Partnership to Advance Clean Energy - Deployment (PACE-D)
Technical Assistance Program

Challenges for Scaling Up Solar Rooftop in the BESCOM Region

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February 2017
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ACRONYMS

Acronyms	Definition
APPC	Average Power Purchase Cost
BESCOM	Bangalore Electricity Supply Company Limited
CERC	Central Electricity Regulatory Commission
CUF	Capacity Utilization Factor
DC	Direct Current
DSCR	Debt-Service Coverage Ratio
DISCOM	Distribution Company
EPC	Engineering, Procurement and Construction
FIT	Feed-In Tariff
FI	Financial Institution
GOK	Government of Karnataka
GW	Gigawatt
GWp	Gigawatt Peak
HT	High Tension
IRR	Internal Rate of Return
KPTCL	Karnataka Power Commission Corporation Limited
kWp	Kilowatt Peak
KV	Kilovolt
LCOE	Levelized Cost of Energy
LT	Low Tension
MNRE	Ministry of New and Renewable Energy
MLA	Member of Legislative Assembly
MWp	Megawatt Peak
O&M	Operations and Maintenance
PACE-D	Partnership to Advance Clean Energy – Deployment
PPA	Power Purchase Agreement
PSU	Public Sector Unit
RESCO	Renewable Energy Services Company
ROI	Return on Investment
SNA	State Nodal Agency
TA	Technical Assistance

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EXECUTIVE SUMMARY

The Government of Karnataka (GOK), via its notification dated May 22, 2014, brought out a progressive solar policy envisaging a minimum solar rooftop capacity installation of 400 Megawatt peak (MWp) by 2018. Following this, the Karnataka Electricity Regulatory Commission (KERC), via its order dated October 10, 2013 and subsequent amendments of May 2, 2016 and September 19, 2016, provided the necessary regulatory framework for installation of solar rooftop in the state of Karnataka.

The Bangalore Electricity Supply Company Limited (BESCOM)[1] subsequently developed the necessary framework and processes for implementing solar rooftop projects as envisaged under the solar policy. This was the first of its kind initiative in India where a state utility developed a customer-friendly framework including standardized forms and templates and detailed processes that aimed to help the common man set up his own grid-connected solar rooftop system. While BESCOM benefitted from the first mover advantage, it also faced certain challenges due to which the progress made in terms of actual solar rooftop deployment was not up to the expected level.

BESCOM, along with the USAID Partnership to Advance Clean Energy – Deployment Technical Assistance (PACE-D TA) Program, initiated a study to map and analyze the challenges that are hampering the installation of solar rooftop in the state. The study was undertaken in June-July 2016 through personal interviews and online survey.

The key objectives of the study were to:

- Identify the key drivers and influencers for solar rooftop across consumer categories.
- Identify challenges being faced by each stakeholder i.e., developers, engineering, procurement and construction (EPC) players and consumers in scaling up solar rooftop in the BESCOM region.
- Recommend interventions that can provide impetus to solar rooftop installation in the BESCOM region.

The key findings of the study have been summarized below.

Challenges to Scale Up

Long gestation period required for approval and commissioning: Consumers who had set up solar rooftop systems cited uncertainty and long waiting period for getting all required approvals as one of the key reason for slow offtake of projects. For the consumers who had not installed these systems, access to finance, time consuming nature of the installation and approval processes, lack of trust in vendors and high cost of the solar rooftop systems were the major challenges.

Option of only Gross Metering mechanism for educational institutions, hospitals and domestic customers: Grid tariff in these segments are higher compared to levelized solar energy costs, resulting in attractive saving through Net Metering schemes. Customers felt that they should be allowed to use Net Metering framework just like industrial and commercial customers.

Poor grid availability in semi urban and rural areas: Customers also citied limited distribution infrastructure and availability of grid to support larger penetration of solar rooftops as critical technical challenges.

High customer acquisition cost: Solar developers also reported high customer acquisition cost as a key challenge, especially for domestic consumers. This was attributed to low consumer awareness, long gestation period for decision making and small size of the rooftop system, leading to high customer acquisition cost.

[1] BESCOM is responsible for power distribution in eight districts of Karnataka - Bangalore urban/rural, Kolar, Tumkur, Ramanagar, C.B. Pura, Chitradurga and Davanagere districts.

Customer Preferences and Drivers

Environmental concerns and savings in electricity bills: While educational institutions and domestic consumers cited environmental concerns as their key driver for solar rooftop installation, the key driver for commercial and industrial consumers was Return on Investment (ROI)/savings in electricity bills. Nearly 93 percent of the consumers felt that they would seriously consider installing a solar rooftop system if they received a positive feedback from users. All consumer categories pointed to the Internet as the primary medium for awareness on solar rooftop.

Ownership Vs. rental: All consumer categories indicated a strong preference for owning the solar rooftop systems. They expected a payback period of five to eight years. Amongst the consumers who showed a preference for third party investment or rent-a-roof models, the expectation of savings, as a percentage of levelized cost, was very high. While 50 percent of the respondents expressed willingness for entering into an agreement with a third party, 80 percent of the respondents were in favor of a similar arrangement with BESCOM, implying greater consumer confidence in BESCOM.

Overall experience: The consumer reports on vendor interaction experience were positive, while the experience of dealing with BESCOM and banks was reported as less than satisfactory. Nearly 87 percent of the consumers who installed the solar rooftop systems said that they would recommend solar rooftop to a friend, implying an overall positive experience.

Recommendations

1. Operational

Making the approval and commissioning processes time bound will remove a major impediment to solar rooftop deployment across all consumer categories. Some of the key suggestions from the survey and discussions are as follows:

- A web-based dashboard to be developed which allows stepwise tracking from 'submission of customer application' to 'final interconnection with the grid'.
- Timelines for each step of the processes to be defined and available online. Target dates for approvals for each applicant to be set up[2] for every step based on the date of application. In case of delay, specific reasons for delays should be updated.
- Deemed approvals to be allowed for certain processes in case no red flags are raised by targeted date.
- Third party inspectors from reputed, empaneled, and inspection agencies to be considered for final inspections before grid synchronization.

2. Regulatory

The regulatory amendment on solar rooftop by KERC dated September 19, 2016 has provided a choice of Net and Gross Metering schemes to educational institutions, hospitals and domestic consumers. This removes a major impediment for solar rooftop scale up for these consumer categories.

In addition, increasing the settlement period for banked energy to one year would help the consumers to avoid netting excess generation and export to the grid at average pooled purchase cost, especially for consumers who go through periods of very low demand (e.g., educational institutions with lean demand during summer holidays and domestic consumers who may go on vacations).

3. Financing and Business Models

The Program recommends development of specific risk assessment frameworks for specific business models and utilities to be adopted by banks.

Financing issues can also be resolved through the development of appropriate distribution company (DISCOM)-anchored business models where collection risks may be decreased and aggregation benefits can be leveraged to reduce costs and improve project quality. It may be noted that DISCOM-anchored business models are being adopted globally.

[2] Current BESCOM process has time targets but they are not normally met.

Development of special business models such as community solar, coupled with virtual Net Metering, can also help attract public and private investment by matching owners of rooftops with users of electricity. Community solar is also gaining popularity globally, especially Europe, and the U.S.

4. Improving Grid Infrastructure

Increasing grid availability and quality in semi urban and rural areas, especially during peak sunshine hours, can prevent the loss of generation from solar rooftop systems (non-hybrid systems without battery). BESCOM may commission a study to develop an action plan for tail-end grid upgradation and operational management.

5. Promotional Activities

Providing non-financial incentives such as "green certificates" to solar rooftop installers can be a good way of incentivizing consumers[3]. Domestic, educational institutions and hospital consumers who list "environmental concerns" as their key driver may view this as a tangible benefit, while for industrial and commercial consumers this can be a great marketing tool, addressing the greening requirements of global investors and customers.

It is recommended that GOK and/or BESCOM run social media campaigns for solar rooftop promotion. Traditional media outlets such as newspapers, television, bill boards, etc. can also be utilized as part of a comprehensive campaign. Apart from this, incentivizing Members of Legislative Assembly (MLAs) and ward representatives to install solar rooftops in their area can be a good seeding approach.

6. Information Availability

Consumers will be able to make informed investment decisions if the information on empaneled vendors, past performance records of installations and projects, satisfaction ratings from past customers and so on, is made available on a centralized dashboard. Apart from this, simple tools to help the customers assess the system size, investment required and financial attractiveness would also be a great help.

Solar has emerged as the fastest-growing energy generation technology globally over the past decade due to large-scale adoption by utilities and consumers, rapid decline in the cost of solar energy, increased awareness on climate change and energy security, and enabling frameworks by policy makers. Within the solar industry, decentralized solar PV rooftop has witnessed a rapid scale up due to its ability to replicate rapidly when provided with an enabling policy and regulatory environment. By the end of 2013, almost 60 percent of the global solar PV capacity was from solar PV rooftop.

The Government of India (GOI) has set an ambitious target of 100 Gigawatt peak (GWp) for solar PV by 2022 of which 40 GWp would be set up as solar rooftop. Each state has been assigned a target for ground-mounted and solar rooftop installations. As a part of this initiative, the GOI has proposed a target of 2.3 GWp for solar rooftop for the State of Karnataka by 2022.

The GOK notified the Karnataka Solar Policy 2014-2021 on May 22, 2014 which envisages deployment of 400 MW of grid-connected solar rooftop projects in the state by 2018. The policy incentivizes solar rooftop adoption by promoting solar rooftop installations on public buildings, domestic, commercial and industrial establishments connected to the grid through Net and Gross Metering. The policy also provides incentives with respect to higher Floor Area Ratio (FAR).

The KERC, via its order dated October 10, 2013, adopted a Net Metering framework for all consumer categories whereby the excess power is exported to the grid and settled on a monthly basis at INR 9.56/kilowatt hour (kWh) for non-subsidized projects and INR 7.20/kWh for subsidized projects (30 percent capital subsidy). Subsequently, in order to promote solar rooftop deployment in consumer categories with low retail tariffs (domestic, hospital and educational institution), the Commission, via its order dated May 2, 2016, introduced a Gross Metering framework with Feed-In Tariffs (FITs) ranging between INR 7.08/kWh and INR 5.20/kWh based on the installed capacity. For Net Metered projects, the Commission

[3] The idea was provided by a few customers during the survey.

proposed that any surplus injected into the grid be settled at average power purchase cost (APPC)[4] of DISCOM. The Commission also capped the solar capacity at 150 percent of the consumers contract demand or sanctioned load.

The Commission, via another order dated September 19, 2016, brought forth an amendment to the May 2, 2016 regulation, whereby it allowed the option of Net Metering for domestic, educational and hospital consumer categories and limited the solar rooftop capacity to 100 percent of contract demand/sanctioned load. Since the survey was carried out during the period June-July 2016, the impact of September 19, 2016 amendment is not reflected in the survey responses. However, the response of the consumers has been analyzed in the light of September 19, 2016 amendment.

Aligned with the GOK's vision, all distribution utilities including BESCOM have undertaken steps and deployed the necessary guidelines required for operationalizing the solar rooftop policy and regulatory framework.

[4] Pooled cost of purchase' means the weighted average pooled price at which the distribution licensee has purchased the electricity including cost of self-generation, if any, in the previous year from all energy suppliers long-term and short-term.

1.1 CONTEXT AND PROBLEM STATEMENT

The state utility BESCOM launched its visionary Net Metering framework for solar rooftop in November 2014. The first of its kind in India, the scheme generated a lot of interest amongst residents who felt encouraged to install solar panels on their rooftops and sell extra electricity to BESCOM. As a result of this, the utility received several applications for solar rooftop projects of different sizes. However, the initial inertia related to solar rooftop projects slowed down, with only 30 MWp installed capacity in BESCOM's control area as of October 24, 2016.This was primarily due to teething hiccups as the utility itself was learning in the process and the required ecosystem was evolving.

The present study was commissioned by the Program to identify the challenges in scaling up solar rooftop in the BESCOM region and recommend interventions that might be required to provide impetus to solar rooftop installations.

1.2 SURVEY OBJECTIVES

The main objectives of the survey include:

- Identify, analyze and rank the major challenges being faced by consumers and developers in scaling up solar rooftop.
- Understand main drivers for consumers to adopt solar.
- Identify necessary actions at the policy, regulatory and implementation level to scale up solar rooftop.
- Identify and evaluate various business models and analyze the prospects for BESCOM to enter the solar rooftop space as a service provider.

1.3 SURVEY AREA BOUNDARY

The respondents (developers and consumers) were limited to the BESCOM region. The survey area boundary ensured that specific challenges with respect to the operational aspects of one DISCOM are adequately captured. However, the learning from this study is applicable across all DISCOMs in Karnataka.

1.4 SURVEY IMPLEMENTATION

The study was undertaken in June-July 2016 through personal interviews and online survey. The major stakeholders for the survey were developers, EPC players and consumers in the BESCOM region. The consumers were further categorized into (a) educational institutions and hospitals, (b) domestic, (c) industrial and commercial, and (d) public sector undertaking (PSU) and government. The categorization was done based upon the differences in regulation for solar rooftop deployment, tariffs, metering options and financial incentives that apply to each these categories.

Details of the survey instrument and design, sample characteristics, stakeholder profiles and the targeted questionnaires have been provided in Annexures I to V of the report. The following sections provide an analysis of the survey findings.

The study was designed to obtain an understanding of issues pertaining to solar rooftop expansion, specifically with regard to the overall Business Attractiveness including (a) Customer Acquisition Cost, (b) Operational Challenges, (c) Regulatory Challenges, (d) Technical Challenges (e), Financing Issues, and (f) Miscellaneous. The mapping of challenges for different consumer segments is shown in Figure 1.

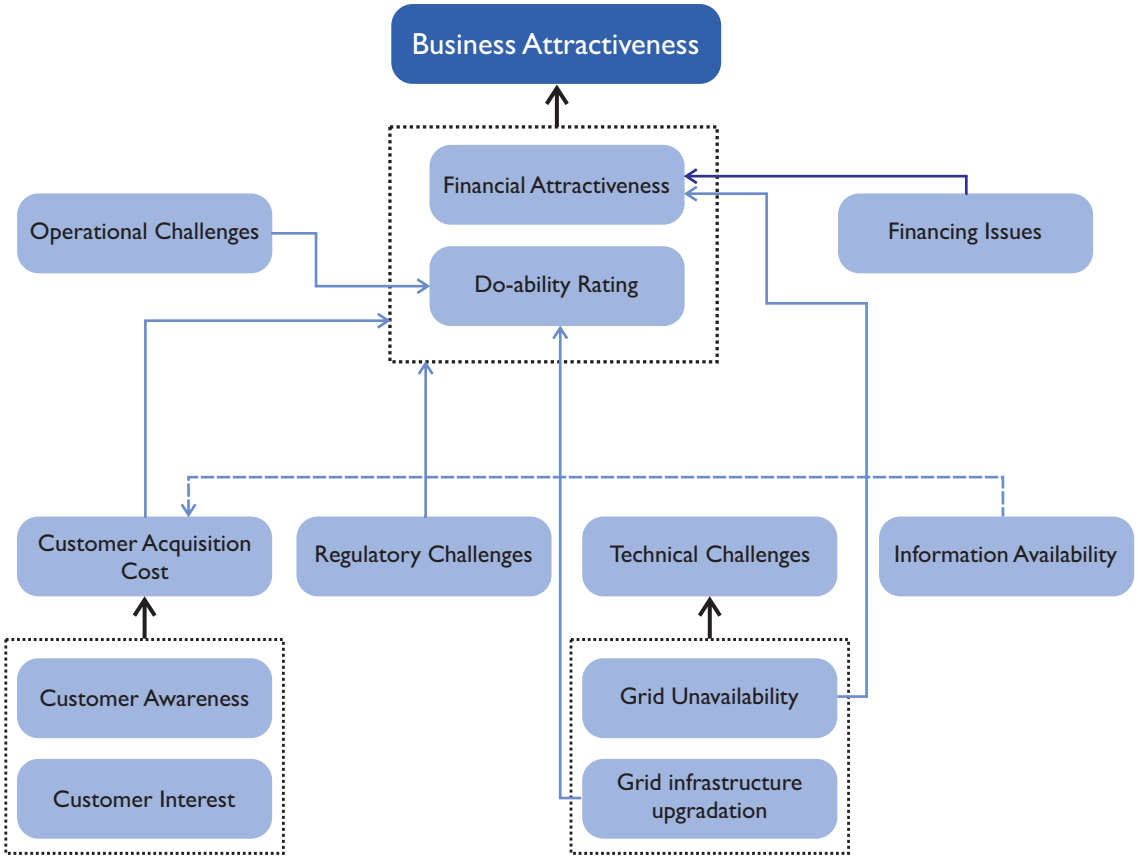


Figure 1. Challenges impacting consumers and investors in developing solar rooftop projects

1.5 IDENTIFYING AND PRIORITIZING CHALLENGES ACROSS CONSUMER CATEGORIES

The main objective of the survey was to understand the specific areas in which different consumer categories face major challenges. The priority order of challenges faced by different consumer categories was ascertained through ranking questions. Subsequent questions delved deeper into each of these concern areas to understand the reasons for each challenge. The ranking of challenges for different consumer categories has been provided in Figure 2.

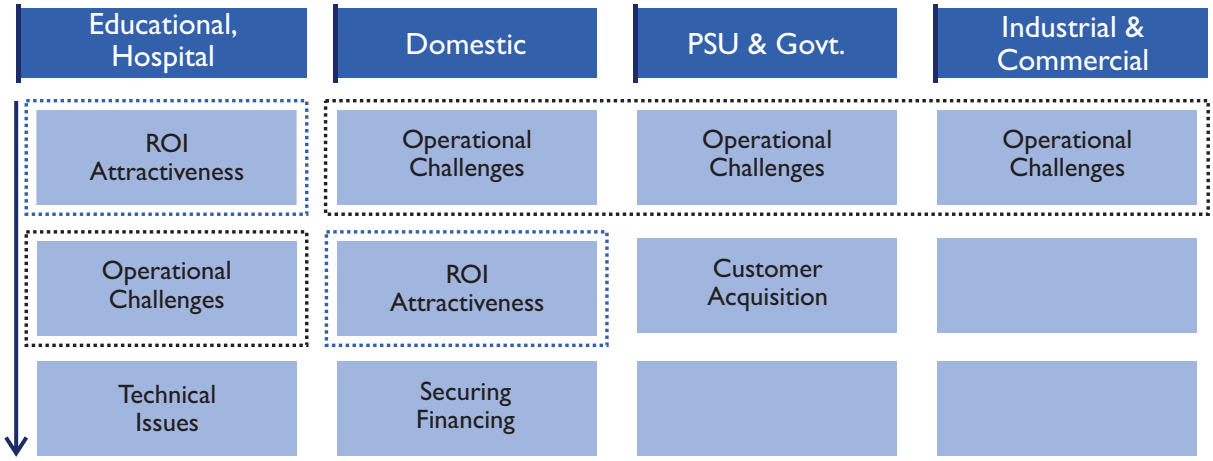


Figure 2. Ranking of challenges across various consumer categories interested in investing in solar rooftop

The study revealed that operational challenges are amongst the top two challenges across all consumer categories. When investigated further, the long gestation period for approval and interconnection process were identified as major operational challenges. In addition,

- ROI attractiveness and interconnection point were perceived as significant challenges for educational institutions and hospitals.
- ROI attractiveness and access to finance were reported to be amongst the top three challenges for domestic consumers.
- Developers considered acquisition costs for domestic customers as high.
- Technical issues related to inadequacy of grid infrastructure and poor grid availability were also viewed as potential and significant constraints to further solar penetration.

1.6 CHALLENGE 1: DELAYS EXPERIENCED IN THE APPROVAL AND COMMISSIONING PROCESS

In order to appreciate the challenges being faced by consumers in the application, approval and commissioning processes, it is pertinent to briefly explain the current process. The consumers are required to submit an application with the necessary information to BESCOM (either online or off-line). Post the receipt of application by BESCOM, a technical feasibility assessment is required to be completed within 10 days, and if the proposal is found technically feasible, an intimation to execute the power purchase agreement (PPA) with BESCOM is sent to the consumer. The consumers are expected to submit the PPA within 10 days to BESCOM. Once the PPA is received by BESCOM, it is expected to issue an approval letter for installation to the consumer within three days. The consumer is expected to complete the solar rooftop installation within 180 days and submit the work completion report to BESCOM. On receipt of the work completion report, BESCOM issues the commissioning certificate within the next seven days. The process flow for solar rooftop projects and their estimated timelines as prescribed by BESCOM is provided in Figure 3.

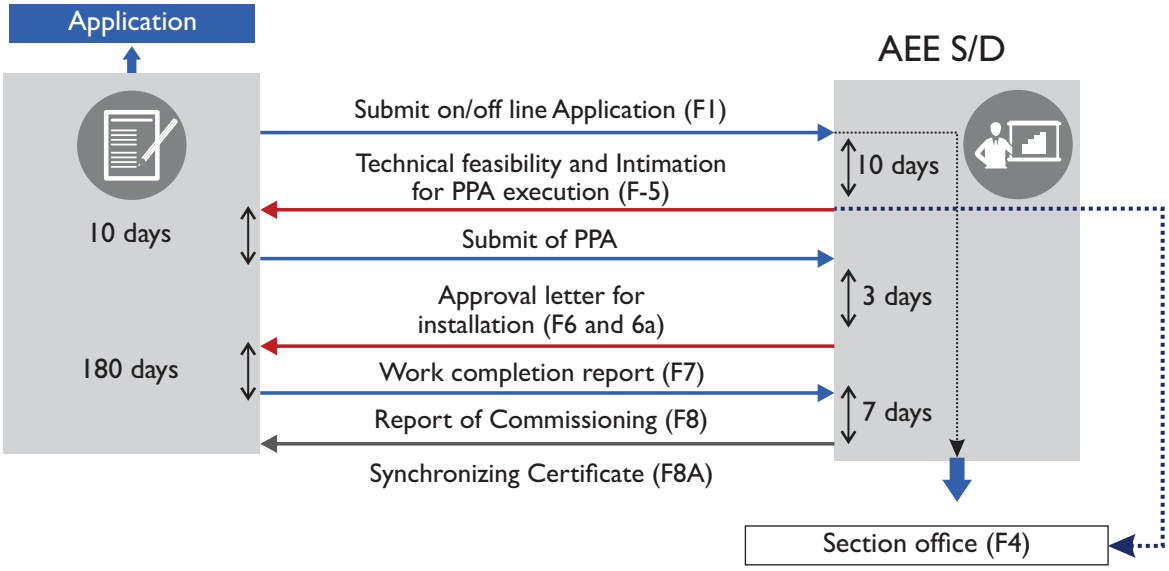


Figure 3. Time frames for grid-connected solar rooftop systems

The three major processes are for (a) Application, (b) Approval, and (c) Commissioning. In spite of the processes and timelines being defined, there were appreciable delays across these processes leading to dis-satisfaction among consumers. The reasons for the same have been ascertained below.

1.6.1 Application Process

Application process is the first contact between the eligible consumer and the utility for installing the grid-connected solar rooftop plant. Simplifying this process has the potential to significantly reduce time and effort of the transaction both at the utility as well as the consumer end and encourage eligible consumers to opt for grid-connected solar rooftop.

Approximately 80 percent of the consumers were satisfied with the application process. However, some consumers did face challenges for some time, as BESCOM was not accepting new applications based on the directive from the Energy Department, GOK.

1.6.2 Approval Process

Post the application process, a technical feasibility assessment report[5] is prepared by BESCOM. If the proposed solar rooftop installation is found to be technically feasible, a notice is sent to the consumers for PPA execution.

The effectiveness of the approval process was assessed along three parameters: (a) process complexity, (b) process responsiveness, and (c) time taken to complete the process. The consumer responses on various aspects of the approval process have been listed below:

- Process Complexity: 80 percent of consumers report the process as "simple".
- Process Responsiveness: 70 percent of consumers were satisfied with the responsiveness of BESCOM to the queries related to approval process.
- Time Taken to Complete the Process: 60 percent of the consumers were *not satisfied with the time taken to complete the process.* In fact, *"time taken to complete the approval process" was attributed as one of the major reasons for dissatisfaction amongst consumers.*

Overall, approximately 50 percent of the consumers were not satisfied with the approval process. The major reasons leading to delays in the approval process are:

- At the time of the survey, BESCOM was in the process of developing the required monitoring procedures and protocols under the interconnection process to ensure timely approvals and commissioning of solar rooftop projects. As there was no mechanism available at that point of time customers faced delays in the approval process.
- While BESCOM has defined timelines for each process, there is no penal provision for not meeting the timelines and no feedback mechanism to identify the reasons why timelines were not met.
- Activities linked to effective and timely solar rooftop interconnection process are not a part of key performance index (KPI) for the BESCOM engineers.
- BESCOM engineers now have additional responsibilities which have made their work schedule more hectic. This sometimes lead to delays in the approval process.

1.6.3 Commissioning Process

It is BESCOM's responsibility to ensure safety and reliability of distribution network especially when connecting distribution generation sources such as solar rooftop. Therefore, utility inspection before commissioning and interconnection with the grid becomes critical to ensure safety and reliability of the gird.

As a part of the commissioning, post inspection, a Commissioning Report and Certificate is provided by BESCOM to the consumer for connecting their system to the grid. Apart from approval from the BESCOM engineer, additional approval of the Electrical Inspectorate, GOK is required if the capacity of solar rooftop system is more than 10 kWp.

Based on the survey feedback, around 65 percent of the consumers were not satisfied with the commissioning process especially the inspection visit. The reasons for high dissatisfaction level were:

- The commissioning process was, in most cases, delayed beyond the original schedule.
- The consumers were required to follow up regularly with BESCOM for the inspection visit.
- The consumers, developers and EPC players provided feedback on the need for more training of BESCOM engineers on solar PV rooftop, especially their role in the commissioning of the project.
- There were delays from the Electrical Inspectorate, GOK as well.

[3] As of now, the technical feasibility assessment report mainly assesses the distribution transformer capacity, solar PV installed capacity on the feeder and interconnection voltage.

The major reasons leading to delay in the commissioning process may be listed in terms of:

- Inadequate number of Electrical Inspectors on staff.
- Since this was the first ever initiative by a utility, BESCOM did not have the required resources or best practices to train its engineers in a timely manner. As a result, some BESCOM engineers have only basic knowledge of solar rooftop and its implementation process.
- Delay in setting up a monitoring and evaluation framework for interconnection at the circle, sub-division or headquarter level.
- While BESCOM has defined the timelines for each process, there are no penal provisions for the utility or its engineers if these timelines are not met.
- BESCOM engineers have little motivation to work on solar rooftop issues as it is not a part of their performance matrix, unlike maintenance of KV lines which is a core component of their performance matrix. In addition, they now have additional responsibilities which sometimes leads to delays due to their heavy work schedule.

Time taken in completion of approval and commissioning processes has been identified as a major operational challenge. Since this is ranked amongst the top two challenges for all consumer categories, reducing the time taken to complete the approval and commissioning process is expected to eliminate a big impediment for scaling up solar rooftop in BESCOM region.

1.7 CHALLENGE 2: BUSINESS ATTRACTIVENESS FOR EDUCATIONAL INSTITUTIONS, HOSPITALS AND DOMESTIC CONSUMERS PERCIEVED AS LOW

The business attractiveness for developers of solar rooftop for the various consumer categories was measured by a matrix comprising of financial attractiveness (Y-Axis) and do-ability rating (X-Axis) as shown in Figure 4. The do-ability rating comprises of attractiveness rating for the particular consumer category independent of financial attractiveness (customer acquisition costs, counterparty risks, technical challenges, ease of implementation, etc.).

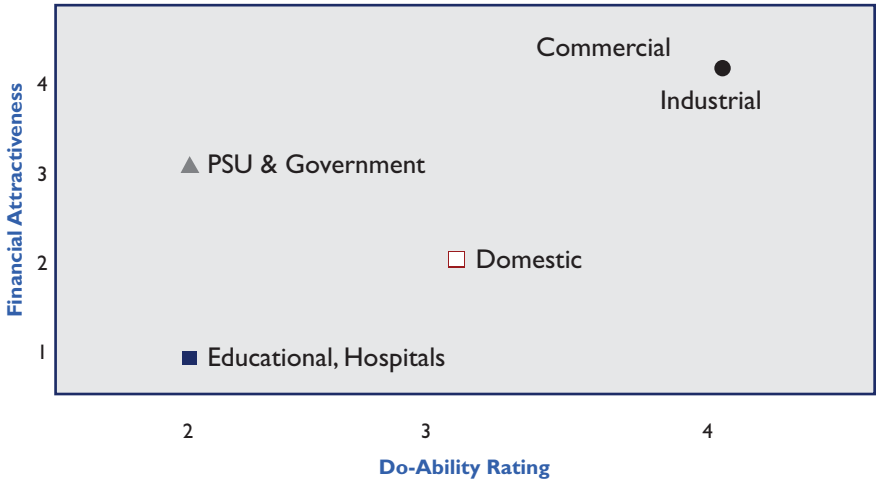


Figure 4. Business attractiveness for different consumer categories

The business attractiveness for different consumer categories has been described below:

Industrial and Commercial Consumers: For these two consumer categories, both financial attractiveness and do-ability rating was reported as high.

1. The financial attractiveness was high due to the relatively higher cost of utility power vis-à-vis solar power and also its ability to benefit from accelerated depreciation benefit.
2. The do-ability rating was high, mainly on account of lower customer acquisition costs (relative to other consumer categories), larger installation size per customer, and the ability of these consumers to make an investment decision.

Domestic Consumers: Both financial attractiveness and do-ability rating were reported as low:

1. The financial attractiveness was low, due to the unavailability of the Net Metering option, binding them to a perceived low Gross Metering tariff.
2. The do-ability rating was low, mainly on account of higher customer acquisition costs, lower installation size and lower awareness.

Educational Institutions and Hospitals: The do-ability rating was rated as low, while the financial attractiveness was rated as "very low":

1. The financial attractiveness was very low because of the unavailability of Net Metering option, binding them to perceived low Gross Metering tariff.
2. The do-ability rating was low because these consumer categories had to interconnect at the high tension level[6].

PSUs and Government Buildings: The financial attractiveness was rated at medium, while the do-ability was rated at low by the developers:

1. The do-ability rating was reported as low by the developer as it is a developer-specific perception as explained below.

1.7.1 Perception of Low Gross Metering Tariffs

The perception of low financial attractiveness for educational institutions, hospitals and domestic consumers was attributed to a relatively low FIT as prescribed by the Commission for these consumers under the Gross Metering Scheme. More details on the perception around low Gross Metering tariffs can be found in Annexure VI.

1.7.2 Option of Net Metering Vis-à-Vis Gross Metering

Another reason for perception of low financial attractiveness by these consumers is based on the relatively higher returns available to industrial, commercial, PSU and government consumer categories, where the savings due to Net Metering were higher than the returns from Gross Metering FIT. More details on the perception around low Gross Metering tariffs can be found in Annexure VI.

Not allowing Net Metering to educational institutions, hospitals and domestic consumers has been rated as a key challenge for the growth of solar rooftop. The September 19, 2016 regulatory amendment, allowing Net Metering option to educational institutions, hospitals and domestic consumer categories, is therefore a welcome step.

1.7.3 Settlement Period of One Month for Banked Energy Is Short

Presently, the settlement period of one month for both Net and Gross Metered consumers is not perceived as a challenge. However, the investment community felt that to create a better business case, the settlement period should follow an annual cycle for settlements as agreed by other states.

Variation in solar rooftop generation and load can lead to net energy export during few months and net energy import in others. Thus, the most efficient balancing for export and import can happen over an annual cycle. In case of settlement period of one month, net energy exports during high generation months would get compensated at the average pooled purchase cost rate[7], which is much lower than the cost of generation of solar rooftop (as of FY 2017)[8].

1.7.4 Lower Do-Ability for PSUs and Government Consumers

For PSU and government buildings, the do-ability rating was low for the developers and EPC players, primarily due to the stringent technical eligibility requirements for bidding. However, this feedback was highly developer specific. As per the Program's understanding, the do-ability aspects for PSUs and government buildings remain moderate to high, given the sanctity of the contractual agreements, large rooftop space available with low probability of shading in the future from nearby structures and much lower business risk for the counterparty.

[6] Before September 19, 2016 amendment to solar rooftop regulation.
[7] APPC rate for FY 2017 for BESCOM as approved by the Commission is INR 4.110/kWh (Source: FY 2017 BESCOM Tariff Order).
[8] Cost of generation (including ROE) as approved by the Commission for FY 2017 ranges between INR 5.2 -7.08/kWh.

For industrial and commercial consumers, the do-ability rating was high, as these consumer categories offer developers/EPC players lower counterparty risk, scale (solar PV capacity) and customer acquisition costs, etc. As far as domestic consumers are concerned, the do-ability rating was low as the perceived counterparty risk and the transaction/customer acquisition costs were high.

1.8 CHALLENGE 3: HIGH CUSTOMER ACQUISITION COST

Higher customer acquisition costs lead to price offerings to the consumer.

The customer acquisition cost for developers/EPC players depends on customer awareness, interest and size of the transaction. One of the ways to reduce customer acquisition costs is by enhancing consumer awareness through promotional activities.

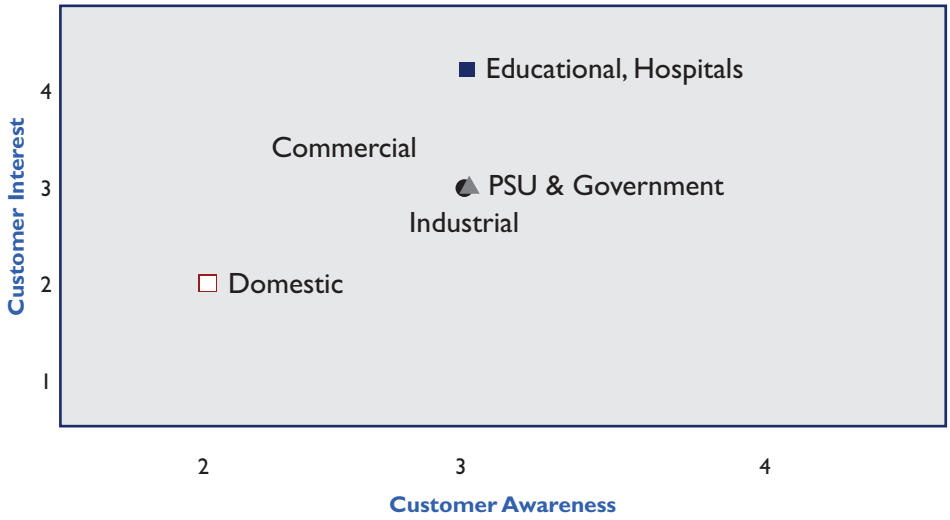


Figure 5. Mapping interest versus awareness across consumer categories

The level of awareness of solar rooftop amongst various consumer categories is as following:

- For domestic category, potentially the largest segment, both customer awareness and interest were reported as low.
  - The awareness levels for domestic consumer category were reported as low leading to increased acquisition costs.
  - The time consuming nature of solar rooftop installation was the major reason for low consumer interest.
  - Business models which can offer avenues to domestic consumer category to invest in solar rooftop without getting in time consuming hassles, may lead to substantial scale up. This can be achieved through a variety of mechanisms such as development of community/utility based business models which allow:
    - Easy sign up.
    - Transparent and effective setting of costs.
    - End to end handling of approvals and interconnection.
    - Trusted technology choice and implementation.
- For commercial, industrial, PSU and government category, customer awareness and interest were reported as medium.
- For educational institutes, while the customer awareness was reported as medium, customer interest was reported as high.

1.9 CHALLENGE 4: POOR GRID AVAILABILITY

Grid availability is defined as the duration during which grid power is available to the consumers over a given period. Since the grid interactive systems without storage cannot supply power during grid outage, grid unavailability especially during peak solar generation hours result in financial loss for the consumers. As per the Karnataka Power Commission Corporation Limited (KPTCL) data for FY 2014, 40 percent of 11 kilovolt (kV) feeders in Bangalore urban and 77 percent of 11 kV feeders

in Bangalore rural have more than four hours of grid unavailability per day. The grid availability will definitely be a challenge for the development of solar rooftop in semi-urban and rural areas. The GOK along with BESCOM needs to come up with targeted solutions for the development of solar rooftop in these areas.

1.10 CHALLENGE 5: GRID INFRASTRUCTURE CONSTRAINTS

Lessons from countries with high solar rooftop penetration indicate that solar rooftop scale up requires grid infrastructure up-gradation as the challenges posed by high penetration of solar rooftop include:

- Reverse power flow.
- Significant voltage variability and voltage imbalance.
- Lack of visibility of actual circuit loads due to Net Energy Metering (NEM).
- Phase imbalance.
- Increased operation and maintenance for voltage regulation equipment.
- Longer, steeper shape of the traditional duck curve, requiring generators to respond much faster to keep up with electricity needs.
- High voltage on circuits and secondary services with a commensurate reduction in conservation voltage reduction compliant circuits.
- Technical challenges raised by events like solar eclipse.

Developers and EPC players were of the opinion that distribution infrastructure up-gradation is a medium term challenge and need to be addressed if targets are expanded beyond 400 MWp.

1.11 CUSTOMER BEHAVIOUR: KEY DRIVERS AND INFLUENCERS

The study has identified a number of drivers and influencers of customer behaviour which affect the uptake of solar rooftop systems across consumer categories.

1.11.1 CB 1: Educational Institutions, Hospitals and Domestic Consumers Report "Environmental Concern" as the Key Driver for Solar Rooftop Adoption

The key drivers for different consumer categories are shown in Figure 6. The numbers indicate average rating assigned by the consumer group category to that particular attribute.

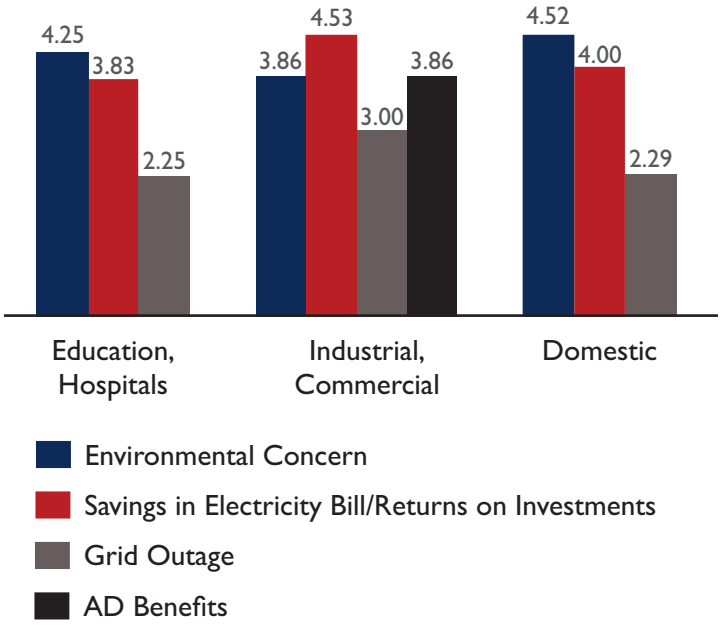


Figure 6. Drivers for various consumer categories for investing in solar rooftop

The key investment drivers for solar rooftop across various consumer categories are as follows:

- Educational institutions, hospitals and domestic consumer categories list "environmental concerns".
- Industrial and commercial consumer categories list "ROI/savings in electricity bill".
- Accelerated depreciation benefit was also an important driver.

Intangible incentives such as green certificates may also boost solar deployment for consumers where environmental concerns play an important role.

1.11.2 CB 2: Solar Rooftop Customers Seek Word of Mouth Referrals

Nearly 93 percent of respondents stated a high probability for solar rooftop adoption if they receive positive feedback from system owners from their neighborhood. Local champions such as ward counselors, schools, and MLAs can take the lead in spreading awareness and generating interest in solar rooftops.

1.11.3 CB 3: Advertisement through Social Media Campaigns can be the Most Effective and Least Cost Option for Increasing Solar Rooftop Awareness

Knowledge regarding sources of awareness for different consumer categories can help vendors, GOK and BESCOM choose the most appropriate medium. The various sources of consumer awareness for solar rooftop for different consumer categories have been listed below:

- Internet was reported to be a major medium for generating awareness.
- Advertisements by the government were a major source of awareness closely followed by social media.
- Industrial and commercial consumers reported contact by vendor sale representatives as another major source of awareness.

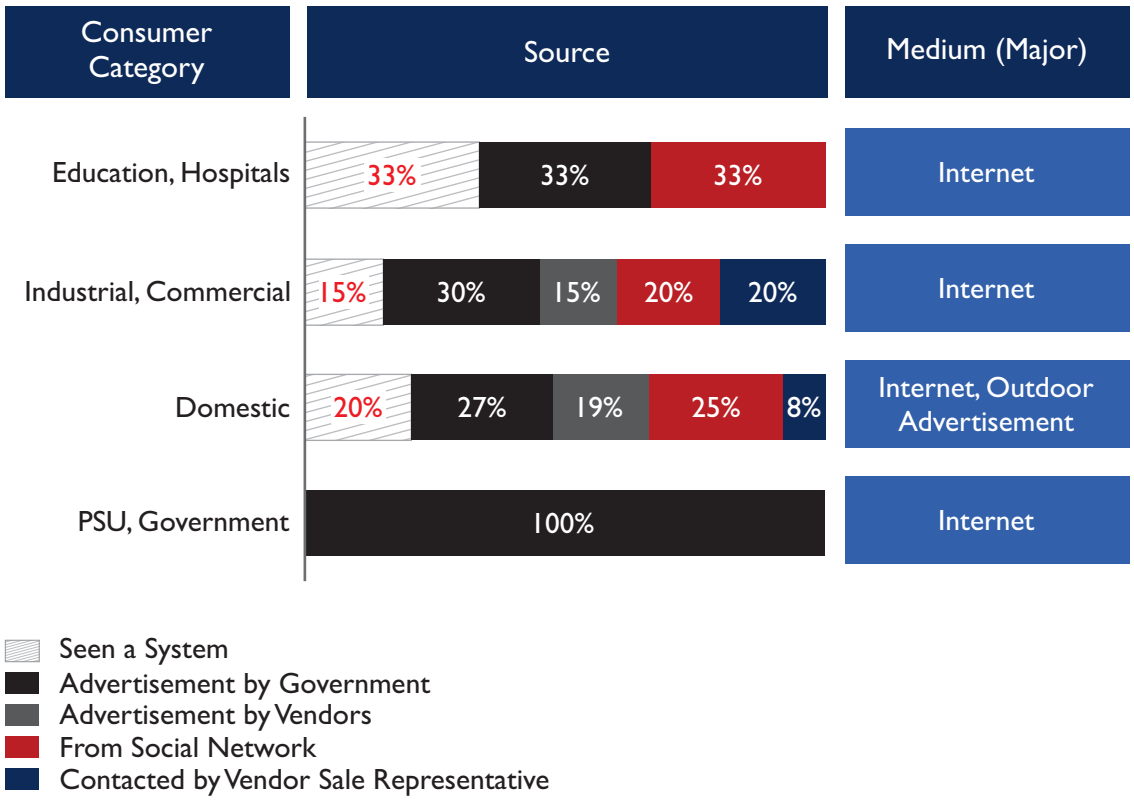


Figure 7. Sources of information on solar rooftop across various consumer categories

Advertisement by the government through social media campaigns can be the most effective and least cost option for increasing awareness alongside traditional communication media such as TV, radio, bill-boards. Additionally, BESCOM can also use monthly bills, flyers, etc.

1.11.4 CB 4: Consumer Categories, Apart From PSU and Government, Reported a Predominant Preference for Self-Owned Business Model

Consumers reported a predominant inclination towards self-owned systems, a trend visible across consumer categories. The preference for third party PPA and rent-a-roof model was reported to be relatively small, probably because of difficulty of finding developers/investors.

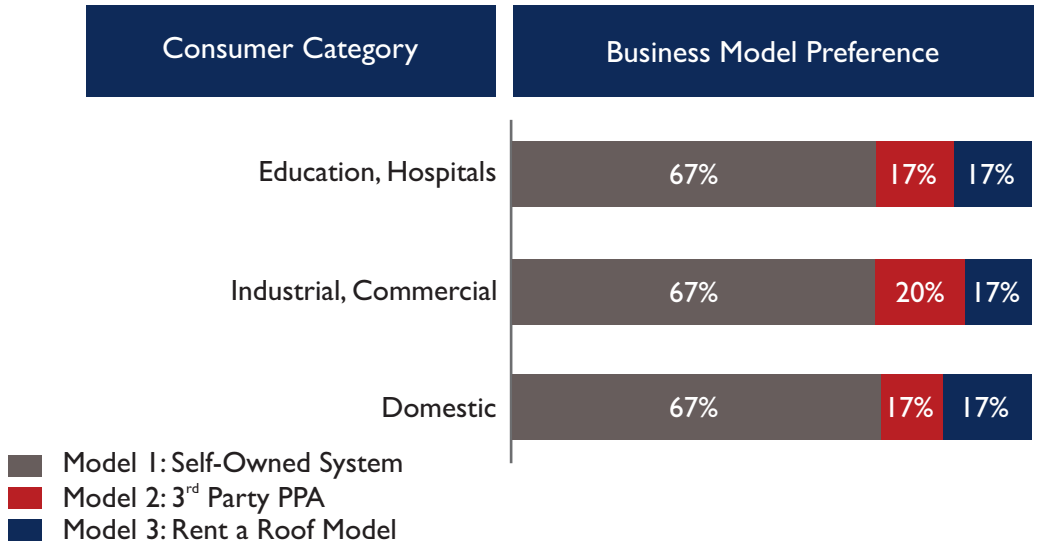


Figure 8. Business model preference across consumer categories for solar rooftop

For the industrial and commercial category, the accelerated depreciation benefit was an important factor in support of self-ownership. However, with reduction in accelerated depreciation benefit from FY 2018, the preference for Models 2 and 3 (as referred in Figure 8) may increase.

The experience of other mature markets such as California shows that third party ownership models typically gain preference as the market matures. Therefore, a similar trend can be expected in India (and in Karnataka) as well.

1.11.5 CB 5: Return Expectations

The expected payback period from self-owned systems was five to eight years. For third party models, the respondents expected a tariff of INR 3/kWh from PPA and @ INR 320/sq. m per annum for rent-a-roof model. The expected tariff of INR 3/kWh is 30-40 percent of the levelized cost of generation from solar rooftop. The rental return expectations were higher, possibly due to the fact that consumers might be using the comparable metric for rentals of residential/commercial spaces, which, at its lowest, would be approximately INR 2,600/sq. m per annum as of FY 2017.

1.11.6 CB 6: Consumers Perception of Various Participants in Solar Rooftop Installation Process

The customers' overall satisfaction level with solar rooftop appeared to be driven by their experience of dealing with important participants in the solar rooftop installation process. Some specific findings were:

a. Customers appeared to have largely positive reports of experience with the vendor:
    1. On an average, each consumer interacted with three vendors.
    2. Approximately 86 percent of the sample population interacted with vendors during their decision-making and implementation processes and found the overall experience as good.
    3. The consumers felt that higher transparency in costing, customer education on benefits, and being more responsive on queries[9] would enhance confidence further.

[9] As reported by consumers.

b. Consumer satisfaction ratings of BESCOM's approval and interconnection process were low:
    1. Nearly 58 percent of the sample population interacted with BESCOM and expressed discontent with BESCOM's service offerings.
    2. Consumers expected BESCOM engineers to be better trained in technical aspects.
c. Consumers appeared to be unhappy regarding financing options:
    1. Consumers reported they were not able to secure non-recourse financing from either public or private sector banks.
    2. Apart from this, consumers found the knowledge of banking staff inadequate. Only 12 percent of the sample population interacted with financial institutions.

1.11.7 CB 7: Solar Rooftop Owners Have Overall an Positive Experience

To understand the satisfaction of consumers who have installed solar rooftop system; the survey had a question on their likelihood of recommending to a friend. Nearly 87 percent of consumers who installed solar rooftop systems reported positively. This implies an overall positive experience and the ability of solar rooftop to scale up rapidly, once bottlenecks are removed.

1.11.8 CB 8: Consumers Trust BESCOM More than Vendors for Solar Rooftop Installation

Consumers, who had not proceeded with solar rooftop installation, were questioned on their openness for a third party PPA. Nearly 50 percent of the respondents were positively inclined for the same. Surprisingly, 80 percent of the respondents were in favor of a similar arrangement with BESCOM.

Consumers may gain confidence in solar rooftop if BESCOM encourages the deployment of the same through utility-based business models. DISCOM-anchored business models can be a potential solution for rapid scale up.

Specific recommendations, based on the findings of the study, include:

- Process, Policy and Information-related improvements
- Grid infrastructure upgrade
- Business model improvements

1.12 PROCESS, POLICY AND INFORMATION-RELATED IMPROVEMENTS

These improvements are not expected to require significant investments and will result in immediate impact.

12.1.1 Recommendation 1: Time Bound Approval and Interconnection Processes

BESCOM has set time targets for all its key processes to ensure smooth and timely installation of solar rooftop systems. However, sometimes time-bound approvals are not followed in practice which leads to delays. To address this challenge, the following recommendations may be considered:

- A web-based dashboard which allows stepwise tracking from 'submission of customer application' to 'final interconnection with the grid'.
- Target dates for approvals may be set up[10] and specific reasons for delays, may be updated online for each applicant.
- Policy should allow 'deemed approvals' if no red flags are raised by the time target for a specific step.
- Possibility of using third party inspection from reputed and empaneled inspection agencies could be considered if adequate electrical inspectors are not available.

Additional recommendations in this regard include:

- Monthly management review process for approvals and status of interconnections (at circle, substation, and headquarter level).
- Incorporating targets for solar rooftop implementation in the performance evaluation of engineers.
- Training of field engineers.
- Using third party, empaneled vendors to augment assessment, approval and interconnection processes.

[10] The current BESCOM process has time targets but they are not normally met.

12.1.2 Recommendation 2: Project Evaluation Tools for Banks Integrated with their Loan Approval Process

Development of project assessment tools for banks and integrating them with banks disbursement process can lead to faster disbursement for solar rooftop projects[11].

A central information base on project performance (energy generation, faults, complaints and so on) may further enhance bank confidence on expected performance from a system in a given city, substation or geographical area as well as with reference to the developers and vendors involved.

Bank staff, involved with solar rooftop approvals, may also be provided with appropriate training as such projects can often have complex techno-commercial and regulatory considerations.

12.1.3 Recommendation 3: Option of Net Metering and Extended Settlement Period

Educational institutions, hospitals and domestic consumer categories have already been given the option of Net Metering as of September 19, 2016 regulatory amendment to solar rooftop regulations by KERC. It is also believed that the settlement period for banked energy needs to be increased from one month, as domestic and educational institutions have longer load periods arising from holidays and outstation trips.

12.1.4 Recommendation 4: Awareness Generation and Promotional Activities

Majority of the consumers are not aware of sources for appropriate information on vendors, expected performance, assessment of potential savings, etc. In this regard, it is recommended that:

- State Nodal Agency (SNA) or BESCOM runs promotional campaigns on social media networks.
- BESCOM communicates with consumers through its monthly bills or text messages.
- BESCOM or SNA consider providing non-financial incentives such as “Green Certificates” to solar rooftop installers.
- Local champions such as MLAs, Ward Councilors, schools, etc. are used to generate awareness.

1.13 DEVELOPMENT OF APPROPRIATE BUSINESS MODELS TO ASSIST RAPID SCALE UP

The potential loss of revenue for DISCOM due to solar rooftops can be converted into an opportunity if the DISCOM participates in the implementation process. There are a number of business models that can be anchored by the DISCOMs, which offer benefits to all stakeholders involved with solar rooftops.

13.1.1 Recommendation 8: DISCOM-anchored and Community Solar Business Models

A number of challenges afflict the solar rooftop sector in India. The most crucial include:

1. Resistance from utilities for solar rooftop deployment due to loss of business.
2. Challenges around contractual sanctity under third party solar rooftop models.
3. Challenging interconnection processes.
4. Access to financing.

The utility involvement in solar rooftop market was initially limited to being a facilitator. The utility mainly provided a broad framework for Gross/Net metering and interconnections. Some utilities also sold solar PV systems and provided system rebates. However, a growing number of investor-owned utilities have recently taken up a more active role in encouraging the development of solar rooftop installations due to a number of developments in the market, key among them being the impact of disruptive technologies like solar rooftop. Utility-based solar business models have started emerging wherein utilities are now actively involved in innovating on the rooftop business model front in order to capture value from these solar markets.

Utility-based business models have the potential of addressing the above mentioned constraints while also developing a business case for their participation in the solar rooftop development process. They can play a key role in the utility developing solar rooftop systems due to the following advantages over self-owned or third party-owned business models.

[11] The consultants have developed a framework for such as tool for IREDA, under the Program.

Utility-based business models comprise of two broad types: DISCOM-anchored business models and community solar business models. The ability of these business models in addressing the key challenges outlined in this report is illustrated in Figure 9.

Rank	Parameters	Self Financing	PPA with 3rd Part Investor	DISCOM Anchored	Community Solar
1	Unavailable of Financing	✓	✓	✓	✓
2	Approval/Commissioning Process time consuming/cumbersome			✓	
3	Lack of trust in vendors		✓	✓	✓
4	Loss of Business to the Utility			✓	
5	Economies of Scale		✓	✓	✓
6	Contractual Sanctity			✓	✓

Figure 9. Ability of various business models to address challenges to solar rooftop deployment in the BESCOM area

DISCOM-anchored business models may have many variants depending on the role that a DISCOM plays such as on-bill financing, payment assurance, EPC procurement, etc. (Annexure – VII).

The benefits of a DISCOM-anchored business model are:

- Loss of revenues for utility can be arrested.
- Contract security for investors/developers.
- Low cost financing from banks and financial institutions can be made available.
- There are aggregation benefits which include:
  - Lower transaction costs – financing, installation and development, interconnection and commissioning.
  - Economies of scale in project implementation, lower costs, etc.
  - Higher technical reliability and performance.
- Improved planning and infrastructure development.

The benefits of a community solar business model include:

- Matching people with rooftop/ground space, user of electricity and people with investment capital. This model can also obviate the problems from differencing distribution system capacities and rooftop availability.
- Ensuring community participation. People feel an emotional connect with clean infrastructure that they are helping to build.
- Reducing minimum investment requirements. People can own even small parts of the solar capacity.
- Benefits of scale (technology, cost and operations) with optimal location of plants.

Both models will require some policy and regulatory modifications. Community solar may also require a strong anchor and promoter of concept, to help register owners of rooftops with investors and consumers of electricity. This anchoring can be carried out by DISCOMs.

It is recommended that BESCOM consider implementing an appropriate utility-based business model to support faster scale up of solar rooftop, at the same time preventing potential business loss.

1.14 Conclusion

BESCOM, one of the most proactive utilities of India, has always been in the forefront for technological advancement and innovation to provide new services to its consumers. Its initiative to develop an open sourcing framework for solar rooftop is an important development that ensures that solar rooftop project developers adhere to national and international standards while deploying systems and interconnecting them to the grid in a simple, effective and efficient manner. One of the first utilities in India to streamline its interconnection process, BESCOM has generated immense interest amongst stakeholders who are keen to install solar panels on their rooftops and become prosumers. Post the development of initial systems and processes, a number of operational challenges have been identified as installations have started coming up on the ground. It is now time to address these teething problems and operational challenges, learn from the initial hiccups and adopt best practices to scale up solar rooftop deployment in the state of Karnataka. While the present study has identified the key areas of concern and provided feedback on the next steps, BESCOM should undertake such studies on a regular basis to continuously get market feedback and make its solar rooftop implementation framework and administrative procedures more robust and well-designed.

ANNEXURE I: SURVEY INSTRUMENT

Survey Objectives

The main objectives of survey were to:

- Identify and rank the major challenges being faced by consumers, developers and BESCOM in scaling up solar rooftop.
- Understand main drivers for adopting solar for consumers (category wise).
- Identify necessary steps for solar rooftop scale up and the associated costs/efforts.
- Assess the impact of individual changes suggested.
- Understand the perspective of developers on existing business models and associated challenges.

Stakeholders

The major stakeholders for this survey were consumers in the BESCOM region, developers/EPC players and BESCOM. The consumer segment was further subdivided into (a) educational institutes and hospitals, (b) domestic consumers, (c) industrial and commercial consumers, (d) PSUs and government. The stratification of consumer category was necessary as different consumer categories have different tariffs, metering options, key drivers, financial incentives (subsidy, accelerated depreciation benefits, etc.).

While consultants were not able to attain BESCOM response, it is proposed that for similar surveys in future, DISCOM's response should also be captured. The design parameters for DISCOM questionnaire are thus provided in Annexure for any surveys in future.

Classification of Challenges for Questionnaire Design

Identification of major challenges for questionnaire design, based upon the understanding of solar rooftop sector and interaction with developers/EPC players in the BESCOM region, included: (a) Business Attractiveness, (b) Customer Acquisition Issues, (c) Operational Challenges, (d) Regulatory Issues, (e) Technical Issues, (f) Financing Challenges, and (g) Miscellaneous. The sub-categories in the major challenges are listed below.

1. Solar Rooftop Business Attractiveness in BESCOM Region:
    a. Consumer segment focus areas:
        i. Educational institutions and hospitals
        ii. Domestic
        iii. Industrial and commercial
        iv. PSUs and government
    b. Most important challenges for solar rooftop in BESCOM for each consumer category under the new regulation (May 02, 2016):
        i. ROI attractiveness for consumer category
        ii. Regulatory issues
        iii. Contractual issues with customer
        iv. Customer acquisition cost
        v. Operational challenges
        vi. Technical issues
        vii. Income expectation of the consumer from the rooftop space
        viii. Clarity on standards
        ix. Securing financing
        x. Availability of meters

c. ROI attractiveness for each consumer category under the new regulation
d. Do-ability rating for solar rooftop for each consumer segment

2. Customer Acquisition Issues:
   a. Customer awareness for solar rooftop for each consumer category
   b. Customer interest for solar rooftop for different consumer segments
   c. Contractual level difficulty with customer in BESCOM for EPC contract
   d. Contractual level difficulty with customer in BESCOM for third party PPA
   e. Customer acquisition costs? High/low
   f. Customers return expectations? High/low

3. Operational Challenges:
   a. Application process
   b. Approval process
   c. Inspection and commissioning process

4. Regulatory Issues:
   a. Regulatory appropriateness
   b. Settlement period
   c. Wheeling, banking and CSS waiver period

5. Technical Issues:
   a. Grid availability
   b. DT infrastructure up-gradation requirement

6. Financing Challenges:
   a. Securing debt for third party PPA
   b. Soft loan impact

Survey Parameters

The parameter list on which the survey questionnaires were designed is shown in Figure 10.

Developers/EPC	Consumers
1. Solar Rooftop Business Attractiveness for each consumer segment a. Consumer Segment focus area b. Most important challenges for solar rooftop in BESCOM c. ROI attractiveness d. Do-ability rating 2. Customer Acquisition Issues (Cost, time & Contract) 3. Operational Challenges 4. Regulatory Issues 5. Technical Issues 6. Financing Challenges 7. Improvement Areas	1. Awareness 2. Interest 3. Knowledge Assessment 4. Solar rooftop model preference and reason 5. Vendor Interaction 6. BESCOM interaction 7. Interaction with Banks 8. Installation experience 9. Performance (post installation)

Figure 10. Key parameters for survey design

Survey Approach

Interaction with BESCOM, developers and other relevant stakeholders was carried out before designing the questionnaire. Based upon the understanding of solar rooftop market, the Program carried out judgment sampling, demarcating the consumer groups in the manner detailed below.

Sample Stratification

The consumer sample was divided into four groups to understand the challenges for each consumer group. The grouping was based on metering approach (Gross or Net), incentives and do-ability aspects.

Group Category	Consumer Category	Metering	Additional Incentives
Group 1	Hospital Educational Institutions	Gross Metering	Note FiT reduces if subsidy availed
Group 2	Industrial Commercial	Net Metering	AD benefits
Group 3	Government Dept. PSUs	Net Metering	Achievement Linked Incentives AD benefits
Group 4	Domestic	Gross Metering	Note FiT reduces if subsidy availed

Figure 11. Consumer sampling approach for survey

Sampling Methodology

Judgment sampling was used for developers and EPC players as it provides the flexibility in reaching out to the most relevant developers and EPC players based upon the sector knowledge.

For consumers, a random stratified sampling would have been ideal; however, it was necessary to select a sample which had certain minimum threshold knowledge of solar. To accomplish the same, only those consumers were contacted which had shown a preliminary interest in solar. The list of such consumers was obtained from the list of consumers who had applied to BESCOM for solar rooftop installation.

Sample Size

The consultants attempted to contact enough number of consultants for each consumer category and developers such that the findings are representative of BESCOM region.

The sample size for PSU and government category was found to be insufficient to draw any conclusions. Hence, no further analysis was carried out for this consumer segment. Apart from this, the sample size is inadequate to draw out any statistical conclusions from this study.

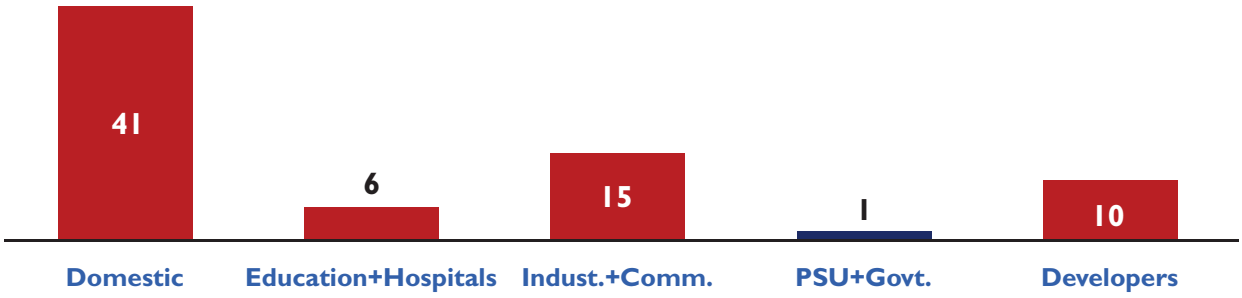


Figure 12. Profile of survey respondents across categories

Contact Method

A mix of online and offline (one-one) contact method was utilized to increase the survey reach. The distribution of online versus offline is presented in Figure 13.

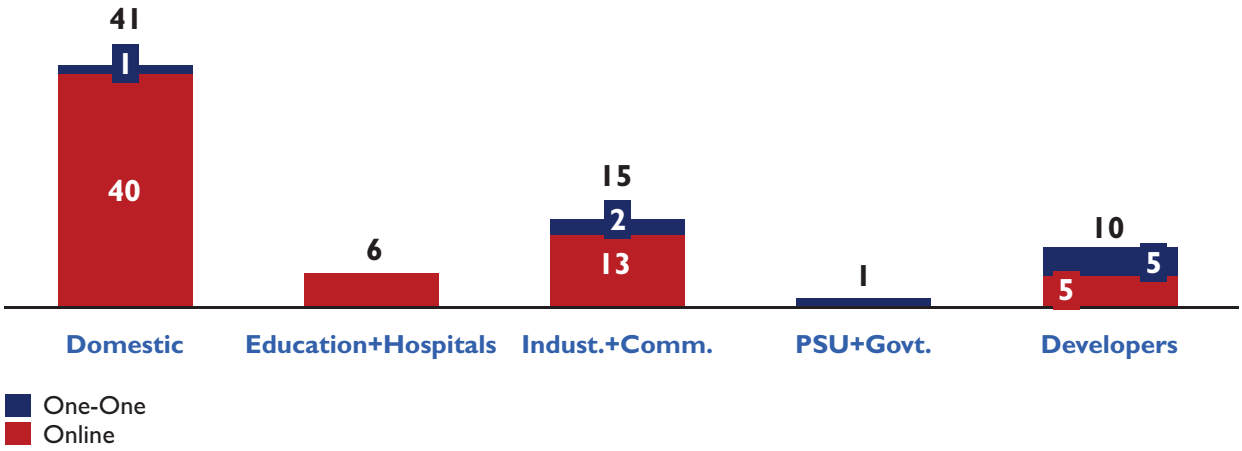


Figure 13. Engagement method for various consumers across categories

Personal discussions were carried out for in-depth analysis and to ascertain any major deviation from the online survey. No significant deviations were noted between online and offline sampling. Thus, no distinction was made between online and offline data collection for survey analysis.

Survey Area Boundary

The respondents (developers and consumers) were limited to the BESCOM region. The survey area boundary ensured that specific challenges with respect to operational aspects of one DISCOM are adequately captured. However, the learnings from this study should be applicable across all DISCOMs in the State of Karnataka.

Questionnaire Design

The set of questions were framed on the parameters discussed above. The questionnaire was designed to align with the survey's objective as outlined above and outcome from the survey is expected to provide fact based recommendation to BESCOM and other stakeholders. The questionnaire consisted of questions that required ranking and/or rating, multiple choice and subjective answers.

ANNEXURE II: SAMPLE CHARACTERISTICS

Developers/EPC Players Profile

The developers/EPC profile with respect to capacity installed, business model and consumer segment focus is presented in Figure 14.

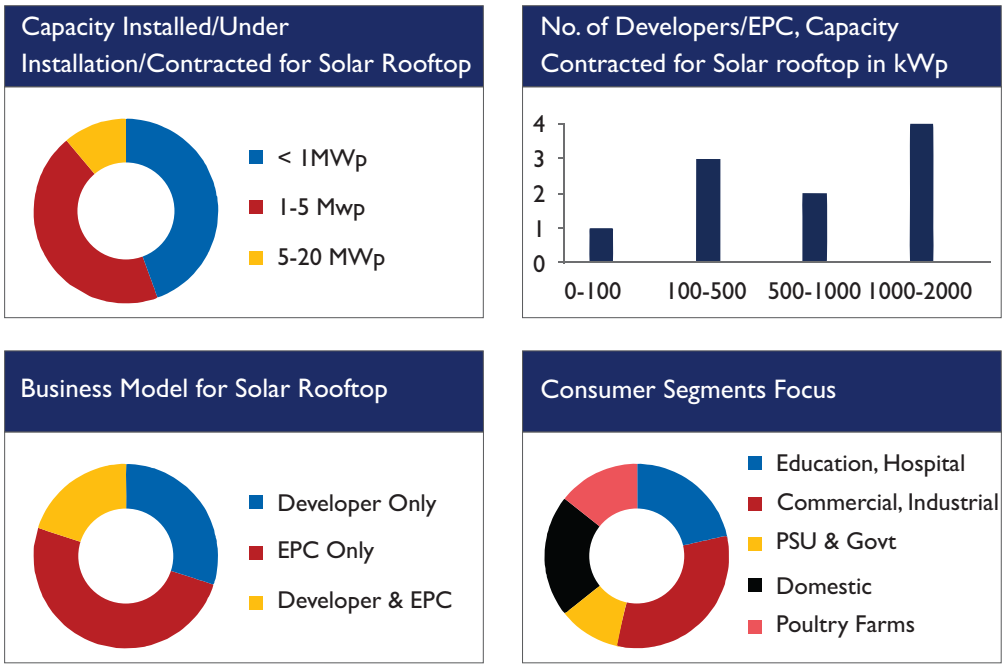


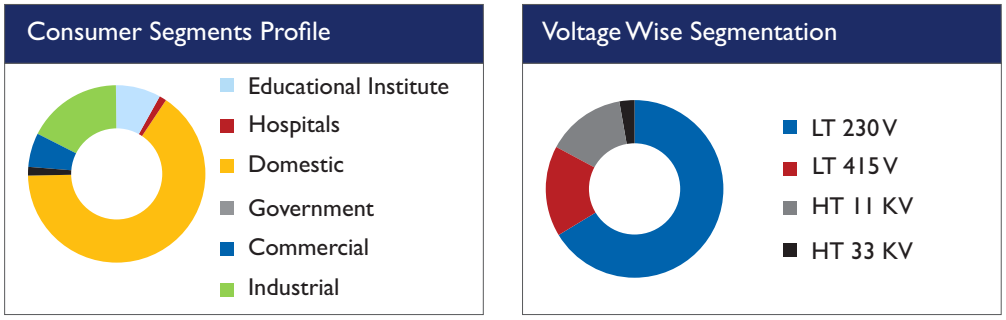
Figure 14. Profile of various developers/EPC players who participated in the survey

Sample Characteristics

All respondents are from BESCOM region only. The sample comprises of developers/EPC players whose capacity installed/under installation/contracted is distributed across 0-20 MWp range. The sample has a mix of EPC, developers, and developers and EPC players. The consumer segment focus area is adequately represented for each consumer category. With approximately 14.9 MWp of solar rooftop capacity installed in Karnataka as of July 2016, the sample can be considered representative of developers/EPC players in the BESCOM region.

Consumer Survey Profile

The consumer profile with respect to consumer category, interconnection voltage levels, region, solar rooftop system owners, interaction with different entities and business model segmentation is presented in Figure 15. It is important that results are seen in the light of consumer profile.



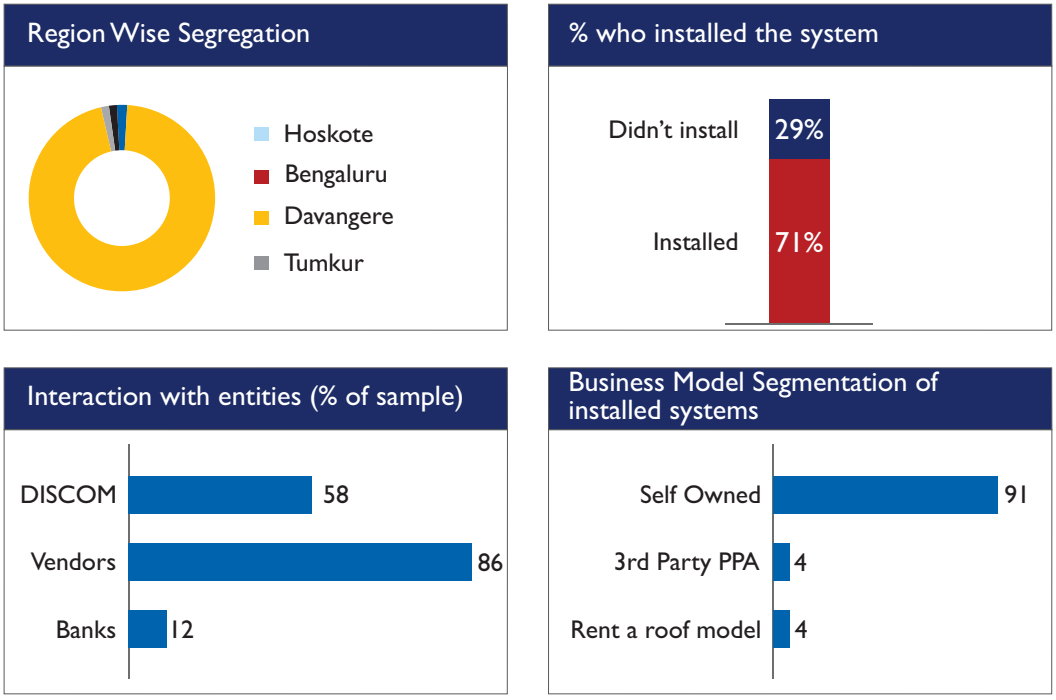


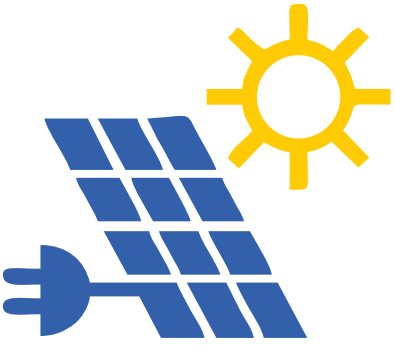
Figure 15. Profile of various consumers who participated in the survey

Sample Characteristics

The sample comprises of predominantly Bangalore consumers. While all consumer categories are adequately represented; the domestic category sample is predominant. However, since the sample stratification was done prior to survey (Group 1, 2, 3, 4); consumer segment wise analysis was carried out for each consumer category.

The sample is adequately represented by the consumers who installed the system (71 percent of samples installed solar rooftop systems). However, the percentage of samples that interacted with banks is limited. As such, the findings of interaction with financial institutions should be considered illustrative only. The business model segmentation of consumers that installed the system is predominantly self-owned. As such, majority of the analysis on third party PPA and rent-a-roof model are perception based.

The stratified consumer size for each consumer category was not adequate to carry out any statistical analysis. As such, the confidence intervals for survey answers were not calculated.



ANNEXURE III: BESCOM SOLAR ROOFTOP QUESTIONNAIRE FOR CONSUMERS

Objective

1. Identify and rank the major challenges being faced by consumers BESCOM in scaling up solar rooftop (electricity generation through solar PV technology).
2. Understand main drivers for adopting solar for consumers (category wise).
3. Identify necessary steps for solar rooftop scale up and the associated costs/efforts.
4. Assess the impact of individual changes suggested.

Parameter List

1. Qualifier – Resident of Karnataka and some awareness about solar rooftop

2. General Information:
   a. Name
   b. Organization
   c. Consumer category
   d. Average monthly bill
   e. Interconnection voltage

3. Consumer Awareness:
   a. Objective of solar rooftop installation
   b. Communication medium/mode
   c. Awareness about BESCOM's FAQ on solar rooftop
   d. Awareness of governments' INR 9.56 /unit regulation
   e. Awareness about May 2, 2016 new regulation

4. Consumer Interest:
   a. Self-effort made to learn about solar rooftop
   b. Primary reason for interest in solar rooftop
   c. What specific reason prompted to consider solar rooftop?

5. Knowledge Assessment:
   a. Rating of consumer knowledge on technology, policy, regulatory parameters
   b. Probability that a solar helpline number shall be used if implemented
   c. Impact of new regulation on solar rooftop installation plans

6. Solar Rooftop Model Preference and Reason

7. Vendor Interaction:
   a. Number of vendors interacted
   b. Ease of obtaining vendor list
   c. Ease of obtaining vendor past performance records
   d. Challenges in dealing with vendor
   e. Overall vendor rating

8. BESCOM Interaction:
    a. Rating on application process, approval process, information availability, commissioning visit

9. Interaction With Banks:
    a. Number of banks approached in public or private sector
    b. Challenges faced
    c. If loan approved
    d. Overall experience of interaction with banks

10. Installation Experience:
    a. General experience – Sanctioned load, solar capacity installed, FIT (if applicable)
    b. Business model in which the system was installed
    c. Challenges faced while installation
    d. Post installation experience (quality, savings, etc.)
    e. Challenges in installing solar rooftop
    f. Overall installation experience
    g. Would you recommend solar rooftop to a friend?

11. If Consumer Did not Install the System:
    a. Main reasons for not proceeding with installation
    b. Interest in installing solar rooftop in future
    c. Interest in installing solar rooftop in third party model
    d. Interest if third party is BESCOM

ANNEXURE IV: BESCOM SOLAR ROOFTOP QUESTIONNAIRE FOR DEVELOPERS

Objective

1. Identify and rank the major challenges being faced by consumers, developers and BESCOM in scaling up solar rooftop
2. Understand main drivers for adopting solar for consumers (category wise)
3. Identify necessary steps for solar rooftop scale up and the associated costs/efforts
4. Assess the impact of individual changes suggested
5. Understand the perspective of developers on existing business models and associated challenges

Parameters List

1. General Information:
   a. Name
   b. Organization
   c. Capacity installed/under installation in Karnataka/India
   d. Business model

2. Solar Rooftop Business Attractiveness in BESCOM Region:
   a. Consumer segment focus area:
      i. Education, hospitals
      ii. Domestic
      iii. Industrial and commercial
      iv. PSU and Government
   b. Most important challenges for solar rooftop in BESCOM, Karnataka for each consumer category under the new regulation (May 2, 2016):
      i. ROI attractiveness for consumer category
      ii. Regulatory issues
      iii. Contractual issues with customer
      iv. Customer acquisition cost
      v. Operational challenges
      vi. Technical issues
      vii. Income expectation of the consumer from rooftop space
      viii. Clarity on standards
      ix. Securing financing
      x. Availability of meters
   c. ROI attractiveness for each consumer category under the new regulation
   d. Do-ability rating for solar rooftop for each consumer segment

3. Customer Acquisition Issues:
   a. Customer awareness for solar rooftop for each consumer category
   b. Customer interest for solar rooftop for different consumer segments
   c. Contractual level difficulty with customer in BESCOM for EPC contract
   d. Contractual level difficulty with customer in BESCOM for third party PPA
   e. Customer acquisition costs? High/Low
   f. Customer's return expectations? High/Low

4. Operational Challenges:
    a. Application process
    b. Approval process
    c. Inspection and commissioning process

5. Regulatory Issue:
    a. Regulatory appropriateness
    b. Settlement period
    c. Wheeling, banking and CSS waiver period

6. Technical Issues:
    a. Grid availability
    b. DT infrastructure up-gradation requirement

7. Financing Challenge:
    a. Securing debt for third party PPA
    b. Soft loan impact

8. Current Status:
    a. Incentives/Subsidy
    b. Promotional activities
    c. Emphasis on quality

9. Improvement Areas:
    a. How best to stir up demand?
    b. Business model appropriateness for each consumer category
    c. Educational institutions, hospital and domestic customers should also be given the provision of net metering
    d. Do you believe that industrial, commercial, PSU and government customers should also be given the provision of gross metering?
    e. Tax incentives for residential consumers

ANNEXURE V: QUESTIONNAIRE FOR BESCOM

1. **Operational Aspects:**
   a. Application process: Needs total revision, needs some change, as required, better than envisaged, perfectly fine
   b. Approval process: Needs total revision, needs some change, as required, better than envisaged, perfectly fine
   c. Payment mechanism: Needs total revision, needs some change, as required, better than envisaged, perfectly fine
   d. Energy accounting: Needs total revision, needs some change, as required, better than envisaged, perfectly fine
   e. Integration of solar rooftop aspects into existing software: Needs total revision, needs some change, as required, better than envisaged, perfectly fine

2. **Safety:**
   a. How big is safety an issue for BESCOM field staff: Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned
   b. Do the current safety protocols need revision? Yes/No
   c. Proposed changes _____

3. **Manpower for Solar Rooftop:**
   a. Total strength: Absolutely inadequate, slightly inadequate, okay, slightly high, extremely high
   b. Solar rooftop understanding of field staff: Very poor, poor, okay, fair, excellent
   c. Technical – Current
   d. Interconnection issues: Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned
   e. Metering issues: Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned
   f. Bi-directional flows: Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned
   g. DT level cap: Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned
   h. Any other technical issues

4. **Technical – Future:**
   a. Reverse power flow: Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned
   b. Significant voltage variability (voltage imbalance): Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned
   c. Lack of visibility of actual circuit loads due to net energy metering (NEM): Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned
   d. Phase misbalancing: Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned
   e. Increased O&M for voltage regulation equipment: Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned
   f. Longer, steeper shape of traditional duck curve, requiring generators to respond much faster to keep up with electricity needs : Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned
   g. High voltage on circuits and secondary services with a commensurate reduction in conservation voltage reduction compliant circuits: Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned
   h. Technical challenges raised by events like solar eclipse: Not at all concerned, slightly concerned, moderately concerned, very concerned, extremely concerned

i. Do you believe that BESCOM is ready to rapidly scale up solar rooftop? Yes/No
j. If no, what do you propose?

5. Technical Solutions:

a. Technical up-gradations:
   i. On load tap changing MV/LV transformers: Very low priority, low priority, medium priority, high priority, extremely high priority
   ii. LV voltage regulators: Very low priority, low priority, medium priority, high priority, extremely high priority
   iii. MV electronic voltage regulators: Very low priority, low priority, medium priority, high priority, extremely high priority
   iv. Optimized volt/var control systems: Very low priority, low priority, medium priority, high priority, extremely high priority
   v. MV static/var compensators: Very low priority, low priority, medium priority, high priority, extremely high priority
   vi. Mesh/Loop distribution systems: Very low priority, low priority, medium priority, high priority, extremely high priority
b. Technical studies commissioned (e.g., network study and simulation of network behavior): Very low priority, low priority, medium priority, high priority, extremely high priority
c. Consumer behavior change (demand response incentives): Very low priority, low priority, medium priority, high priority, extremely high priority
d. Specifications change: Change in specifications of distribution infrastructure to be procured
e. Tools required (software): Very low priority, low priority, medium priority, high priority, extremely high priority

6. Regulatory aspects:

a. **Capacity Targets:** Linked to RPO trajectory/overall grid penetration level/monetary outlay/others
b. Do you envisage any challenge with solar plant capacity at 150 percent of contract demand? Yes/No
c. What is the percentage of grid penetration of solar rooftop? Do you believe that state grid can easily handle?
d. Overall satisfaction with solar rooftop regulation: Not at all satisfied, slightly satisfied, moderately satisfied, very satisfied, completely satisfied

7. Rank the challenges being faced by BESCOM (1 implies most pressing issues):

a. Operational challenges (application process, approval process, energy accounting, etc.)
b. Manpower issues
c. Training requirements
d. Technical up-gradations
e. Safety issues

ANNEXURE VI: PERCEPTION OF LOW GROSS METERING TARIFFS EXPLAINED

FIT is a cost plus approach with tariff determination heavily influenced by underlying assumptions. Some of the assumptions adopted by KERC in FIT determination as per May 2, 2016 regulation, which were perceived as aggressive are listed below:

a. Capacity Utilization Factor (CUF) of 19 percent is typically agreed upon as normative tariff for MW size solar PV plants; however, achievable CUF of solar rooftop projects in cities such as Bangalore is reported to be approximately 16.5 percent by various developers/EPC players. A journal publication reporting the performance of 20 kWp rooftop system at IISC, Bangalore reports an average CUF of 16.5 percent for three years operational history of the plant. The major reasons for lower CUF has been attributed to lower GHI in city areas due to dust and pollution, scheduled/unscheduled grid outages during sunshine hours and higher probability of shading in rooftop systems (as compared to ground mounted systems).

b. KERC tariff assumes no generation loss due to grid unavailability. However, as per the report published by SELCO foundation, based upon KPTCL data (FY 2014), almost 40 percent of 11 kV feeders in Bangalore urban areas had grid unavailability of greater than four hours/day. In Bangalore rural areas, 77 percent of 11 kV feeders had grid unavailability greater than four hours/day. Since no solar generation can be pumped into the grid when grid is unavailable, it results in revenue loss for these consumer categories.

c. The tariff determined by KERC assumes that debt is readily available to consumers and calculates a leveraged return on equity (70 percent debt). However, based upon the consultants' understanding of the sector's current status, debt is not readily available to all consumer categories. The levelized cost of energy (LCOE) thus derived is higher with an assumption of 100 percent equity finance.

d. There were no provisions within the design of FIT for leasing the rooftops.

Apart from this, while tariff for educational institutes and hospitals under net metering option for 500-1,000 KWp solar capacity would be INR 7.35/kWh (FY 2017); under the gross metering approach, the realizable tariff for solar generation (for solar capacity in the same range) is only INR 5.2/kWh (KERC regulation May 2, 2016) (refer Figure 16).

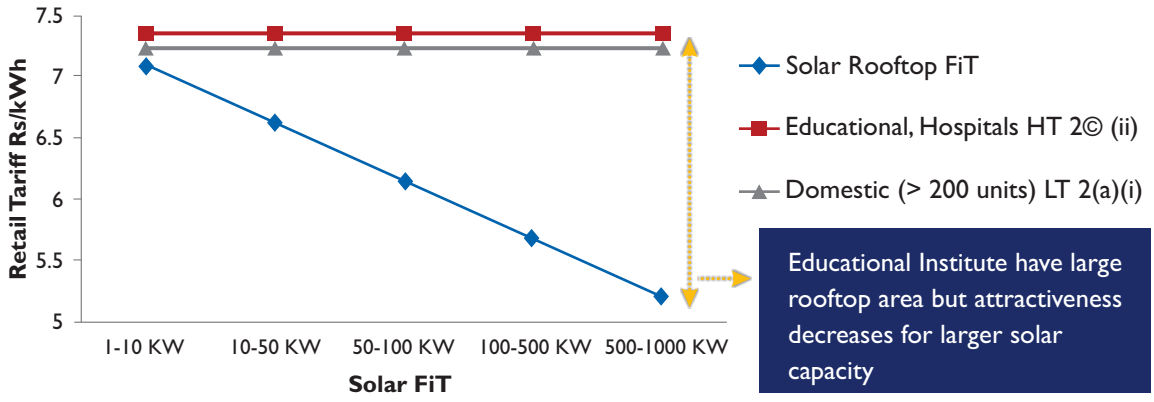


Figure 16. Comparison of solar FIT with retail tariff across various consumer categories

Since the retail tariff is expected to rise in future, the perceived financial attractiveness decreases further for educational institutions, hospitals and domestic consumers. Apart from this, the consumers in this category do not get the benefit of electricity duty reduction (as would have been possible with net metering). Also, for the domestic category, the way this income will be taxed is still unclear (under the net metering scheme, this becomes a part of savings, and hence not taxed).

Advantages of gross metering approach in terms of reduced counterparty risk for the developer (third party PPA) and easier access to finance because of decreased counterparty risk were not perceived as strong enough incentives in counterbalancing the relatively lower financial attractiveness as compared to other consumer categories.

ANNEXURE VII: DISCOM-ANCHORED BUSINESS MODELS

DISCOM-anchored business models can potentially mitigate most of the challenges identified as per the survey.

DISCOM-anchored business models allow DISCOM's to play a proactive role, such that the threat to DISCOM revenues from solar generation by consumers can be converted to an opportunity.

The description of various DISCOM-anchored business models are provided below.

Model 1: DISCOM-Anchored Procurement

A DISCOM procures high quality EPC and/or solar components (e.g., solar modules) and offers the solution to its customers registered with DISCOM. Auction may be used for reducing costs. DISCOM sets up efficient processes for customer registration, capacity sanction, choice of EPC providers, technical estimation, performance assurance (third party engineers), direct transfer of subsidies to the contractor, pre-approved loans from banks and so on. This makes it easy for customer to contract with assurance.

Model 2: On Bill Financing

A DISCOM, with its scale and size, raises cheaper debts (banks, bonds) and offers its customers loans to install solar rooftop from the chosen vendors. The customer repays in installments (fixed lease rental, INR/kWh generated basis) through his electricity bill. This model has been used successfully internationally. In India, the 'efficient lighting' initiative at homes has been implemented similarly. Payment is assured because DISCOM has a hold over the customer.

Model 3: DISCOM as Super ESCO

A DISCOM owns the rooftop systems and supplies electricity to net metering consumers at attractive tariffs. In this case, the scale will reduce cost of finance and EPC. Alternately, DISCOM acts as an aggregator. It invites bids from developers for generation tariff, adds its own margin and offers a competitive tariff to the rooftop owner. It can build in low cost financing for contractors to improve costs further. Payment risks for contractors are reduced as they get money from DISCOM.

Model 4: DISCOM for Payment Assurance

A DISCOM, due to its regular connect with customers, collects payment for electricity generated from its clients and pays the rooftop investors, for a fee. This reduces the payment risks for investors in rooftop portfolios and makes it possible to get cheaper finance. Counterparty payment risk is a very significant problem faced by current investors.

Advantages of DISCOM-Anchored Business Model over Standard (Gross Metering and Net Metering) Models

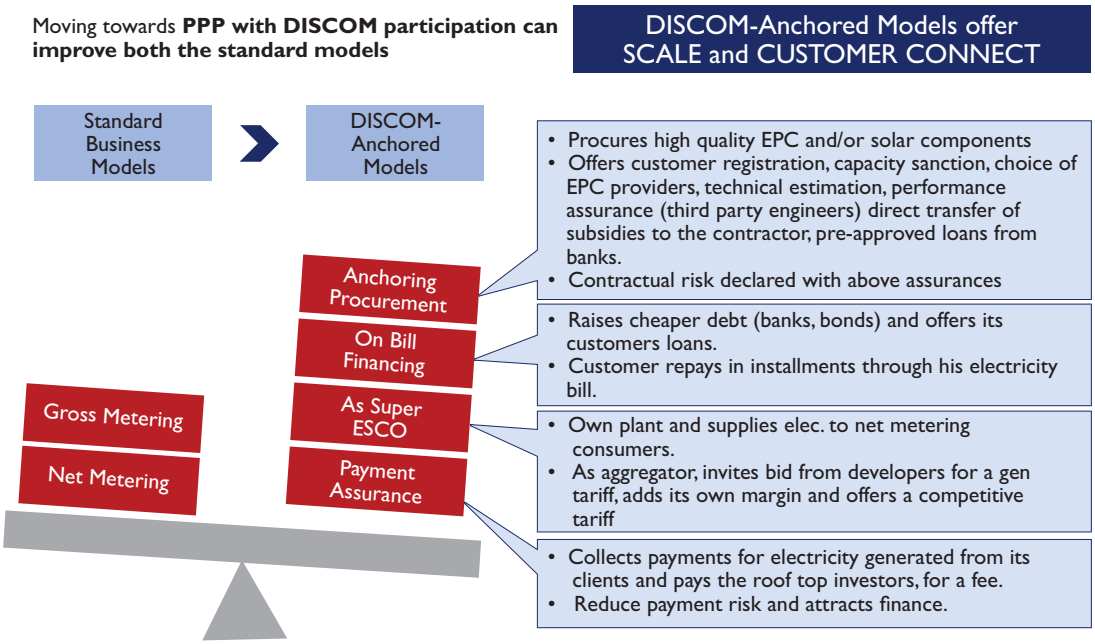


Figure 17. Details of DISCOM-anchored solar rooftop models

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