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Insights into India's Solar Rooftop Market

IFC has released a White Paper on Grid-Connected Rooftop Solar PV Development Models. Energetica India highlights the Indian market for the readers and also speaks to Ms. Isabel Chatterton, Regional Manager, PPP Transaction Advisory Services, IFC South Asia; to gain more insights into the report.

Indian presence on the global solar energy scene started in 2008 with the launch of the Government of India's National Action Plan on Climate Change (NAPCC), which stressed the need for widespread diffusion of renewable energy technologies in India with specific focus on solar energy.

Recognizing the wide availability of solar resources in the country and the range of applications possible, the government of India identified development of solar energy as a thrust area to enhance India's energy security and combat climate change. The Jawaharlal Nehru National Solar Mission (JNNSM) was launched under the NAPCC to significantly increase the share of solar energy in India's energy mix. Launched in January 2010, it encouraged a number of states, including Gujarat, Karnataka, and Rajasthan, to develop their own solar energy policies. Today, JNNSM and the Gujarat state solar policy are key initiatives leading the way for solar development in India.

As a result of those policy efforts, India has added over a gigawatt capacity of solar energy in the last three years and has reached an installed capacity of 2,632 megawatt. The government of India plans to add around 20 gigawatt of solar power generation capacity over the next decade. The draft guidelines for JNNSM's second phase set a target of 1,000 megawatt of rooftop projects both at off-grid and grid-connected levels during 2013-17.

MNRE launched a pilot scheme in 2013 for grid-connected rooftop PV power projects, which is being implemented by the Solar Energy Corporation of India. The scheme allows system sizes from 100kW to 500kW and aggregation of capacity from smaller roofs. Under the scheme, 30 percent of the cost is provided as subsidy and 70 percent is to be met by the consumer, with surplus solar power to be fed into the grid. India has decided to follow the dual path approach by provisioning schemes and programs that encourage development of large scale grid-connected projects as well as small and medium

Parameter	Type	Capacity target	Incentives for rooftop owner	Metering
Gujarat	Grid-connected	5 megawatt in Gandhinagar	Incentive linked to rooftop solar power generation	Gross
Karnataka	Grid-connected	250 megawatt	Tariff of Indian rupees 3.40 ($0.06) per kilowatt hour	Net
Tamil Nadu	Grid-connected	350 megawatt	Generation-based incentive of Indian rupees 2 ($0.03) per kilowatt hour for the first two years; Indian rupees 1 ($0.02) per kilowatt hour for the next two years and Indian rupees 0.50 ($0.01) per kilowatt hour for subsequent two years	Net
Andhra Pradesh	Grid-connected	-		Net
Uttarakhand	Grid-connected	5 megawatt	Feed-in tariff of Indian rupees 9.20 ($0.15) per kilowatt hour	Net
Kerala	Grid-connected	10 megawatt	Indian rupees 93,000 ($1541.52) per 1 kW system	Net

Table 1: Select state rooftop solar policies and targets for rooftop solar power generation:

State	Large grid-based solar PV tariff (not availing AD)	Rooftop solar PV tariff (not availing AD)	Large grid-based solar PV tariff (availing AD)	Rooftop solar PV tariff (availing AD)
Gujarat	INR 9.64 ($0.16)	INR 11.57 ($0.19)	INR 8.63 ($0.14)	INR 10.36 ($0.17)
Madhya Pradesh	INR 15.35 ($0.25) (for plants > 2 megawatt)	INR 15.49 ($0.26)	INR 14.38 ($0.24) (for plants > 2 megawatt)	INR 14.08 ($0.23)
Maharashtra	INR 8.98 ($0.15)	INR 9.48 ($0.16)	INR 7.69 ($0.13)	INR 8.19 ($0.14)

Table 2: FIT framework for ground-based and rooftop-based solar project development (applicable in fiscal year 2013).
*AD–Accelerated Depreciation: The Indian government allows for accelerated depreciation at the rate of 80 percent on a written-down value basis for various renewable energy items under Section 32, Rule 5 of the Income Tax Act. Accelerated depreciation is limited to solar and, in some cases, biomass projects across India.

ground-mounted and rooftop-based projects. Although national and state policies have successfully kick-started the development of utility scale solar power projects in India, the small-scale segment is still in a nascent stage of development.

In 2010, the Gujarat government initiated its rooftop solar program and chose Gandhinagar to be developed as a model solar power city. To achieve this goal, it decided to promote the development of distributed rooftop-based solar PV projects, and to start with a pilot project in that city. The state implemented two pilot projects through a public-private partnership (PPP) route to prove concepts, India. The scheme allows system sizes from 100kW to 500kW and aggregation of capacity from help firm up policy and regulatory frameworks, and develops a potential developer base. These pilot PPP projects are envisaged to lead market transformation towards self-replication of rooftop projects in the city, and beyond. Following its success in Gandhinagar, the Gujarat government is in the process of scaling up the initiative in five cities across the state, namely, Bhavnagar, Mehsana, Rajkot, Surat, and Vadodara.

Besides Gujarat, no major grid-connected rooftop solar PV projects of megawatt scale have been implemented in India, despite provisions being made in states' tariff orders for rooftop solar systems. However, a few initiatives have been launched recently in this market. Rooftop solar PV deployment in India is impacted by the lack of distinct policy and tariff frameworks that address specific requirements of the sector vis-à-vis large grid-connected MW-scale projects. Solar power is primarily used to meet renewable purchase obligations of distribution utilities, either through a feed-in tariff or competitive procurement based on auctions.

International experience indicates that rooftop solar PV installations have played a significant role in solar capacity development. For example in 2011, 60 percent of all solar generation capacity added in Germany was through rooftop solar projects. Today, German rooftop solar installations number more than one million. Likewise in Japan, the solar program has grown primarily through rooftop installations and more recently by incorporating solar cells into the façades of buildings, complementing or replacing traditional view or spandrel glass.22 Some of the key factors supporting the expansion of rooftop solar PV installations are:

- The sector's ability to proliferate under conducive policy and enabling regulatory environments
- The absence of land-related issues
- The ability of rooftop solar PV projects to feed directly into load centers, thus reducing transmission and distribution losses and avoiding costly transmission evacuation infrastructure

National and State-Level Policies

In June 2010, MNRE launched the 'Rooftop PV and Small Solar Power Generation Program' (RPSSGP) to provide incentives for both ground-mounted and rooftop-based solar projects. To date, all installed capacity under this program has been developed through ground-mounted projects, and unlike grid-connected large utility-scale projects and small-scale decentralized distributed generation projects for rural electrification, rooftop solar PV installations have seen only limited development.

With JNNSM identifying rooftop as a separate segment, several states have integrated rooftop solar PV into their state policy frameworks. This is summarized in table 1.

Despite significant thrust given to rooftop solar in policy frameworks in Rajasthan, Tamil Nadu, Karnataka, and Madhya Pradesh, and successful initiatives in Gujarat, Karnataka, and Tamil Nadu, these policies do not outline a clear roadmap. As a result, there is no detailed implementation framework, including permit mechanisms, technical codes, and commercial arrangements. In-

dia's rooftop solar PV potential thus remains largely unexploited due to these deficiencies in the enabling environment.

The Central Electricity Regulatory Commission issued draft tariff guidelines for rooftop solar PV plants (projects of capacity of less than 2 megawatt) in June 2010. Several state electricity regulatory commissions issued orders that put the tariffs

Energetica India catches up with Isabel Chatterton, Regional Manager, PPP Transaction Advisory Services, IFC South Asia

Energetica India: What impact has the shift of solar PV manufacturing base to Asia created across the globe; especially for rooftop solar?

Isabel Chatterton: Countries globally are faced with climate change and energy security concerns. Estimates indicate that over 700 million people across South Asia do not have access to electricity. There is a significant need to eradicate energy poverty in developing economies by focusing on both grid-connected and off-grid energy through innovative and market transforming initiatives.

In the past few years, there has been a shift from developed to developing economies in the use of renewable energy. Developing regions like Asia are increasingly turning to renewable energy sources to sustainably meet their energy needs. Globally, we've seen a dramatic increase in solar PV manufacturing capacity and an increasing shift of such facilities from high-cost developed countries to low-cost economies in Asia. Some of the world's largest solar manufacturing firms are Chinese–they have the led the boom in solar PV manufacturing over the last decade.

Increases in economies of scale, new manufacturing techniques, use of new materials and lower labour costs have led to a decline in solar PV production costs by upto 90%.Thesecost reductions have created opportunities for solar developers to promote solar PV as a viable and, in some countries, competitive source of power.

Energetica India: Which are the leading rooftop solar PV countries, w.r.t implementation? Please help explain the reasons

Isabel Chatterton: Growth in small rooftop and other small-scale PV installations have been successfully implemented in markets such as Germany, Spain, Japan and the U.S. These markets have developed their

rooftop solar PV sector using a combination of government subsidies and attractive feed-in-tariff regimes amongst other incentives.Germany have the world's largest share of small-scale PV installations. Japan, Australia, Italy, and the U.S. are other countries with significant shares of rooftop solar PV installations.

Energetica India: What are the benefits of rooftop solar PV compared to large sized solar on-ground PV projects?

Isabel Chatterton: There are many benefits to a rooftop solar PV system over a utility scale ground mounted PV installation.

Rooftop solar PV systems can be permitted and installed faster than most ground-mounted systems as interconnection and site eligibility norms for rooftop systems are easier to execute. These systems provide a clean, quiet, and visually unobtrusive power source and also improve the reliability of power supply without the need to establish long-distance transmission lines associated with large-scale solar generation plants.

Rooftop solar PV systems on unused rooftops can also lead to potential savings on grid electricity consumption and income generation. In some models, third-party developers lease rooftops from building owners, which provides long-term rental income.

Generally, large projects face significant hurdles and delays due to land acquisition as well as clearances and approvals from various authorities. In India, for example, several authorities across village and state levels need to be consulted for land-related approvals. In comparison, rooftop solar PV projects require relatively few clearances; projects are usually permitted through automatic standard provisions in most countries. Site selection and related clearances under building by-laws can also be standard rather than project-specific.

Clearly, rooftop solar projects are easier to permit and simpler to develop.

Energetica India: What kind of challenges does the growth of rooftop solar PV face on a general global basis?

Isabel Chatterton: A key barrier in most developing markets is the lack of clear capacity targets for grid-connected rooftop solar PV development. In India for instance, while the Jawaharlal Nehru National Solar Mission provides an enabling framework, a definite roadmap needs to be outlined to ensure implementation.

Furthermore, several states in India need to strengthen regulatory frameworks for net-metered rooftop solar PV projects.

Finally, attractive financing options for rooftop owners are also needed to make such projects more viable.

Energetica India: Which implementation rooftop solar PV model works best for India? Please help explain the reasons

Isabel Chatterton: There is no silver bullet to the development of the solar PV sector in India. Along with utility-scale solar PV projects, rooftop solar PV can play an important role in addressing India's energy needs.

While feed-in-tariff models for rooftop solar PV have been piloted, long-term rooftop availability remains a key risk for private developers in such models. Leasing private rooftops for 20-25 years is difficult since rooftop owners are not willing to

for large ground-mounted projects at par with those of small-scale rooftop solar PV projects. However these uniform tariffs do not adequately reflect the cost difference between the two types of installations and tariff expectations. State regulators have begun to acknowledge this difference, and have specified differentiated tariffs accordingly. Table 2 summarizes differen-

commit to such long term leases. Further, state electricity utilities are reluctant to buy power from such projects due to the higher costs.

Net-metering may offer an alternate and practical option to rollout the rooftop solar PV model across India. Energy generated by such projects is first consumed by the consumer and the surplus is sold to the utility at the prevailing retail tariff. The energy sold is setoff against consumption from the grid. This is a more palatable model, and the cost of such power is equivalent to the prevailing retail tariff for that consumer. From a consumer's perspective, there are savings in electricity bills.

If a private developer is able to aggregate several rooftops, the installation costs are reduced, making such projects more attractive for the developer and the consumer. Alternate sub models allow for ownership of the rooftop solar PV modules by the consumer while the developer carries out operation and maintenance only. Flexible lease arrangements with adequate compensation clauses can be developed allowing flexibility to both the consumer and developer.

Energetica India: What are the policy suggestions for the Indian government to further encourage the growth of rooftop solar PV in India?

Isabel Chatterton: For the grid connected rooftop solar market to take off in a significant way, the regulatory framework must be established to complement India's ambitions on solar energy. The national regulator and some state regulators have put forward favourable policies like net-metering and/or feed-in-tariff. This is the basic building block of a favourable enabling environment. Ensuring that this policy framework is enforced will be central to ensuring the rapid growth of solar rooftops in India.

Government also need to communicate the potential and feasibility of solar rooftops.All stakeholders need to be aware of its opportunities, potential, and viability. For instance, in the IFC supported solar rooftops project in Gandhinagar, Gujarat, authorities developed a communication platform. This included a website,easily accessible facilitation centres, and extensive media campaigns.

Additionally, state and central governments, utilities, different equipment suppliers, project developers, financial institutions and consumers all have key roles to play to develop an ecosystem for the market to mature. For instance, on the utility side, there has to be clarity in various permitting provisions, safety provisions, and allowable technical configurations. Equipment vendors should also be willing to undertake performance related risks over the medium-term until the consumer is confident.

Consumers now have greater understanding on how electricity is priced, and based on the trend, they are likely to participate in the project. Clear regulatory signals on commercial and long-term pricing could go a long way in building confidence.

Energetica India: For grid connected rooftop solar PV plants, what kind of grid connected issues does India face? How can we cross this hurdle?

Isabel Chatterton: Together with a supportive regulatory framework, appropriate project initiatives supported by adequate fiscal incentives can send a strong signal to catalyse the rooftop solar market in India and move it to a mature self-replicating phase as grid parity is achieved.

The net-metering model of rooftop solar implementation has helped bring citizens, corporates and other stakeholders together to support the green energy revolution in India. By developing policies like specific economic incentives to attract stakeholders to install solar panels on rooftop spaces; consume solar energy and sell any surplus energy to the grid, the sector can easily be prioritized by the government. Recognizing quality rooftop solar developers in a transparent manner could also help.

Also, an analysis of available rooftop space in respective jurisdictions could be taken up by states to allow developers and investors to estimate the potential, and then approach rooftop owners in a targeted fashion. Defining standards for net meters clearly will also help avoid any technical snags in the development of this model.

These insights are captured in a comprehensive white paper by IFC which was launched recently by Mr. Tarun Kapoor, Joint Secretary for the Ministry of New and Renewable Energy, Government of India at the prestigious Inter Solar'14 in Mumbai.

Energetica India: How easy is it to finance a self owner rooftop solar PV plant in India, as of today?

Isabel Chatterton: Rooftop solar is probably the only way in which a household in India, can generate energy to meet, at least partially, its own electrical energy needs. All distributed sources can contribute positively to energy security, and among them rooftop solar is probably the most important due to the ease of reliability.

However, there are no central or state government schemes which promote attractive financing options for purchasing and installing rooftop solar PV modules on private rooftops. Given the high interest rates, it becomes unattractive to implement such projects due to poor returns– even for commercial rooftop owners who pay electricity tariffs close to, or higher than, solar PV generation costs.

For a rooftop owner, the key benefits of a rooftop solar system are the utilization of idle rooftop space to generate power, reduce electricity expenses, and provide additional revenues from the sale of power or from roof rentals.

If the price of solar modules declines further, and innovations and mass deployment of energy storage technology continue, rooftop solar can play a significant role in India's quest for energy independence

tiated tariffs in the three states that have recognized this difference, namely Gujarat, Madhya Pradesh, and Maharashtra.

Rooftop solar projects in India started as captive projects, most availed capital subsidies from the government. In almost all cases, solar developers played the role of engineering, procurement, and construction (EPC) contractors, and still do.

However, it did not witness the growth of the ground mounted segment. More recently, different models where energy is fed into the grid availing benefits other than capital subsidies have started to emerge. The rooftop solar program of Gujarat is one such. Here the concept of "feed-in tariff" based on "gross-metering" as an incentive has been introduced for the first time in India. The project has shown that the private sector can perform the long-term role of a developer–in addition to engineering, procurement, and construction roles–when facilitated with the appropriate framework.

Andhra Pradesh, Tamil Nadu, Karnataka, and Uttarakhand have also drafted state-specific regulations and guidelines including enabling provisions that encourage the private sector to further this role. Recently, the Forum of Regulators proposed a draft model regulation on net metering. It provides for a consumer or a third-party player to develop a rooftop solar project without open access or wheeling charges. A conducive policy and regulatory framework is therefore emerging, which is attracting more private players to the market. Many private developers, recognizing the opportunity to diversify into a profitable business, have increased their participation in rooftop solar projects. The Solar Energy Corporation of India has invited bids in three phases to develop rooftop solar project across the country under gross metering or captive schemes. This is attracting the private sector.

The proof-of-concept stage is most critical to pave the way to sustainable large-scale development. For this, India can rely on several demonstration and pilot rooftop solar projects that have, in the last few years, established technical feasibility for both captive and grid-connected systems with the participation of private sector players. Table 8 presents projects which contributed to proving sustainability of the

concept. Apart from these, nodal agencies in states such as West Bengal, Punjab, and Gujarat have successfully deployed captive rooftop solar PV systems on government buildings.

Barriers to Rooftop Solar Development in India

Several barriers constrain the development of rooftop solar projects in India. The first phase of JNNSM did not result in any rooftop solar project in spite of a separate scheme for small-sized and rooftop projects. This scheme addressed solar PV projects of a maximum of 2 megawatt on ground or rooftops. The scheme had a maximum capacity limit of 100 megawatt and around 90 megawatt of projects was installed. The projects were to be connected at 33 kilovolt and similar tariffs were fixed for both ground-mounted and rooftop projects. The scheme garnered enthusiastic response in the ground-mounted segment, but almost none in the rooftop segment. Similarly, while solar tariff orders in several states provide for grid-connected rooftop projects, not many have been taken up. Since the same technology and systems are used for both ground-mounted and rooftop projects, the lack of inclination towards the rooftop projects clearly shows that regulatory and grid interconnection issues are hindrances to deployment.

Non-recognition of the Capital Cost Difference and hence Lack of Optimized Feed-in Tariff

The JNNSM scheme fixed similar tariffs for both ground-mounted and rooftop projects. The tariffs were based on notified tariffs of the Central Electricity Regulatory Commission, valid for that year (2010-2011). The Central Electricity Regulatory Commission specified tariff was for solar PV technology, irrespective of mounting system, ground or rooftop. The Gujarat Electricity Regulatory Commission GERC on the other hand, realistically provided different capital costs and tariffs for rooftop projects. The capital costs for rooftop projects was considered a little higher and led to higher tariffs for rooftop projects.

Regulatory Uncertainty with Reference to Net Metering

The ambiguous regulatory framework and the absence of technical guidelines to connect small-scale distributed power generation systems into the grid acted as a barrier to extensive deployment of net metering systems. The net metering arrangement conflicts with some legal clauses in the Electricity Act 2003, including regulations on captive generation and consumption, open access, and renewable purchase obligations. These needed to be addressed through a separate regulation on net metering that was issued in August 2013 by the Forum of Regulators (draft model regulation for rooftop solar grid interactive systems based on net metering). Moreover, net metering requires implementation standards for important parameters like voltage, flicker, synchronization, islanding, and protection.

The Central Electricity Authority of India issued a draft regulation on interconnection of small-scale generating systems with the grid late in 2012, which was notified recently. The inability of utilities to pay for excess electricity being fed into the grid is a big issue. The result is generation that is sized exclusively to meet individual building demands, not to meet the overall demands of the system.

Lack of Sustainable Business Models

Although the technology for rooftop solar systems is well proven, the market lacks sustainable business models. Individual households as well as commercial rooftop owners lack knowledge, information, and financial incentives to install these systems to optimal standards. India lacks pilot projects developed jointly by public and private sector, to serve as proof-of-concept to encourage future segment growth

Source: Harnessing Energy from the Sun: Empowering Rooftop Owners; White Paper on Grid-Connected Rooftop Solar PV Development Models; IFC and NTFPSI.

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