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Assessment of RESCO Model for Rooftop Solar in Schools of Delhi, India

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Abstract: The present study was conducted with the aim to understand the implementation of the rooftop solar policy in schools with a specific reference to the RESCO modelUnder this model, the consumer does not have to bear the cost of the solar installation and instead only pays for the electricity generated. The study aimed to understand the drivers, barriers and satisfaction level of the selected stakeholders at various stages of its implementation associated with the same. Government schools were chosen for the study due to their excessive energy demands. At the same time, they have great potential to tap solar energy owing to availability of large rooftop areas and high requirements of electricity. The study was conducted in Delhi, India. Stakeholders for the study included government officials, officials from selected schools, project developers and officials from DISCOMs, i.e. electricity distribution companiesThe study found that Ministry of New and Renewable Energy (MNRE) is the nodal Ministry of the Government of India for all matters relating to new and renewable energy. To implement the policies and programmes of MNRE, each state has its State Nodal Agency (SNA) which implements and promotes the policies and programmes made by MNRE in their respective states. When asked about the drivers for implementation of the policy, officials from schools reported government mandate as the major driver which was followed by reduction in electricity bills and environmental benefits. Further, various barriers were reported by the stakeholders during each step of the process of implementation of RESCO model. The study also collated suggestions given by selected stakeholders to overcome these barriers while implementing the RESCO model in schools. To overcome the delay in site verification, officials from DISCOMs suggested that government can create a separate department for solar in DISCOMs to reduce their workload and facilitate timely site verifications. Further, project developers and officials from schools suggested that the process and the documents required for the Detailed Project Report DPR can be reduced which will lead to reduction in the number of stakeholders, in turn reducing the time taken for preparation of DPR. Further, it was suggested that the timeline for submission of documents for net metering can be increased by the government as it is not possible to submit an extensive list of documents in two days. The study can be used by policy makers and professionals who are working in the area of grid connected rooftop solar systems. Incorporating the suggestions is expected to help in overcoming the barriers and can smoothen the installations of grid connected rooftop solar systems under RESCO model in schools.

Keywords: RESCO, Schools, Solar policy, Solar rooftop

Introduction

India is the fastest-growing economy in the world, with a population of over 1.4 billion [1]. It is a developing nation and one of its developmental goals is to provide electricity to each of its citizens and to meet the energy needs of the growing population [2]. Due to its population size, India is the third largest energy consumer in the world. In global primary energy consumption, the share of India is likely to increase by 9.8% by the year 2050 [3].

In terms of energy production, fossil fuels are at the forefront, with coal accounting for the largest share (nearly 50%). Renewable sources provide a modest fraction, however several of these renewable sources such as solar have a massive potential [4]. Although, the capacity of renewables between 2016 and 2022 in India saw a compound

annual growth rate of 15.92% and it is expected to double by 2026. Further, government of India has set to achieve 500 GW of non-fossil fuel based installed capacity by 2030 [5].

India is a tropical country, where sunlight is available for long hours per day and in great intensity. Therefore, within the renewable sector, solar energy has a great potential as the future energy source. The total solar potential of India is 750 GW and the installed capacity till 2022 was 59.34 GW. It is noteworthy that solar energy capacity in India has increased by more than 18 times between 2016 and 2022, from 2.63 GW to 59.34 GW [6]. Further, according to EY Attractiveness Index 2021, India has achieved fifth rank globally in solar power deployment [5].

Within the solar energy sector, rooftop solar has the highest compound annual growth rate and its capacity is expected to grow by 47% year on year. From the total rooftop solar capacity of 7920 MW in 2021, C&I sector held the maximum share of 75% [7]. The C&I sector comprises of schools, hospitals, nursing homes, factories, malls, restaurants, companies, etc. Educational buildings form a large part of this sector due to their excessive energy demands. At the same time, they have large potential to tap solar energy owing to availability of rooftops and high requirements of electricity. Thus, rooftop solar is a promising solution to meet their electricity demands [8].

To promote rooftop solar energy, MNRE is facilitating the implementation of a broad spectrum of policies and programmes such as the grid connected rooftop solar programme which aims to promote rooftop solar in all consumer segments such as institutional, commercial, etc. At the state level, every state has a State Nodal Agency (SNA) which is responsible for promotion and implementation of policies and programmes of MNRE [6]. Government had launched RESCO model to increase the uptake of rooftop solar. RESCO, i.e. Renewable Energy Service Company is a zero-investment model, in which the consumer only pays for the electricity generated. The deployment of rooftop solar under RESCO is steadily increasing and RESCO accounted for nearly a third of all cumulative rooftop solar installations in 2020 [9].

Methodology

The study was carried out in Delhi, India. Educational institutions namely, schools were selected for the study. Inclusion criteria for the selection of schools were that the rooftop solar system should be grid-connected, installed under the RESCO model and should be at least one year old. This was done in order to understand the operation of the rooftop solar system. Systems older than a year were not chosen as the government policies are dynamic in the solar sector. A total of four schools formed part of the final sample.

The sample consisted of 6 government officials from Ministry of New and Renewable Energy (MNRE), Energy Efficiency and Renewable Energy Management Centre (EE&REM, Delhi) and Indraprastha Power Generation Company Limited (IPGCL), 8 officials from schools, 4 owners/managers of project developers and 4 officials from DISCOMs,, i.e. the electricity distribution companies. For data collection, interview schedules and questionnaires were used. Separate interview schedules and questionnaires were made for each stakeholder. The interview schedule prepared for government officials aimed to collect information regarding the implementation of RESCO model. The second interview schedule designed for officials from DISCOMs aimed to collect information regarding net metering in terms of metering and billing arrangement. Further, the questionnaire prepared for project developers had questions on the installation, operation and maintenance of rooftop solar systems in selected schools. The second questionnaire prepared for the officials from schools aimed to gather information on their role in the implementation of rooftop solar in terms of documentation, timeline, cost and energy savings. All four stakeholders selected for the study were also asked about their drivers, barriers, satisfaction level and suggestions for better implementation of the RESCO model in schools.

A code sheet was devised for all the responses obtained by converting the open-ended questions into close-ended questions. After this, a master sheet was made in which the data was entered, which was followed by calculations of percentages. The questions with rating scales were analysed by calculating the mean ratings along with standard deviations. Wherever applicable, bar graphs, pie charts or other necessary diagrams were made. Conclusions and inferences were drawn as per the objectives of the study.

Results and Discussion

Framework of government policy at the central and selected state level for rooftop solar in schools

The Ministry of New and Renewable Energy (MNRE) is the nodal Ministry of the Government of India for all matters relating to new and renewable energy. The broad aim of the Ministry is to develop and deploy renewable energy for supplementing the energy requirements of the country. To implement the policies and programmes of

MNRE, each state has its own state nodal agency which implements these policies and programmes in their respective states.

MNRE launched the phase I of the Grid Connected Rooftop and Small Solar Power Plants Programme in 2015 for the installation of 4,200 MW rooftop solar (RTS) plants in the country by the year 2019-20. The implementation agencies for sanctioning the RTS projects under this programme were State Nodal Agencies (SNAs), Solar Energy Corporation of India (SECI), Public Sector Undertakings (PSUs) and other Government Agencies. MNRE on 19th February 2019 approved Phase-II of this programme for achieving a cumulative capacity of 40 GW rooftop solar plants by 2022. In this phase, DISCOMs and its local offices were made the nodal points for implementation by MNRE. Further, it was seen that the selected state, Delhi had its own policy over and above MNRE. The initiatives for grid connected rooftop solar installations by central and selected state government have been illustrated in Table 1.

Table 1: Initiatives for grid connected rooftop solar installations by central and selected state government

Initiatives by central government			
State	**Rooftop solar policy**	**Operative period**	**Details of the rooftop solar policy**
PAN India	Grid Connected Rooftop and Small Solar Power Plants Programme	2019-2022	• MNRE promoted grid-connected rooftop solar in all consumer segments, viz., institutional, commercial, etc. for rapid deployment of rooftop solar, DISCOMs were brought to the forefront as key drivers. Further, they promoted multiple business models such as the RESCO model and created awareness, capacity building, and human resource development for rooftop solar.
Initiatives by selected state government			
State	**Rooftop solar policy**	**Operative period**	**Details of the rooftop solar policy**
Delhi	Delhi Solar Policy, 2016	2016-2021	• State promoted the development of grid- connected rooftop solar plants through promotion of multiple financial models such as RESCO. Further, state assisted solar project developers to participate in schemes announced by MNRE.
Delhi	Delhi Solar Policy, 2022	2022-2025	• State aims to create a state portal to provide information about solar systems and has proposed new deployment models such as Hybrid RESCO, and peer to peer energy trading model. Further, the targets for installed solar capacity have been increased to 6000 MW by 2025.

Responses of Selected Stakeholders with Respect to the Implementation of RESCO Model in Schools

The grid-connected rooftop solar programme was issued for achieving 40,000 MW of energy from rooftop solar. This phase was implemented through DISCOMs. They were made nodal points due to their direct contact with the consumers and were involved in each step of the process (MNRE, 2019). Associated stakeholders were selected for the study to understand the implementation of the RESCO model under the rooftop solar policy in schools. It was found that the schools were approached by the state nodal agency through tenders to install rooftop solar in their respective schools. There were several steps involved in the process of installation of rooftop solar under RESCO model. Table 2 presents the process of installation of rooftop solar under RESCO as per the stakeholders.

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Table 2: Responses of selected stakeholders regarding the process, steps and time taken in the implementation of the RESCO model

S. No.	Stages of Process	Associated Stakeholders	Time allotted for each step as per policy	Actual time taken in each step	Details of each step
1.	Release of tender by the government for project developers to install rooftop solar under RESCO in selected government schools	• Officials from IPGCL • Officials from EE&REM • Project developers	3 months	4 months	• In this step, the project developers bid for the tender by submitting their bid proposal along with supporting documents on the e-tendering website. A processing fee was submitted by the developer which was between Rs. 15000- 20000. • The documents needed to be submitted included: General information, price bid for RESCO, bid bond, bank performance, consortium agreement, undertakings, among others. • Further, the officials evaluated the bid and selected the project developer.
2.	Selected project developers contact the schools to install rooftop solar	• Project Developer • Officials from schools	-	2 days	• The project developers selected in the tender further contacted the officials of the schools. In this step, they explained about the details of the proposed rooftop solar plant and fixed the time for site verification with the school authorities.
3.	Site verification and issuance of Letter of Approval (LOA) by the project developer to DISCOM	• Project developer • Officials from schools	15 days	2-3 months	• An engineer from project developer visited the school for site verification. The engineer examined the building structure and the layout of the roof in detail such as availability of shadow free area, height of the tress, amount of time for which sunlight is received. • Blueprint of the building was provided by the officials from school & architects of the buildings were also contacted to take opinion on how rooftop solar can be installed in the existing building. Based on the data, a detailed project report was prepared by the developer. • School principal signed a power purchase agreement with the developer.

Table 2: Responses of selected stakeholders regarding the process, steps and the time taken in the implementation of the RESCO model (contd.)

S. No.	Stages of Process	Associated Stakeholders	Time allotted for each step as per policy	Actual time taken in each step	Details of each step
4.	Submission of net-metering application form by project developer to DISCOM	• Project developer • Officials from schools • Officials from DISCOM	1-2 days	1 week	• In this step, project developer submitted the net metering application form on behalf of the school on the DISCOM's portal. • Documents to be submitted in this included occupancy proof, signature ID, photographs, latest electricity bill, pan card along with written request for net metering on letter head of the developer's company. • Further, an undertaking for installing rooftop solar and net meter was also submitted on a Rs. 10 non-judicial stamp paper which was duly attested by the principal of the school. Along with this, Rs.500 had to be submitted as fee.
5.	DISCOM conducts site visits and further required documents are submitted by the project developer	• Project developer • Officials from schools • Officials from DISCOM	15 days	1 month	• DISCOM conducted site visits to check the technical feasibility of the site for net meter installation. If the site was found feasible, DISCOM issued No-Objection Certificate NOC to the school. • Further, the developer submitted undertakings for declaration of the roof rights. • Approved NOC, registered form and single line diagram duly attested by consumer along with the stamp, copy of PPA, project report was submitted to the DISCOM.
6.	Evaluation of the submitted documents by DISCOM	• Officials from DISCOM	2 days	15-20 days	• In this step, the documents received by the DISCOM were evaluated in line with the site visit conducted by them. • Once the documents were verified, the DISCOM proceeded with the net metering process. • If the documents were not found in order, the project developer was contacted to re-submit them.

NOC: No objection certificate

Table 2: Responses of selected stakeholders regarding the process, steps and the time taken in the implementation of the RESCO model (contd.)

S. No.	Stages of Process	Associated Stakeholders	Time allotted for each step as per policy	Actual time taken in each step	Details of each step
7.	Net metering agreement is signed between consumer and DISCOM	• Officials from schools • Officials from DISCOMs	15 days	20-25 days	• Net metering agreement was signed between principal of the school and DISCOM on a non-judicial form of Rs. 100. • Registration charges of Rs. 9,000 were paid for net meter installation. • However, the registration charges for rooftop solar system with a capacity of more than 100 kW ranged between Rs.10,000-15,000.
8.	Installation of rooftop solar system & net meter by project developer and DISCOM respectively	• Project developer • Officials from schools • Officials from DISCOM	3-6 months	5-6 months	• In this step, rooftop solar was installed by the project developer. • Further, after installation of rooftop solar, the project developer intimated the DISCOMs to install net meter & within the next 15-20 days, installation of net meter was done by the DISCOM.
9.	Inspection after installation by DISCOM & further commissioning of rooftop solar & net meter	• Officials from schools • Officials from DISCOM	7-10 days	1 month	• After installation, DISCOM conducted an inspection of the site system for fulfilment of minimum technical specifications and standards, and commissioning certificate was issued by the DISCOM. • Further, the rooftop solar system and net meter were commissioned, i.e., it was synchronized with the grid and the bill was generated after 1 month.

Drivers with respect to the implementation of the RESCO model in schools

The data indicated that schools were mandated by the government to install rooftop solar systems. Thus, government mandate was reported as the driver by all the school officials selected for the study. Further, 50% of the school officials stated that government mandate was followed by environmental benefits as a driver. The data revealed that 25% of the school officials rated low operation and maintenance cost as a driver. They stated that under RESCO model, they did not have to spend money on either operation or maintenance, and all the services were being provided by the project developer. Another driver reported by all the selected school officials was that rooftop solar led to a decrease in their electricity bills by 30-40%.

Further, it was seen that on a larger level, project developers stated that schools generally opted for rooftop solar under RESCO because it was a zero-investment model for them and additionally, they received monetary benefits through reduction in electricity bills. Further, government officials stated that with such a zero-investment model, schools became instrumental in spreading awareness about rooftop solar among students, who were the future consumers.

Barriers with respect to the implementation of the RESCO model in schools

Selected stakeholders gave various responses when asked to report and rate the barriers they faced while implementing the rooftop solar policy. Government officials were involved in the policymaking part, not the implementation, thus their perspectives are not included in this section. The highest mean rating of 4.0 (on a scale of 1 to 5, with 1 is the least important barrier and 5 is the most important barrier)) was given to improper working of e-tendering website due to technical reasons. The project developers mentioned that due to these technical difficulties, the tendering process got delayed. The second highest mean rating of 3.5 with a standard deviation of 0.7 was given to extensive documentation required for net metering application. Project developers stated that there were several documents which needed to be submitted and the time allotted for it as per policy was just 1-2 days, which was difficult to meet. They needed to take the documents from the officials of school who did not cooperate with them at times, leading to delays in the submission of documents.

Further, project developers gave a mean rating of 3.0 to the presence of tall trees in the vicinity of the building. They stated that they could not cut tall trees without prior permission from horticulture department, which took time and led to delays in installation. They also mentioned that tall trees reduced the availability of shadow free area, which resulted in a reduced efficiency of the installed rooftop solar plant. Further, a mean rating of 2.7 with a standard deviation of 0.1 was given to delay in site verification and evaluation of documents by DISCOM. Project developer reported that DISCOMs took a lot of time to fix the dates for site visits which led to delay in the installation. The officials from DISCOMs reported that they were overloaded with work due to limited personnel power, which led to delay in the site verification and evaluation of documents.

Project developers gave a mean rating of 2.3 to officials of schools not cooperating with them while sharing documents. They stated that officials from schools installed rooftop solar because of government mandate and these officials displayed a level of ignorance towards rooftop solar. Due to this challenging dynamic, the officials did not always cooperate with project developers when they had to provide documents. On a more holistic level, government officials felt that the consumers were not aware of the benefits of rooftop solar and there exists a need to educate consumers to be fully aware of the rooftop solar policy and the benefits that accompanied it.

Table 3: Suggestions given by selected stakeholders to overcome barriers faced by them with respect to the implementation of rooftop solar policy

Barriers faced	Suggestions for improvement
Improper working of the e-tendering website	• P: There should also be an offline mode for the submission of bids for tenders • P: In case of prolonged downtime of the portal, the government should increase the timeline for submission of the bids.
Extensive documentation required for submission of net metering application form	• P: The timeline for submission of documents can be increased by the government as it is not possible to submit an extensive list of documents in 2 days. • P: The documents can be taken by DISCOMs in two steps/parts.
There were tall trees and less available shadow free area in the vicinity of the building which led to delay in installation	• S: The horticulture department can speed up the process for cutting down trees (in case where there is minimal shadow free area available on rooftop due to height of trees).
Delay in site verification & evaluation of documents by DISCOM	• D: Government should create a separate department for solar in DISCOMs to reduce their workload and facilitate timely site verifications. • S: DISCOMs should be motivated and can be provided generation-based incentives for installations in institutional sector to ensure timely actions.
There were many stakeholders involved in the preparation of detailed project report	• P: Timeline for the submission of detailed project report can be increased due to involvement of many stakeholders. • S: The process and the documents required for the report can be reduced which will lead to reduction in the number of stakeholders.
Installation of rooftop solar leads to weakening of the building structure	• P: Engineers must be consulted, and proper layouts must be made during site verification process to ensure that the rooftop solar installation does not hamper the structure of the building

D = Officials from DISCOMs, S= Officials from schools, P = Project developers

The data in Table 3 indicates the suggestions by selected stakeholders to overcome the barriers faced in implementation of the policy. The project developers suggested that to overcome the barrier of improper working of the e-tendering website, the government should either accept offline submissions or the government should increase the timeline for submission of the bids. Additionally, to overcome the barriers faced due to extensive documentation in net metering application form, project developers suggested that the time for submission of documents can be increased or submissions could be taken in two parts by the DISCOMs.

Further, officials from schools suggested that to avoid delay in site verification and evaluation of documents by DISCOMs, they should be motivated and can be provided generation-based incentives in institutional sector as well to ensure that they worked on time & in synergy with the government for growth of solar. On the other hand, DISCOMs suggested that a separate department of solar should be made to reduce the burden of work on them. According to the project developers, engineers must be consulted during site verification and technical feasibility analysis and layouts must be made carefully to overcome the barrier of weakening of building structure due to installation of rooftop solar.

On a broader level, project developers stated that they faced the problem of limited financing options for RESCO. To overcome this, they suggested the Reserve Bank of India (RBI) should intervene and provide financing options to RESCO companies. They stated that government can also create a mechanism where loans are being provided by all the financial institutions for RESCO projects. According to government officials, to overcome the problem of lack of awareness among consumers, campaigns and workshops should be conducted by both project developers and DISCOMs and it should not be only government's duty to make people aware about solar and its benefits.

The study presented here highlights the framework and implementation of RESCO model for grid connected rooftop solar installations in schools. The study also presented the perspectives of each stakeholder regarding RESCO model and its implementation in terms of drivers, barriers and suggestions to overcome the barriers. The study showed that in-spite of the government support, there are significant challenges and barriers in the implementation process which has affected the growth of rooftop solar in institutional buildings. To overcome these barriers, the suggestions from this study from each stakeholder can be used in the future to improve the implementation of RESCO model.

Conclusion

The study has offered a view of the implementation of RESCO model in schools in Delhi, India. The study has gathered the drivers and barriers associated with the implementation of RESCO model for rooftop solar and highlighted the suggestions given by selected stakeholders to overcome those barriers. The suggestions given in the study can help to increase the acceptability and implementation of government initiatives for grid connected rooftop solar systems in schools under RESCO model. The study can be used by policy makers and professionals who are working in implementation of the policies and programmes for grid connected rooftop solar systems. Incorporating the suggestions can help in overcoming the barriers and will smoothen the installations of grid connected rooftop solar systems under RESCO model in schools.

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