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Solar Rooftop PV Systems- Markets, Policies and Future Potential

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Abstract - *Reduction in greenhouse gases and providing environmentally friendly power is on agenda of Indian government for a very long time. The key is to harness the power from the sun and reduce dependency on fuel for electrification of the country. To achieve this the country has set an ambitious target of installing 40GW of grid connected solar rooftop power by 2022. However, there is significant scope for accelerating adoption of rooftop solar but the need of the hour is to address barriers hampering the growth of solar rooftops across the country. The purpose of this paper is to review polices and schemes laid down by government of India for development of Rooftop solar plants on vacant roofs of residential consumers along with the analysis of barriers and challenges which hampers the growth of this sector. Finally, a business model is conceptualized to overcome the issues identified.*

Key Words: *Business Model, Solar Rooftop PV systems, Barriers and Challenges*

1. INTRODUCTION

Providing energy sustainable solutions and 100 percent electrification is one of the major commitments of government of India to its more than billion consumers. To meet this commitment the government is looking for a basket of energy resources throughout the country. In current scenario, solar energy source is a best choice because it is abundantly available across the country and is free of cost. The country is facing lot of challenges when it comes to electrification of billions of households, nevertheless we have variety of other reasons to worry such as depletion of conventional sources, local environmental and social impacts, international fuel regulations and most importantly increasing cost of electricity. The solar photovoltaic technology is very popular because of modular in nature and it has a zero fuel costs for 25-30 years of the project life. This technology is the best choice of the policy makers around the globe. As a result, the central and state governments have taken major steps to encourage rooftop solar PV projects under various schemes and policies. However, it is challenging to scale-up this program until:

- The consumers are well educated with the pros and cons of the technology through advertising the rooftop technology so that it reached the mass.
- They should be provided with customized solutions for their rooftops.
- There should be a well-established after sales service network in the country for smooth operations.
- The solar rooftop solution should be provided as a complete package to consumer
- Market should be geared up for rooftop Solar PV installations without subsidies
- The regulations for net metering/feed-in-tariffs should be clearly defined.

2. INDIAN EXPERIENCE

The solar capacity additions in India has seen a remarkable growth since 2014, at present it maintains overall share of approximately 12% in solar capacity addition which is far more less than countries like US and Japan, but in the coming years it is anticipated to grow and be at par with developed countries. The Indian government had laid down foundation to expand it solar energy portfolio in 2015 under the new government leadership with a target of 100GW solar capacity by year 2022 and an investment of US$ 100 billion for the solar sector. Out of the 100GW solar capacity, 40GW is expected from rooftop solar. With such a huge increase in solar capacity, the country will achieve it primary goal of electrification and reduction of greenhouse gas emissions.

The table below gives a snapshot of various policies and schemes introduced by government for development of Solar Rooftop PV sector-

Year	Scheme/Policy	Program	Target
2010	Jawahar Lal Nehru Mission (JNNSM)	Under the mission, the government mandated the cells and modules for solar PV projects based on crystalline silicon to be manufactured only in India which accounts to over 60% of total system costs. Progress- 9.6 GW in 2017	20GW by 2022 100GW by 2022
2012	Grid Connected Rooftop and Small Solar Power Plant Program (RTS)	Under this program, RTS capacity in the commercial and industrial sectors were to be developed without any subsidy support but for residential/social/Institutional and Government sector projects were given subsidy and incentives	60 GW of large and medium scale solar projects, and 40 GW through rooftop solar projects
2014	SRISTI (Sustainable Rooftop Implementation for Solar Transfiguration of India)	Under this scheme a Central Financial Assistance will be provided only for installation of roof top solar plants in residential sectors. 40GW of Rooftop Solar Installations. Subsidy support will be limited up to 5 kWp capacity of plant. The total outlay ₹23,450 crore for 40GW of roof top solar installations.	2015-16: 2GW 2016-17: 4.8GW 2017-18: 5 GW 2018-19: 6 GW 2019-20: 7 GW 2020-21: 8GW 2021-22: 9GW
2016	International Solar Alliance (ISA)	Focuses on promoting and developing solar energy and solar products for countries lying wholly or partially between the Tropic of Cancer and the Tropic of Capricorn.	Government will mobilize more than USD 1000 billion of investment by 2030 for the deployment of solar energy at affordable costs

Progressive policies and efforts of Indian government has encouraged the growth of solar PV in many states of India. Tamil Nadu, Karnataka, Gujarat and Rajasthan are leading in terms of installed capacity of Solar PV system. Net Metering policies are adopted and have been considered as favorable policies in 30 out of 36 states. Residential Rooftop solar policy are different for each state, while in Tamil Nadu, Maharashtra, Karnataka, and Rajasthan allows a maximum of 1 MWp capacity installation, Haryana follow the same guideline with one exception, which allows <1 MWp capacity installations. Conditions for residential and industrial installations offer 100% of your Sanctioned Load for all four states. The state policy offers exemption from banking, wheeling & cross subsidy charges in Tamil Nadu and Rajasthan while Haryana has introduced mandates on both residential and commercial solar sector. In Haryana no permission is required from the building plan sanctioning authority for setting up of Rooftop solar power plants (residential/ commercial/industrial). In the same vein, Tamil Nadu adds that electricity generated by the rooftop solar system shall not be more than 90% of the electricity consumption at the end of the settlement period for residential and industrial sector. Now the question arises- what are the barriers and challenges which needs to be addressed to promote the solar power in India? The aim of this paper is to analyze future potential of Rooftop solar PV systems by compiling major challenges faced by the Indian market and proposing a solution in form of new business model for stakeholders.

3. CHALLENGES IN ROOFTOP SOLAR PV SYSTEMS

Besides various policies and initiatives taken by government and stakeholders, solar rooftop PV sector is growing at slow pace as compared to solar applications in other sectors. In India, Rooftop solar has maintained a 10-12% share of overall solar capacity which is much lower than other key markets such as US, Germany, China, Spain and Australia (Hairat & Ghosh, 2017). Currently, India's focus is to build more capacity and raise awareness about the technology in the market. Every growing market has its own win and lose situation, in Indian scenario, it is important for the government to make electricity available in every corner of the country and along with this vision the country plans to opt for renewable sources as much as possible. There are various loop holes when it comes to laying policies and initiatives, not every policy is successfully implemented and there are various challenges which are faced during the implementation stages. Some of the major challenges are discussed below:

1. Solar Funding and Upfront capital cost: Funding of solar projects has always been challenging both for grid-connected and off grid projects. High upfront cost has made investors apprehensive in investing in the projects. Despite huge subsidy grant by the government in JNNSM first phase, there were marginally very few takers because they could not afford to pay 20% down payment which was required to avail cheap discounts. Since there was no performance

benchmark available, banks had difficulty in accessing the viability of solar projects and they had bitter experience when few financed projects were failed. The project developers inspire an IRR of 15% and above out of the solar projects which makes the financing more difficult. India uses solar energy to a great extent, but still relies on imported modules, about 90% of the panels are imported for rooftop power plants in India. With a view to reinforce the concept of "Make in India" and considering the interests of the domestic manufacturers, vide its notification dated July 30, 2018, intimated the imposition of safeguard duty whereby tax would be levied on the import of solar panels. A 30% subsidy on installation cost, per year INR 60bn will be spent by the government towards payment of subsidy on solar installation (Jain, Jain, & Vaughn, 2018). Unless installation cost declines drastically, the government will find it increasingly difficult to politically justify such high subsidy outgo to implement this solar program. Moreover, the grid based solar power continues to reach only those households that are already connected to energy supply.

2. Unclear Policies and Guidelines for Net-Metering: As of 2018, 30 states in India have announced policy for implantation of grid connected solar PV systems. Each state has different power requirements and thus have come up with its own individual solar policy and net meter requirement. While net metering and grid interconnections are important for growth of solar power growth in the country, the policy makers need to put more thinking into it. There are net metering guidelines in place but because of lack of experience and maturity many distribution licensees are still working on detailed approval process for rooftop solar plants, including net-metering billing. The results of our survey depict that overall implementation remains patchy and installers have varying experiences mainly because of different policy interpretation by local dealers. It has been noted that implementation models are not improving with more experience or years of policy in operation. Rather it is the giving more confusion to dealers, developers, utilities and end consumers. Over the period of time these guiding regulations should be revised and experience in net metering should be considered before laying down new policy.

3. Lack of trust about the performance of plant: The consumers have been provided with numerous benefits by the government for installation of rooftop solar PV systems such as subsidies and tax concessions, but still they are not ready to invest in this technology. When asked in the market survey whether the consumers would like to expand/increase their rooftop solar capacity or install a new plant, most of the response were negative. This is because there are huge doubts and lack of data about the performance of plants in India. Moreover, majority of the companies in the area have little or no experience, hence the gap in trust exists. To add to this issue, banks are reluctant to invest to rooftop solar projects because there are high performance risks and limited information on the track records of rooftop solar investments. Even when banks lend to rooftop solar projects, the high-risk perception has led to excessive costs of borrowing (up to 14.5%) for rooftop solar installations negatively impacting the IRR of the project.

4. New Developers with no experience in solar: To take advantage of generous subsidies and incentives offered by the government, many nascent developers with poor balance sheets and no experience in any energy related activities have entered the game with motive to earn quick profits. Solar PV systems has become everybody business, in the first phase of JNNSM scheme even the digital media companies and cloth merchants were selected for solar generation. Taking advantage of various loopholes of the government subsidy and bidding policy, these companies have taken the program for a ride. The experience of The Gujarat Urja Vikas Nigam Limited (GUVNL) is a case in point where GUVNL has signed at least 88 contracts amounting to a total solar power generation of nearly 970 MW. As per the Power Purchase Agreement (PPA) signed between the GUVNL and the project developers, a feed-in-tariff of Rs 15 per unit for the first 12 years and Rs 5 per unit for the remaining 13 years was awarded. This averages out to Rs 12.54 per unit. The GUVNL claims it considered a capital cost of Rs 16.5 crore per MW to arrive at that figure. But most developers have set up their projects for a capital cost between Rs. 9 crore per MW and Rs. 12 crore per MW. The GUVNL says developers have made windfall gains and mislead the government, and that a 'reasonable and prudent tariff' should be around Rs 9 per unit.

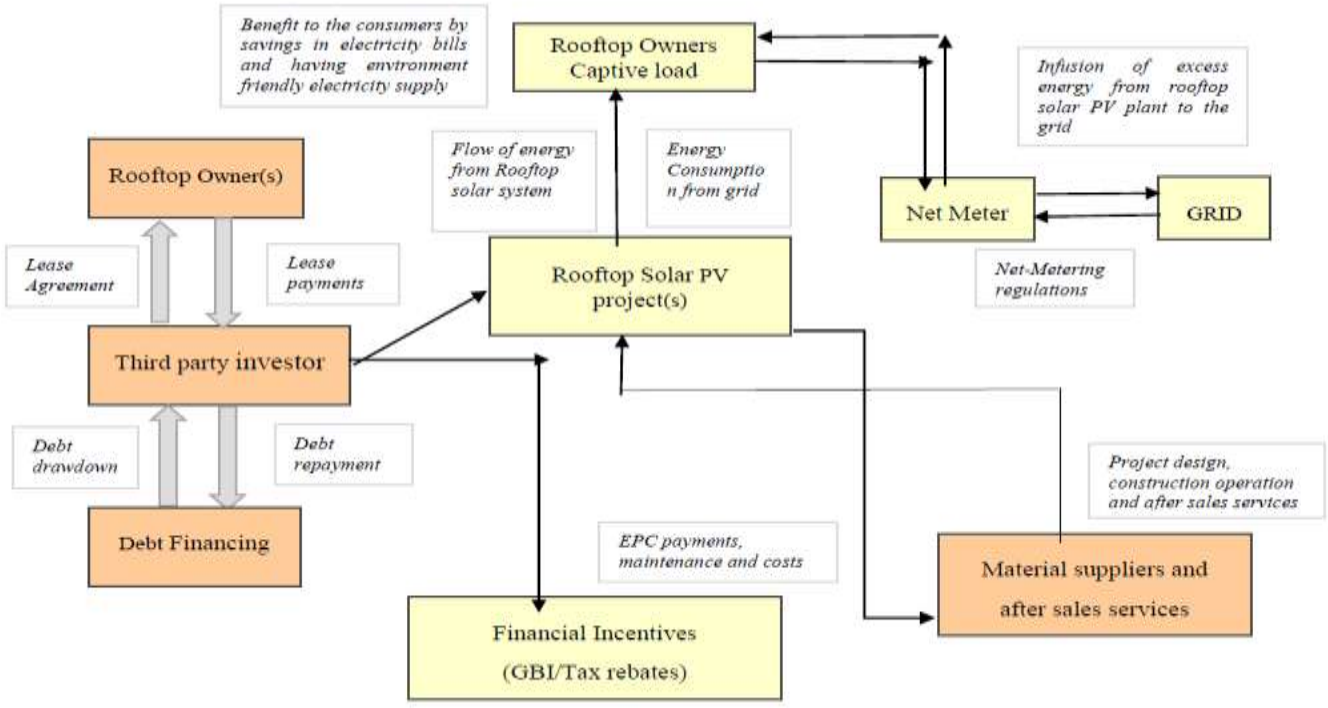
4. RESULTS:

The result of our assessment shows that there are five elements which are needed for commoditization of rooftop solar PV for residential consumers; debt investments, standardization of product according to customers need, after sales services, policies and innovative schemes for Rooftop solar systems and clarity of technical guidelines and ambiguity in regulatory framework such as net metering and Feed-in-tariffs. The compilation of literature review on Solar Rooftop PV systems in different developed countries shows that business models which are customer driven sustains in the market.

Figure – Types of customer driven models Ownership	Individual	Individual	Individual	Leased to third-Party	Leased to third-Party	Leased to third-Party	Leased to third-Party
Uses	For self-consumption	Grid-feed & self-consumption	Grid-feed & self-consumption	For self-consumption	Grid-feed & self-consumption	Grid-feed & self-consumption	Grid-feed & self-consumption
Type of metering	No meters	Net metering	Gross metering	No grid feed	Net metering	Gross metering	Gross metering
Roof types	Individual roof	Individual roof	Individual roof	Large individual rooftop space	Individual roof	Individual roof	Combined roofs
Global Examples	Off-grid solutions in India	Net metering model in Japan	feed-in tariff model in Germany	Walmart rooftop solar PV project by sun Edison	Solar leased systems for residence in USA	Standalone captive rooftop solar PV systems	Pilot project under Gandhinagar Rooftop Program

The result of our study shows that for Indian rooftop solar market to emerge, the crucial step would be to address two major hurdles- Finances and clear metering regulations. A new business model is required for the market players to deploy rooftop solution which gives the flexibility for captive generation and consumption along with third party contractual agreement. Finally, keeping all the critical factors in mind, a third party financing business model is conceptualized which would help to overcome issues in deployment of solar rooftop PV systems in residential consumer segment.

Figure- Business Model for residential rooftop consumers in India



5. CONCLUSION

Overall, it can be concluded that high-visibility initiatives and schemes like JNNSM at central level and state solar policies have been successful in jump-starting solar-based generation projects, but the small solar rooftop segment in particular has yet to take off. The positive take is that in country like India, there is an immense scope for growth in solar PV market. In the present scenario, where the country talks about reducing greenhouse gas emissions and focusing on technologies which are eco-friendly, solar rooftop solutions can be extremely helpful in gaining attention within consumers. Hence there is a need to relook into the business models which will help in the growth of solar rooftop PV sector.

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