provide generation-based incentives (GBIs) for the deployment of. In 2012, a net metering policy was introduced for the first time to accelerate the development of rooftop PV system. Under this scheme, the excess generated energy was fed into the grid, and the owner was credited for every unit of this energy. However, it was realized that the sector was not gathering the desired momentum and there was a need for additional stimulus. A phase-wise development plan was then anticipated for rooftop PV system development.

Phase I of RTS development received approval from the Government of India in 2015 with the declaration of the "Grid Connected Roof-top and Small Solar Power Plants Programme." The goal was to install 4,200 MW by 2019–2020, of which 2,100 MW would be deployed through the Central Financial Assistance (CFA) and the remaining 2,100 MW would be installed without funding support. Provision of "AchievementLinked Incentive/ Awards" was introduced in 2016 as part of this program, and the budgetary provision accordingly increased from 6,000 Million INR (in 12th Five-Year Plan (2012–2017) to 50000 million INR for the five-year period ending in 2019–2020; 30% of the benchmark costs was provided through CFA. Performance statistics reveal that a total of 2158 MW of RTS was installed by December 2018. Recognizing that Phase I of the RTS scheme did not show as much promise as expected, Phase II was announced. It has been reported that the slow growth of rooftop PV system in

the phase I was primarily due to a lack of interest among distribution utilities in combination with a lack of necessary finance to support rooftop PV system interventions.

In Phase II, rooftop PV system development received a further boost with the introduction of the Sustainable Rooftop implementation for Solar Transfiguration of India (SRISTI) scheme in 2017, which aimed to give much-needed impetus to rooftop PV system use. The Government of India approved the scheme in February 2019. In Phase II, it was projected that a total capacity of 38,000 would be deployed, of which 4,000 would be deployed through Residential rooftop PV system, and the remaining 34,000 would be through social, government, educational, PSUs, Statutory/Autonomous bodies, Private Commercial, and Industrial Sectors, among others. CFA (up to 40% the benchmark cost of the rooftop PV system of 3 kWp and 20% of the benchmark cost of RTS system with capacity between 3 kWp and 10 kWp) was provided only to the residential sector. A total budgetary allocation of 66,000 million INR was earmarked for the residential sector. Distribution utilities were also incentivized to install rooftop PV system for social, institutional, and government buildings along with commercial and industrial consumers in their distribution zone. Incentives for distribution utilities were designed by setting the baseline and achievements beyond the baseline for a total target up to 18 GW. Finally, a 10% incentive would be provided if the achievement was beyond 15% of the benchmark. INR 49500 million was kept as CFA to incentivize distribution utilities (MNRE 2019).

Many policies have been developed at the sub-national scale to promote rooftop PV system in each state. Almost all states have come up with net metering policies, with differing provisions to drive rooftop PV system. However, net metering policies have unfortunately been withdrawn in certain states for commercial and industrial consumers, (e.g., which generate negative impacts on future installed capacity). For instance, Maharashtra, Tamil Nadu, Uttar Pradesh and Rajasthan have plans to end the benefits of net metering to consumers. In Maharashtra, Uttar Pradesh, Rajasthan, and Tamil Nadu, for example, net metering benefits are only for residential and agricultural consumers. Interestingly, several states have taken proactive policy initiatives in driving RTS systems. Indeed, efforts at the state level even go beyond the streamlined efforts undertaken at the federal scale. The key policy initiatives undertaken by the states are worth considering. For instance, the solar policy of Gujarat declared in 2009 specifically mentions the importance of rooftop PV systems, and the state declared an innovative initiative called ‘rent-a-roof program’ in 2010 in this regard, which was supported by the IFC. An FiT of INR 11.21 was provided to procure solar electricity generated through Rooftop PV systems. A PPP model was designed for the operation of the interventions.

Initially, two energy companies, Azure Power and SunEdison, were provided roofs on a lease basis for 25 years. Companies were required to pay USD 0.05 per unit of energy produced to the roof-owner. In return, the companies received USD 0.18 from the state government for every unit of energy fed into the grid. This initially started with two cities in Gujarat (Gandhi Nagar and Vadodara), and the model was further extended to another five cities. Similarly, in Tamil Nadu, along with CFA, the state government also provided subsidies of INR 20,000 per kWh for individual applicants for up to 1 kWp for grid connected rooftop PV systems for the residential sector. The government of Odisha also plans to deploy 15 MW of installed capacity through rooftop PV by identifying 900–1,000 buildings in seventeen cities across states. This is in addition to 4 MW of rooftop PV systems deployed in the twin cities of Cuttack and Bhubaneswar. Technical support was provided by IFC, and a PPP arrangement was made to deploy the rooftop PV systems. Several other states have employed other innovative models of deploying rooftop PV systems..

WHAT ARE THE CHALLENGES AND SOLUTIONS

Despite the efforts to incorporate rooftop PV system into the mainstream energy sector in India, this process has not been wholly successful due to policy quandaries, ill-designed institutional and governance structures, distorted market mechanisms (e.g., poor contract enforcement systems), and technical challenges such as those involving grid connectivity. A related and yet quite pertinent aspect is that the push so far has been on the supply side of these interventions, without giving adequate weight to demand related concerns. Most importantly, there is no adequate understanding of how the existing intervention types are performing in varying policy, regulatory, and governance environments [18]. In this section, we attempt to capture some of the persistent challenges and offer a way forward.One of the first sets of challenges is associated with policy-level inconsistencies. Poor and piecemeal implementation of net metering policies at the sub-national scale is a major roadblock for the uptake of rooftop PV in India. Most of the state regulations on net metering set the maximum capacity limit at 1 MW per metering point for rooftop systems to be connected to the distribution grid, which hinders large-scale deployment. Often this capacity ceiling is imposed based on the poor financial health of the distribution utilities. The current policy framework is thus obstructive, and these arbitrary caps hinder the uptake of rooftop PV.

Although rooftop PV requires bottom-up approaches through consumer engagement and participation, the current regulatory and policy regime has been structured in a top-down manner with a uniform set of policies and regulations for all types of interventions [6]. The most recent evidence of such policy-level obstruction is the withdrawal of net metering policies in certain states for commercial and industrial consumers, such as in Uttar Pradesh, where it would generate negative impacts on the

adding capacity. Similarly, other states like Maharashtra, Tamil Nadu,and Rajasthan, have plans to reduce net metering benefits for consumers, while in states like Maharashtra, Uttar Pradesh, Rajasthan, and Tamil Nadu, net metering benefits are only for residential and agricultural consumers.

Another challenge is very much connected with the poor information available to consumers about the benefits of rooftop PV. The existing information asymmetry is a major challenge for the large-scale uptake of rooftop PV projects, especially in the residential segment. Poor understanding and information of the benefits of rooftop PV by users have become the prime reasons for unwillingness to deploy such systems. In one study surveying five Indian cities, it appeared that close to 50% of respondents were unaware of rooftop PV technology and their applicability in household context. Low awareness has been found to be a major hurdle for the uptake of rooftop PV[6]. In addition to the general information asymmetry, there is also a substantial lack of knowledge about the specific products, processes, and approval systems inherent with these systems.

Lack of credible and objective sources of information has led to consumers relying on vendors for information. Spreading the message about the benefits of rooftop PV widely has been recognized as necessary to accelerate its uptake and increase access to the incentives provided by the government.

This lack of information is further compounded by the high upfront capital cost to deploy these systems, as these are often not within reach of the larger section of the society. Although there has been a dramatic reduction of cost for RTS in recent years, the initial cost continues to be a major hurdle even for small projects. The lack of necessary financing for the sector does not help. Banks and financial institutions are reluctant to lend funding for these projects due to their small scale. It is reported that, traditionally, banks charge a high interest rate to developers (10%–12%, or up to 14%) depending upon the associated risks, nature of the project, and credit rating of the borrower.

Lack of technical capacity often acts as a barrier to scaling up these interventions, particularly in rural settings. The needed market eco-system has not been created, and the much-needed supply chain has not yet been established. Although there have been dedicated Government of India funds allocated for capacity building, implementing agencies (i.edistribution utilities) have not been active in playing the needed role to build that capacity. State Wise Policy A detailed mapping of rooftop PV policy making in India reveals that heterogeneous approaches exist in the emphasis for rooftop PV development and rooftop PV policy making at the sub-national scale. This is due to the varying energy potential of states, coupled with differing levels of willingness and ability of state level entities to drive the sector. In this context, the present section maps a detailed analysis of net metering policies declared by various states.

A cursory glance at the key elements of net metering policies reveals that most states do have such policies, but these policies vary significantly in terms of content,structure, and operational modalities. Variations are observed in terms of (1) amendments introduced, (2) capacity of rooftop PV systems allowed under the net metering schemes, (3) declaration of maximum capacity to be connected to the grid, (4) total capacity to be connected to the transformer, (5) export of electricity to the grid compared to self-consumption, (6) billing period for settlement, (7) compensation period for surplus, and (8) compensation for surplus. In terms of net metering permission, almost all states set an upper limit of 1 MW, although variations exist; similarly, the minimum capacity set is 1 kW, although differences can be found across states: West Bengal, for example, has set the minimum capacity of 5 kW.

Similarly, maximum capacity for sanctioned load largely varies from 50% to 100% of the sanctioned load. Varying limitations on transformer capacity are particularly noteworthy. In most cases, it is less than 50% of the transformer capacity, although in some states it is close to 100%. For instance, Jharkhand allows deploying rooftop PV capacity up to 100% of the transformer capacity, while Tamil Nadu has provisions for allowing rooftop PVcapacity up to 90% of the transformer capacity. Another crucial policy provision concerns the export of electricity allowed compared to consumption. Most states allow export above 100% of consumption, although in some states this threshold is set above 90%. In most states, the billing period is monthly and the compensation the period is set as yearly, again with differences across states. Compensation for surplus is of largely two types: either through average power purchase cost (APPC) or a tariff determined by the state electricity regulatory commissions (SERCs).

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