ASIAN DEVELOPMENT BANK INSTITUTE

ADBI Development Case Study No. 2024-2 (February)

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https://doi.org/10.56506/THRB8532

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The authors thank Kent Weaver and Blair Cameron of the Leadership Academy of Development, Stanford University, for their guidance in writing and revising the paper; Mariam Momjyan of the Tariff Policy Department, Public Services Regulatory Commission, Republic of Armenia, and Rachelle Gladys Audar of the University of Tokyo for peer reviewing; the Asian Development Bank's South Asia Department; and colleagues at the Asian Development Bank Institute for their support in organizing the workshop and editing the case study, including KE Seetha Ram, Nghia Nguyen, Tuesday Soriano, and Adam Majoe.

The views expressed in this case study are the views of the author and do not necessarily reflect the views or policies of the government they represent. This case study is based on interviews conducted from May 2023 to July 2023.

Introduction

On 29 September 2018, the heads of 400 government institutions, such as universities and medical colleges, across Madhya Pradesh gathered to sign an agreement to install solar rooftop power generation systems on the premises of their institutions. Under the agreement, the government institutes will only pay for the electricity generated per the monthly bill of the solar power developer, while the installation and operation of the solar rooftops will be the sole responsibility of the developer. This zero-investment model, also known as the Renewable Energy Services Company (RESCO) model, was led in the state of Madhya Pradesh by the New and Renewable Energy Department and implemented by the department's nodal agency, Madhya Pradesh Urja Vikas Nigam Limited (MPUVNL).[1]

Nimish Vora, the PricewaterhouseCoopers (PwC) consultant helping MPUVNL roll out the project, described the 29 September meeting as an example of how innovation in processes was a distinguishing component of the project, "The whole crux of the journey was not the agreement; it was the process. Many other states replicated the agreement, hoping for a similar response from institutes and solar developers, but that did not happen."

[1] MPUVNL is a fully owned company of the Government of Madhya Pradesh.

In response to climate change, India has set targets for the use of non-fossil fuel-based energy sources. In addition, in 2015, India communicated its Intended Nationally Determined Contributions to the United Nations (UN) Framework Convention on Climate Change, which comprised eight targets (Press Information Bureau 2022a).

Of these eight targets, "cumulative electric power installed capacity from non-fossil sources to reach 40% by 2023" was one of the quantitative targets promised by India (Press Information Bureau 2022a). This includes goals for generating renewable energy from solar, wind, hydro, biopower, and nuclear sources (Press Information Bureau 2022a).

Within non-fossil capacity, the target for solar energy has been set at 100 gigawatts (GW) by 2022 (Press Information Bureau 2016), of which 60 GW should be achieved through ground-mounted systems and 40 GW through solar rooftop systems (Das 2022). Due to its subtropical climate, India receives abundant sunlight throughout the year in many regions, making the country an important source of solar energy in the world (Ministry of New and Renewable Energy n.d.).

By November 2017, India had made significant progress in the installation of ground-mounted systems: nearly 16 GW was installed against the target. However, progress in solar rooftop projects was only 0.9 GW against the target of 40 GW (Gulia and Garg 2022). Due to lack of innovative policy interventions, lack of interest and capital investment from consumers, solar rooftop has been a nonstarter in India's solar energy initiatives. "In the whole glorious story of India's solar revolution, distributed solar rooftop has been a blackspot," Vora said.

After India's pledge at the UN Climate Change Conference (COP 21) in 2015, the Indian federal and state governments were desperately looking for a viable and successful solar rooftop model that could catapult its solar energy push.

The Government of Madhya Pradesh was conscious of its solar potential. The state receives plenty of sunlight throughout the year, with an average annual solar radiation of 5.5 kilowatt-hour (kWh)/square meter (m^2)/day (Gupta 2023). This indicates substantial potential for solar energy utilization. The climatic conditions in Madhya Pradesh are suitable for solar power generation due to clear skies and relatively high temperatures.

Manu Srivastava, who was the principal secretary of the Department of New and Renewable Energy and managing director of MPUVNL from 2015 to 2022, believes the renewable energy sector is now at a "beautiful moment in history, wherein, what is environmentally sustainable is also economically viable" and believes in taking full advantage of this opportunity. In 2017, Srivastava achieved a remarkable feat by leading the development of the Rewa Solar Park—one of the largest ground-mounted solar parks in the world. This project attracted global attention for achieving the then lowest solar tariff of $0.036 and became an inspiration for India's clean energy enthusiasts (Mukul 2018). After the successful execution of the Rewa Solar Park, Srivastava set his sights on similar success in solar rooftop projects.

"As per existing schemes of the Ministry of New and Renewable Energy (MNRE) Government of India, the implementation of the solar rooftop segment is divided into two broad categories:

(i) domestic or retail consumers, and (ii) institutional consumers. As per the operational modalities followed by government agencies in Madhya Pradesh, the first category is served by power distribution companies of Madhya Pradesh (MP DISCOMs),[2] where concerned consumers are located, and the second category is served by Madhya Pradesh Urja Vikas Nigam Limited (MPUVNL) across the state," said Karmveer Sharma, current managing director of MPUVNL. So, MPUVNL's focus was on serving institutional consumers under the project.

"One thing I realized about the Rewa project is that it is not easy to replicate," Srivastava said. Ground-mounted projects involve huge capital expenditure (CAPEX) and require vast swaths of land for project execution. However, commissioning solar rooftop projects, especially in institutions, also came with unique problems and challenges such as insufficient capital at the institutions for investment and lack of expertise in operating a solar plant. These challenges, according to Srivastava, created a natural market for the RESCO model and the opportunity for the solar power developer to operate the plant and for MPUVNL to act as a facilitator between the producers (solar power developers) and the consumers who are also project sites—in this case, government institutions. Under the RESCO model, a renewable energy service company develops, installs, finances, operates, and owns the solar rooftop power project and supplies electricity generated by the project to the consumer on whose premises the project is installed or to the power grid.

To be an efficient facilitator, MPUVNL needs to build trust between the producers and the consumers. Srivastava commented, "The idea was simply to make the project bankable and viable." This meant a couple of things—making the project attractive (1) to the government institutions through low cost of power and low capital investment, and (2) to the solar power developers through assured returns over a longer period of time.

However, previous projects in the country using the RESCO model have not been very successful. "Information asymmetry plays the biggest role in the high costs," said Vora, the PwC consultant. Without information about the potential area for solar rooftop installation and the financial capacity of the institutions, solar power developers could not offer a competitive tariff. MPUVNL knew it had to take innovative measures in processes to attract interested parties to the project. MPUVNL's goal was to ensure that it provided all the details to the solar power developer to make the model truly successful.

Background

While deciding on the model for implementation of solar rooftop projects in the state, MPUVNL considered two main approaches: the capital expenditure (CAPEX) approach and the Renewable Energy Services Company (RESCO) approach.

[2] In Madhya Pradesh, electricity distribution is a monopoly being executed by three DIStribution COMpanies (DISCOMs), each of which is solely responsible for electricity distribution in the region assigned to it. These are the West DISCOM, the Central DISCOM and the East DISCOM, all of which are owned by the Government of Madhya Pradesh.

Under the CAPEX model, the consumer would own and pay for the installation of the solar system and for its operation and maintenance for the life of the system. "We realized the limitations of the CAPEX pattern, of which one was that consumers don't have the funds to invest in these projects," Srivastava said. Many institutions were not willing to invest in setting up solar rooftops on their premises, while other institutions that had invested in setting up solar rooftops were not able to maintain them. Srivastava recalled a CAPEX-based solar project that was implemented on the banks of the Bhoj Lake in Bhopal. He noted that the project had suffered due to lack of funds to maintain the solar panels after commissioning. As a result, many CAPEX projects are not utilized beyond the usual 5-year maintenance period.

Another reason for the failure of past CAPEX project, as Vora pointed out, was that the vendors defaulted on both the timelines and payments. "There was something structurally wrong in bringing discipline to the vendor who develops and manages the asset in CAPEX. It became apparent that the vendor was unable to consistently deliver on time and at the agreed-upon cost. Additionally, the CAPEX contracts were not adequately binding in terms of ensuring efficient maintenance following commissioning," said Vora.

Srikanth Deshmukh, superintendent engineer and in charge of the RESCO project at MPUVNL, who reports directly to Srivastava, also mentioned the time-consuming process of the CAPEX model to get the vendor on board. "CAPEX takes time. In CAPEX, we survey the site, we give an estimate that goes somewhere to the higher level, gets approved, the budget is sanctioned, then the budget is sent to us, and then we order. And then someone comes and installs it. A cycle of one year, almost unlike the RESCO, where the overall process of bidding and signing the contract only takes 2–3 months."

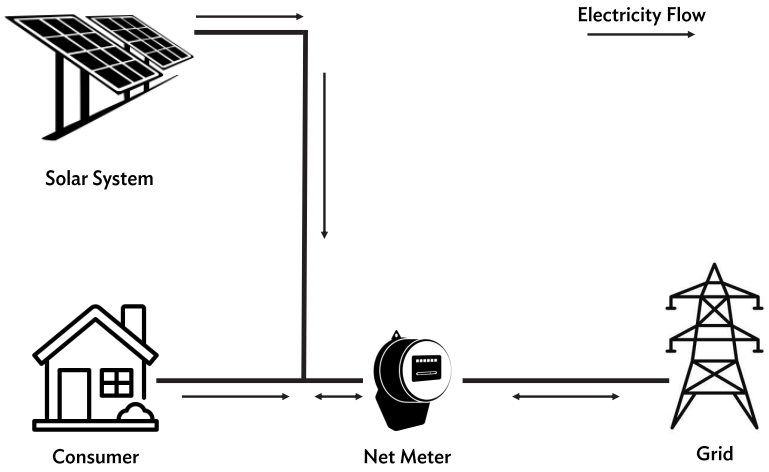
Srivastava and his team at MPUVNL then took a closer look at the RESCO model. As mentioned earlier, the RESCO model differs from the CAPEX model in that the private solar development company owns the project and not the customer. The solar developer bears the entire capital investment for the development of the project and in return receives permission from the customer to use its rooftop space. The customer uses the electricity generated from the solar rooftop and pays a predetermined tariff to the solar developer as per the terms of the power purchase agreement (PPA),[3] adhering to the extant regulations decided by the regulatory authority, which in the case of Madhya Pradesh is the Madhya Pradesh Electricity Regulatory Commission. The tariff, that is price per unit of electricity sold by the developer to the consumer is quoted by the RESCO developer through the tender, taking into account the financial viability, i.e., monthly receivables, initial investment, subsidy paid by the government to the solar developer for solar rooftop installations, etc. With the RESCO model, the customer does not have to pay any upfront costs and only pays for the electricity generated. The RESCO developer is responsible for the operation, maintenance, and repair of the project during the term of the agreement. The term of the agreement is usually 25 to 30 years and provides the solar power developer with a guaranteed return on investment. This model is a cost-effective choice from the customer's standpoint compared to the CAPEX model where the rooftop owner owns the project (Javid and Jha 2021).

[3] A power purchase agreement (PPA) is a long-term electricity supply agreement between a power producer and a consumer. In this case study, it is also referred to simply as an agreement for simplicity.

Under the RESCO model, there are two ways in which the consumer can use the electricity generated from the solar project: export-based and non-export-based. In the non-export-based model, the excess power generated by the project over and above the consumer's demand is not fed into the system. The excess energy can either be stored in a battery or lost. Under the export model, subject to regulatory restrictions, the excess power generated by the project, if any, is injected into the grid at feed-in tariff prices; this method is also known as net metering.

With net metering, the excess power is drawn from the grid when the consumer has an electricity deficit, i.e., when demand is greater than the electricity generated by the solar rooftop. However, if there is surplus power, the excess power is fed into the grid. The consumer then receives a bill based on the cumulative difference between the electricity drawn and electricity fed into the grid (Figure 1).

Figure 1: Net Metering Concept



Source: CEEW Centre for Energy Finance.

The projects carried out by MPUVNL were based on the export-based net metering model. The following rules for net metering projects defined by the Madhya Pradesh Electricity Regulatory Commission (MPERC) applied during the project period:

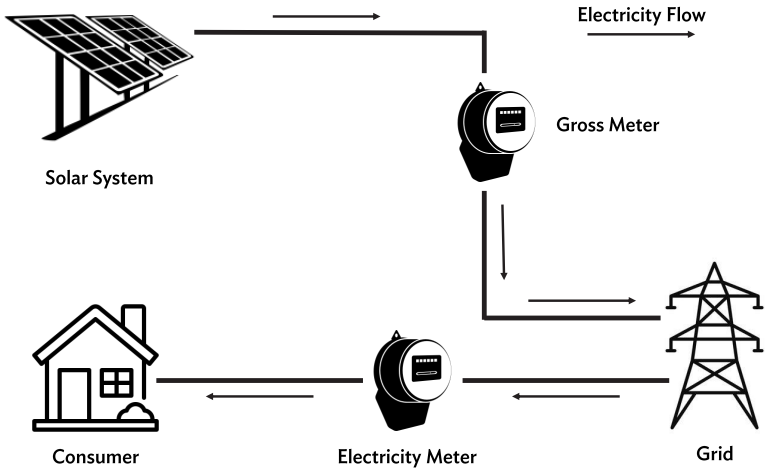
- The cumulative capacity (in megawatts [MW]) of net metering projects shall not exceed 1 MW (MPERC 2015). This has been changed to 500 kilowatts (kW) in the latest regulations on net metering in 2022 (MPERC 2022).
- The cumulative capacity must not exceed 30% of the peak capacity of the distribution transformer to which the consumer is connected (MPERC 2015). The same was changed to 70% in the latest net metering regulations in 2022 (MPERC 2022).

"These norms arrived based on the consumer rules issued by the Ministry of Power and aforesaid limits considered by other Electricity Regulatory Commissions (ERCs) and comments offered by DISCOMs and other stakeholders. No separate study was carried out in this regard," said Umakanth Panda, secretary of the MPERC.

The change in export model regulations is an important risk for solar developers if they invest in the RESCO model. As electricity in India falls under the purview of states, the regulations vary from state to state (Javid and Jha 2021). Recently, gross metering has prevailed over net metering (net metering is the model used in all the projects discussed in the case study). The concept of gross metering (Figure 2) has been introduced in Madhya Pradesh in the current 2022 regulations, which define gross metering as "an arrangement under which all the energy generated by the renewable energy generating system installed on the prosumer's premises is purchased by DISCOMs, and the DISCOMs raises the bill on the prosumer for its consumption at the approved tariff after giving credit for the total generated electricity at the discovered tariff." (Prosumers are entities that are both producers and consumers).[4]

"This means that whenever electricity is imported from the grid, the prosumer pays the same price as a normal customer. Whenever the prosumers inject the excess generated electricity to the grid, the DISCOM can decide the rate depending on the electricity's supply time," explains Priyanka Paliwal, assistant professor at the National Institute of Technology, Bhopal, and an expert in distributed renewable energy. Even Raghuraj Rajendran, managing director of Madhya Pradesh DISCOMs, also commented positively on the recent developments in gross metering when he said, "We have written to the regulator opining to do away with net metering and permit the installations only based on gross-metering going ahead."

Figure 2: Gross Metering Concept



Source: CEEW Centre for Energy Finance.

[4] A prosumer is a consumer that consumes electricity from the grid and can also feed electricity into the grid.

As the enforcement of power purchase agreements is difficult and litigious, the likelihood of the client defaulting on their payments increases over time. As a result, the RESCO model typically offers the RESCO developer with limited legal remedy and are hesitant to undertake projects with customers that do not have a solid track record. Therefore, larger companies with good credit ratings are often more likely to benefit from the RESCO model than smaller businesses/ institutions, which in reality are more likely to rely on a RESCO-based model for the transition to renewable energy (Javid and Jha 2021).

The RESCO model has been successfully implemented in the private sector in the country in the past. But for the government as a customer, the reliance of solar power developers on the government buyers for timely payments was low. Also, it was not possible for the solar power developers to switch off the power when the payments were overdue. "You cannot disconnect electricity from the police department's installations," said Vora.

So there were many challenges when it came to making solar power developers partners in implementing the RESCO model in institutions and especially in government institutions. "Many states were unable to get the solar developers on board. Either the developers did not show interest when the tender was floated, and when some developers showed interest, they quoted a higher bid rate," said Paliwal.

Vora pointed out some of the problems in implementing the RESCO model in an institutional setting and cited the example of one of the first RESCO models in India implemented by the Solar Energy Corporation of India (SECI), the company established by the Government of India to facilitate the implementation of the National Solar Mission. SECI had launched a project in 2014 to implement the RESCO model across India. "SECI implemented a common tender for one state, after which it was left to the selected solar power developer to attract the willing customers in that State to develop solar panels on their respective premises," Vora said. All the marketing for the project was on the shoulders of the solar power developers, and that was made even more difficult with the government institutions as there were bureaucratic hurdles for approvals, which led to poor implementation of RESCO-based solar power generation.

Therefore, it was important for MPUVNL to gain the trust of solar power developers to invest in solar rooftop installations in Madhya Pradesh, especially in government institutions. "Any private sector investment would require the project to be bankable and viable. This principle is typical for ground-mounted and rooftop projects. So if we look at it philosophically, the principle is straightforward, i.e., the interest of the developer is to be bankable and viable. This means that the returns that the developer expects over a more extended period are assured," says Srivastava. "Whereas we pre-identified the building, and mapped the solar rooftop area for each building, institutions of similar sizes and ownership were clubbed together under a contract, after which the bidding was done. That way, the developers knew which projects they could put up," Srivastava said, highlighting the extra effort the team made to ensure solar developers had all the information they needed to bid on the contract.

The idea of extensive solar rooftop installations did not resonate well with the state's energy DISCOMs. "The DISCOMs were initially apprehensive about how the rooftop systems would interact with their existing distribution network," Vora said. "So far as DISCOMs/TRANSCOs

are concerned, integration of renewable energy (RE) is the main issue. Further, power from solar rooftops is not available during peak periods, so appropriate and economical storage facilities are required," said MPERC secretary Panda, as the DISCOMs suffer a loss due to the net metering model as the consumer often supplies excess power during the day when the electricity purchase cost is generally low and consumes more power during the dark hours when the electricity purchase cost is high. However, according to Mohan Dhoke, chief engineer at Madhya Pradesh Power Transmission Company Limited (MPPTCL),[5] the distributed generation, as in the case of solar rooftops, is good for the health of the distribution network as it reduces the load on transformers.

The support of potential host institutions was also needed for the solar installations. "Srivastava gave us full support in onboarding government institutions. He wrote letters to all the federal and state government institutions regarding the RESCO project planning and requested their approval to sign the PPA," said Tarun Swarup, then assistant engineer and member of the RESCO team at MPUVNL. When asked about the initial thoughts on the RESCO project proposal, Pawan Srivastava from the Federal Academy of Police Training, Bhopal, one of the institutional RESCO participants, said, "We were pleased about the project as it fulfills our commitment towards the environment. The most interesting thing was that no capital investment was required from the Academy as the partner company made all the investments under the model."

Delivery Challenges

Against the backdrop of constraints in RESCO-based solar power implementation in Madhya Pradesh, Srivastava and his team had to overcome numerous challenges to successfully implement the scheme. Below are some of the key challenges faced by the team.

1. Information Asymmetry

"[The] basic principle is that we should look at things from the investor's point of view, i.e., if you were the investor, what would make your life simpler. Suppose there is a medical college, say ShivPuri, the solar power developer does not know which this medical college ShivPuri is. It is impractical for him to go to ShivPuri and see it. The idea was to make him see the medical college ShivPuri at the click of a button." – M. Srivastava

The RESCO tenders involved the installation of solar rooftop projects on 643 project sites located throughout the state. These project sites were categorized into different groups based on several factors. RESCO developers were required to bid for each of these groups. However, in order for the RESCO developer to offer a reasonably competitive tariff given the longer commitment period of 25 years, the developers required certain information to carry out their due diligence. "This information was diverse and ranged from the physical description of the site to the financial capability of the beneficiary. It is needed to determine the type of institution that the developers will be working with during project implementation and importantly, to verify the institutions'

[5] MPPTCL is fully owned by the Government of Madhya Pradesh.

creditworthiness," informed Swarup. Elaborating further on this aspect, Srivastava said, "Creditworthiness is an important consideration for the developers as they are sharing a greater risk by investing upfront and recouping their investments through monthly bills to the institutions." Creditworthiness is even more critical in the case of government institutions as outstanding payments (i.e., unpaid or late paid bills) from government agencies to the state-owned DISCOMs is a common phenomenon across India (Sidhartha and Dutta 2022).

To conduct this analysis, the RESCO developers had to visit various institutions and obtain relevant information from them. Because these government institutions were spread throughout the state, it was logistically impossible and financially imprudent for the participants to visit each project site, analyze all the information, and arrive at a competitive tariff. Vora described the problem from the perspective of a government institution, where the panels are installed by RESCO developers, "The institutions might allow it for one vendor, but for many vendors reaching out to them at different times, they may be annoyed and not allow it. The vendors also need the institutions' consumption profile, payment and credit profile. It is inconvenient for the vendors to ask these questions and people don't give answers easily. Not everyone would be happy to share this information." Vora continued, "We can imagine that a mess would soon be created if every participant approached the government institutions individually with their questions, resulting in frustrated institutions and unanswered questions."

This could potentially lead to lose-lose scenario for both the RESCO developers and the institutions if the tender is finalized with a higher tariff due to information asymmetry. Therefore, the challenge was to provide as much information as possible about the sites without making life difficult for the RESCO developers.

2. Economic Viability

In the previous RESCO tenders in the power sector by SECI (Ministry of New and Renewable Energy 2016), as mentioned earlier, a tender was floated where the RESCO developers were asked to bid for a particular capacity generation in a given area. This method had many problems. First, the marketing was left to the RESCO developers. Thus, RESCO developers had to identify willing government institutions with sufficient energy needs and work with them individually to develop feasibility reports, which often resulted in failure to achieve economies of scale that is essential to the viability of the developer's business. A second problem was the importance of the institutions' ability to pay. Srivastava said, "We thought about what the rate the developer would offer would depend on. The rate would depend on the credibility of the consumer." The project included institutions with varying degrees of rooftop surface area and creditworthiness. "Despite this variation in the profile of the institutions, the RESCO developers had to quote the same tariff per unit, which resulted in cross-subsidizing where an institution with a larger rooftop surface area and better credit history did not get better rates than an institution with a smaller rooftop surface area and poor creditworthiness," added Srivastava.

For the economic viability of the project, which in this case is a lower tariff, it was imperative for MPUVNL to draft the tender to address the concerns of the RESCO developers and institutions.

So, the challenge for Srivastava's team was to design and invite the tender in a way that the tariffs are appropriate for the institutions based on their energy requirements and creditworthiness and the developers can achieve economies of scale to break even.

In addition, the RESCO project requires solar power developers to make an upfront investment, which may discourage some solar power developers from participating in the bidding process. Developers who choose to participate in the bidding process may quote higher tariffs that may not appeal to consumers, rendering the project ineffective. In order to bring down the tariffs, interventions such as subsidies were announced by the federal and state governments (All About Renewables n.d.). One of Srivastava's challenges for his MPUVNL team was to increase project viability by instilling investor confidence through timely release of subsidies. This can have a positive impact on the developer's finances, as the tariff quoted by the developer takes into account the promised subsidy.

3. Project Sustainability

The solar power developers made an upfront investment in the solar rooftop projects, and the investment costs and profit could only be recovered through the monthly payments made by the beneficiary institution for the generated electricity. Thus, the sustainability of the project depends on the sustainability of the developer's cash flow, which largely depends on the institution's timely payments. "[We] need a very strong payment mechanism for monthly bills," quips Hardik Kumar, senior engineer for EPC projects at Adani Green Energy Ltd., one of the RESCO developers, which installed 18 rooftop systems under this project. "(RESCO) developers will not be able to take any immediate action (if payment is delayed) [against] the institutions considering the legal complexity, at most the developers will not maintain the plant, hampering solar generation," said Paliwal while explaining the negative repercussions of delayed payment to the solar power developers.

If the institution delays the monthly payments to the developers despite the use of the generated rooftop power, it will not only affect the developers' cash flow but also their morale and interest in operating and maintaining the project. Since the RESCO developer is solely responsible for the operation, maintenance, and repair of the project under the RESCO model, payment delays can affect the sustainability of the project. In addition to the RESCO developer's concerns, Srivastava mentioned the institution's concerns regarding the operation and maintenance of the constructed facility, "If there is one major learning for us through the CAPEX model, it was that we need to include provisions in the contracts that incentivize the developers to maintain the solar panel assets at highest efficiency," he added.

Another important challenge for Srivastava's MPUVNL team, therefore, was to develop a contract document that would embed the provisions that would alleviate the stakeholders' concerns.

4. Organizational Change Management

As Srivastava's team was used to executing CAPEX-based projects, the idea of RESCO-based solar rooftop power generation took him some time to get the full support of the team. "At first, a lot of officers did not agree, but Manu Sir was a great support in convincing them," said Vora. Most of the concerns were related to the change in performance and delivery requirements of the RESCO-based projects as facilitators rather than project executors, which the organization and its officials were often used to. "MPUVNL staff were not used to visiting beneficiaries to collect information. They had a very different approach toward their work and deliverables until then; they were more used to giving approvals for various projects rather than collecting information," said Vora.

Since MPUVNL is a lean organization with about 40 employees, it had to go beyond its usual work responsibilities to be closely associated with the project. "For the execution of the project, stakeholder coordination and field visits were a crucial component. This was not possible with the team strength that MPUVNL had available. MPUVNL has limited staff; there is only one person looking after one district," said Vora. Another organizational aspect of this project was finding the right partners to support with technical expertise while ensuring that the cost to the government remained low.

Response to the Delivery Challenges

Addressing the challenges of distributed renewables in India required innovative thinking and strategic intervention. While Srivastava and the MPUVNL team have implemented important solutions to address these challenges, it is important to note that despite their efforts, some problems remained. "Nevertheless, we're proud of the progress we've made in this field and we will remain committed to finding sustainable solutions to India's energy needs," Srivastava said.

1. Information Asymmetry

MPUVNL had to overcome the challenge of data asymmetry to enable RESCO developers to find the optimal and lowest tariff. To achieve this, Srivastava and his team developed the unique concept of a "virtual data room" that can host a bouquet of technical and financial details that the developers need, to understand their client at a click of a button (Figure A2 and A3 in the Appendix).

"The 'virtual data room' refers to a cloud drive that contained all the relevant information about the sites, both physical and financial details. This included information on details such as estimated rooftop and ground area, GPS coordinates of the location, transformer capacity, average electricity consumption of the institution, copies of previous electricity bills, contracted demand, estimated capacity, transformer size, project installation view, indicative solar photovoltaic (PV) array layout superimposed on a Google image for each site, and contact information. It even provided bidders with information such as the required number of panels and inverters and the length of cables needed to implement the project at a particular site," said Srivastava.

The technical execution of creating the data room was supported by the World Bank under a special program, Sustainable Partnership for Rooftop Solar Acceleration in Bharat (SUPRABHA) jointly implemented by the World Bank and the MNRE. The biggest challenge faced by Srivastava and his team in setting up a "virtual data room" was to collect information from hundreds of institutions across Madhya Pradesh in a short span of time. The MPUVNL team decided to strategically carry out the information-gathering process. They used a top-down approach by reaching out to the respective administrative heads of department of the respective institutions, convincing them about the RESCO project and asking them to request the required details from the institutions under their jurisdiction. For example, they approached the principal secretary of the Medical Education Department, the Government of Madhya Pradesh, to reach out to all the medical college consumers.

Srikanth Deshmukh, superintendent engineer, then RESCO project in charge at MPUVNL, explained, "We (MPUVNL) approached the commissioner of the respective departments and showed the format, which had so many columns and rows, and requested for information. We circulated this format to all the institutions, set a time limit, and obtained all the forms. A satellite picture of different institutions was generated using satellite imaging and heliscopic technique.[6] The data was organized by creating a folder for each proposed project in the rooftop projects, which in turn contained a subfolder for each institution."

In this way, "Approximately 80% of the site information is available in our data room, so any developer can find brief details about the sites without visiting the site, just by using the data room," said Swarup. For the sites where it was difficult to geo-tag individual buildings in Google Earth, the appropriate buildings were identified and the respective system capacities were calculated. "To ensure exact placement of the buildings within the physical boundaries of the institutions and to avoid confusion with the buildings of the adjacent institution, local teams were also deployed to validate the location and the draft," informed Swarup.

The RESCO developers were able to find brief information about the sites without having to visit them. Since the contact details of the institutions were also provided, RESCO developers can reach any institution by phone for further clarification. "The 'data room' was very useful and a strong selling point. There were certainly variations, but these were discovered during the initial design stage itself. The data room and other information was by and large accurate, even if some of the contemplated designs/sizes were not," said one of the RESCO developers, who did not wish to be quoted. "Although other information was useful, the data for estimating solar power capacity was not accurate," said Hardik Kumar of Adani Green Energy Limited, pointing out some gaps in the data room information.

Overall, the "data room" has indeed instilled confidence in RESCO developers to participate in the RESCO tender. "It has helped to ensure the transparency of the bidding process by providing all bidders access to the same information. The validation of the data room's success is the competitive tariff quoted in the tender," said Srivastava.

[6] M/s Folsom Labs is the developer of the solar PV design tool HelioScope. This tool aims to simplify the process of designing and engineering solar power systems. It claims to make the solar design process 5 to 10 times faster for solar designers. HelioScope offers a web-based user interface with solar layout tools and energy simulation.

2. Economic Viability

Economic viability is crucial for the continuity of the project as it improves the profit margin for the project developer and leads to a competitive tariff.

2.1 Grouping of the Institutions

Achieving economies of scale in the distributed renewable energy sector is a major challenge due to the lower capacity potential of each installation, remote locations, higher unit costs to generate revenue, operation and maintenance costs in remote locations, among others. To overcome this inherent limitation of distributed solar energy, MPUVNL had to get a large number of institutions on board to have a tender with a significant capacity addition that can attract the interest of solar developers. "We reached out to different government departments and private organizations and convinced them about the RESCO project. We pre-identified 643 project sites for implementation of the RESCO project including federal/state/private universities and colleges, industrial training institutes, government medical colleges, power grid substations, and urban local bodies. We have also worked extensively with the beneficiary institutions to get pre-clearance for the respective institutions to sign the PPAs from the respective administrative authorities," said Srivastava.

However, getting several institutions on board is only one part of MPUVNL's job as they also had to decide on the mode of bidding for the institutions. "We divided the interested institutions into different project groups based on various parameters of the institutions, viz., ownership (federal government, state government, private), size of projected installations, which depends on the type of institution (universities, colleges, hospitals, government offices), etc., and invited a separate tender for each group," Srivastava said. He added that the ownership largely reflects the payment credibility of the respective institutions.

For example, all government colleges across the state with an individual capacity ranging from 8 kW to 80 kW formed one group, while all medical colleges in the state with an individual capacity ranging from 1 MW to 1.5 MW formed another group. In this way, all project sites were grouped into 27 project groups. The group capacity ranges from 25 kilowatt peak (kWp) for individual private organizations to 5.4 megawatt peak (MWp) for all projects of a genre across the state combined, and so on. Bidding for each group was separately invited, and the winner had to implement all the projects in that group. MPUVNL also fixed the maximum tariff for each group of projects at $0.049/kWh after conducting their due diligence.

"This ensured that each project group had similar institutions with similar characteristics such as credit profile, capacity addition, etc.," said Srikanth Deshmukh. Srivastava argues that the clubbing of institutions was necessary "because the idea was that we should not be cross-subsidized. Because if you club a small building and a big building, the big building will always get a lower rate than the smaller building. So we thought that we should not be cross-subsidizing. If a large building with a good payment track record deserves a lower rate, it should get it. That is why, for example, universities and colleges, although they fall under the same higher education department, were clubbed separately because the universities are bigger and the colleges are smaller. In addition, all medical colleges with a site capacity of >100 kW were clubbed together, all medical colleges with a site capacity of <100 kW capacity were clubbed, and so on."

Srivastava commented that the quoted tariffs for the respective groups confirmed that the grouping of institutions was indeed logical and reflected the developers' confidence in the payment credibility of the institutions. "The tariffs received were lowest for the federal government institutions and for few state government institutions with larger commissioned capacity, while the tariffs were higher for state government institutions with lower commissioned capacity and for the private institutions."

2.2 Provision of Subsidies by the Government for RESCO Developers

A reduction in investment costs can trigger a domino effect in the solar rooftop sector, as it leads to a reduction in tariffs, which in turn can lead to increased adoption and better payment practices by institutions. In an effort to promote distributed renewable energy in India, the Government of India and the governments of several states, including Madhya Pradesh, have launched several schemes that provided subsidies for solar rooftop projects (All About Renewables n.d.). The subsidies were to be paid through the project implementing agencies such as MPUVNL and were to be paid to the RESCO developer after the project was commissioned. The subsidy announcement during the invitation of tender for these projects allowed bidders to precisely model their capital requirements required for each of their sites in advance.

"The subsidy was about 28%–30% of the project capacity from the federal government and 15% to 20% of the project capacity from the state government," informed Paliwal. So the promised subsidy was about $2.3 million from the federal government and $1.8 million from the Government of Madhya Pradesh. "The government subsidy lessened the financial burden on solar power developers, which eventually led to the tariffs being reduced to as low as $0.017 per kWh during bidding, which was about four times lower than the lowest DISCOM tariff of $0.073 per kWh," Srivastava said.

However, full disbursement of the subsidy has not yet been paid in full to the RESCO developers. The federal and the state governments have only released a partial amount of the promised subsidy. The failure to disburse the subsidy to the RESCO developers on time has had a very negative impact on the project's financial performance. "We have not received a single part of the subsidy promised by the government," shared Hardik Kumar of Adani Green Energy Limited, giving an indication of the gloomy outlook of the companies that participated in this RESCO process. "We have received about 25% of the promised subsidy," shared another RESCO developer who did not wish to be quoted.

The subsidy challenge had a major impact on the perception of the protagonists regarding the provision of subsidy in implementing similar projects in the future. Srivastava commented, "I think it is much better as the tariff would still have been much lower than the DISCOM tariff even without the government subsidy. The weak point of the project was the subsidy. Although the subsidy was promised, people did not receive it. I think that is the biggest weakness of this project. So it's better if there is no subsidy so that the real rate comes about."

3. Project Sustainability

The RESCO projects are based on long-term PPAs with a term of 25 years. In order for the project to remain sustainable, both the developers and the institutions must make a long-term commitment by fulfilling their respective obligations, i.e., timely payments by the consumers and regular operation and maintenance by the developers to ensure that the solar plant operates at optimum efficiency.

3.1 Timely Payments by Consumers

During the pre-bidding process, MPUVNL made extensive efforts to obtain pre-clearance on the terms of the PPAs. "25 years of PPA ensure that the respective roles and responsibilities of both sides are maintained," Srivastava said. In addition, MPUVNL has arranged "comfort letters" for payment security and timely payment of bills from the institutions. "In RESCO 1 and 2, we tried to ensure payment security through comfort letters. So the comfort letter only served to reassure that it was the respective administrative departments who bear the payment liabilities," says Vora. "An appropriate tender provision was also made to address delays in the monthly payments to the developers by including a letter of credit which the developer could use to get the due payment from the bank without any reference or instructions from the procurer," Srivastava added. "However, the tender provisions related to payment were not as comprehensive as the bid project because institutions were not ready to give payment guarantees to MPUVNL. There were government departments that gave guarantees that they would pay, but that was not as strong as the CAPEX-based ground-mounted project that we did earlier in Madhya Pradesh (Rewa)," Srivastava added.

Hardik Kumar of Adani Green Energy Limited reported that to date they have still not received 50% of last year's receivables. "Federal institutions are as good as our best private customers, but that is not the case with state government institutions, probably because they use different systems for their monthly payments," added another RESCO developer who did not wish to be quoted.

RESCO developers can turn to MPUVNL to mediate or approach the MPERC for their intervention as there is a binding PPA between the developers and the institutions. "For projects in RESCO mode, the role and involvement of MPUVNL is limited until the execution of the power purchase agreement between the RESCO developer and the beneficiary organization (consumer), known as the PPA parties. Once the PPA is executed, the transaction and the relationship between the two parties will be governed by the PPA, which does not define any role or involvement of MPUVNL. Post-PPA, the role and involvement of MPUVNL is not envisaged. So, keeping the sanctity of the PPA intact, any interventions outside the jurisdiction may not be lawful," said Karmveer Sharma, current managing director of MPUVNL, when asked about the steps taken by MPUVNL with regard to the delayed payments by consumers. "Despite the appropriate provisions in the PPA, in case of default in payment, the affected party can approach the commission under Section 86 1(f) of the Electricity Act, 2003," added MPERC secretary Panda.

Srivastava added, "In hindsight, the perceptions of the developers were correct. The developers had kept the tariff low for the Government of India departments, which they expected to pay on time. These institutions actually paid on time. On the other hand, they had set the tariff higher for the state government institutions, which were expected to cause delays in the monthly payments, and there were some delays in these institutions." There was also no point of contact for payments to RESCO developers. Therefore, the developers had to go from pillar to post in various institutions to collect the bills.

3.2 Operation and Maintenance by Developers

The sustainability of the projects also depends on the maintenance of the solar infrastructure by the developers. "In the RESCO model, the amount is paid per the electricity units being generated, regardless of consumption. This keeps the interest of the (RESCO) developer in both production and maintenance. This is the uniqueness of the model," said Paliwal. "Since there is no provision for payment of minimum charge or fixed monthly payment to the developers, the RESCO developers remain motivated to maintain the solar panel infrastructure as they can realize their investment only through the monthly bills, which in turn directly depend on the electricity generated by properly maintained solar panels," added Srivastava.

MPUVNL has also asked solar power developers to provide a remote monitoring system (RMS) to enable monitoring of projects from a remote location. The system provides real-time data on the performance of the projects, including energy generation, energy consumption, and other parameters. This data is used to optimize the performance of the solar power plants and ensure they are operating at maximum efficiency. "The solar projects in the RESCO model are functioning efficiently as can be inferred from the RMS," shared Deshmukh.

4. Organizational Change Management

To execute Srivastava's vision, the MPUVNL team had to work differently than usual; they had to transform their role from that of project approver and executor to that of a facilitator. During the project period, MPUVNL staff were involved in drafting the agreement, validating the data room, and clarifying doubts of solar developers and institutions. "After the tender document was floated on the website, we tried to clarify the issues raised by the solar developers and take their suggestions into consideration. If the developer is ready to participate in the tender with some minor corrections or suggestions that are in favor of the projects, we incorporated them in our tender documents and our projects were successful. We also helped them with the installation of the projects. So the projects went smoothly," said Swarup, highlighting MPUVNL's promptness in the project execution stage. They also contacted government institutes after the contract was signed to help resolve issues during implementation. This led to the capacity development of the staff. "It was not that people were experts when they started. Along the way of implementation, people developed expertise," said Vora.

Vora also emphasized that one of the biggest challenges faced in implementing the project was not only building the capacity of staff, but also creating a self-sustaining ecosystem. "If you want to drive a large-scale transformation, you definitely need an anchor. However, an anchor alone is not sufficient. Beyond the anchor, you need an ecosystem. That was the challenge that we tackled to some extent. But I would say it could have been even better if the ecosystem had been more accepting of moving on autopilot according to the regulations. Currently, it depends on who is driving it," said Vora.

After the transfer of Srivastava as principal secretary of Madhya Pradesh's Department of New and Renewable Energy Department, the solar rooftop project did not see much additional traction through the MPUVNL. However, after Srivastava became the principal secretary of the Department of Technical Education, Skill Development and Employment, he continued his vision in this department. He launched the Solar Rooftop in State's Technical Institutions (SRISTI) project, which envisages the introduction of RESCO-based solar rooftop generation for industrial training institutes. The SRISTI project was launched in 2022 and is currently in the phase of the first tender, which will be published soon.

Outcomes

In July 2017, MPUVNL invited bids for the development of 33 MW of grid-connected solar rooftop plants based on the RESCO model. A total of 31 companies submitted bids for the tender (Kabeer 2018).

"The bids were opened in December 2017. This was followed by several rounds of discussions with the bidders as part of pre-bid meetings. These provided a forum for bidders to ask questions about the tender and to get clarifications from MPUVNL. The meeting was also an opportunity for MPUVNL to get feedback from the bidders on the tender documents," informed Srivastava. By August 2018, five developers were selected under RESCO 1. "In the RESCO 1 tender, we have included all kinds of government and private institutions, ranging in capacity from 5 kW to 1.3 MW," said Swarup. Around the same time, bids were invited for RESCO 2 for 10 kW. "RESCO 1 and 2 were mirror images of each other. The leftover medical colleges and government colleges were included in RESCO 2," explained Deshmukh. By October 2019, one developer was finalized through RESCO 2.

A low tariff of $0.017/kWh was obtained for RESCO projects and the project was commissioned in December 2018. Tariffs varied for different clusters and largely reflected the confidence of solar developers in the credit profile of the respective institutions. Some of the central government institutions received the lowest tariff of $0.017/kWh and some of the private sector institutions received the highest tariff of $0.031/kWh in the tender.

"In RESCO, we got the lowest rate in the country. In RESCO 2, we made the opening at RE-INVEST 2020, which is a national-level renewable energy conference or meet held in Greater Noida. That's a big deal. We opened a power purchase there. We did it all in the full public air and didn't know the

price. The rate was even lower than the previous one. The World Bank director and the secretary of MNRE (Government of India) were also present," said Srivastava happily.[7]

PwC consultant Vora emphasizes, "The way things are done is a very important aspect that is generally overlooked. People think that it is the document that works, but it is not. That's the differentiating factor. The unique thing is that many people did not look at this segment. In fact, they did not even consider India as a destination for investment and especially in government segments to bid. They thought India was not the first but the fifth country and the private sector was the only segment. The government was not there. And forget the state governments, even the federal government did not think of bidding. But the big international private companies finally bid for this project. That is the sign of the impact the project has made. A company from Singapore took part in a bid in India and also won something."

The RESCO projects, in which several domestic and international players have participated, have shown that it is possible to achieve very low tariffs for solar rooftop by demonstrating the creation of a market for solar rooftop in Madhya Pradesh, which has the potential to generate significant amounts of solar power. Moreover, the Capacity Building Commission of the Government of India has identified the RESCO project as one of the notable innovations that have immense potential for scaling up and wider application. Some of the notable achievements of the RESCO model in Madhya Pradesh are highlighted in Table 1.

Table 1: Metrics on the Implementation of Solar Rooftop Projects

S. No.	Item	Particulars
1	No. of trees cut reduced	25 lakh (annually)
2	CO_2 avoidance	60,000 tons (annually) up to December 2021 (analyzed by MIS of MPUVNL)
3	Quantity of power generated	200,000 units (kWh) from July 2020 to May 2023 amounting to $80,000
4	Coverage of institutions	643 sites covered
5	Average tariff achieved	[$0.039/ $0.023] per kWh; minimum rate achieved is $0.017 per kWh

CO_2 = carbon dioxide, kWh = kilowatt-hour, MIS = management information system, MPUVNL = Madhya Pradesh Urja Vikas Nigam Limited.

Source: MPUVNL.

Following the success of the RESCO 1 and 2 tenders, the team sought to launch two further tenders. However, the third and fourth tenders were not as successful as the first and second tenders.

[7] Figure A1 in the Appendix shows photographs of the Renewable Energy Services Company (RESCO) solar rooftop installations.

The RESCO 3 tender focused on industrial companies in 2019, in the form of an auction. "There are a variety of sectors in industrial estates. Not all of them have the same credit profile. Not everyone would enjoy the same rate. An averaging approach was taken for the tariffs," said Vora. The team also brought in Madhya Pradesh's investment promotion company as an intermediary and gave it the authority to recover the lease payments from the industrial companies in case the solar power developers failed to pay. When the tender was floated and the results were announced, COVID-19 struck. "The timing was bad, the project needed investment, and at the time industrial users were facing an uncertain market outlook. The whole thing was designed well but it could not be launched," added Vora. One of the challenges for the companies was to commit to a RESCO agreement for 25 years. The uncertainty of whether a company could survive that long, especially in the midst of COVID-19, was a question.

RESCO 4 was bid in 2021. "We successfully bid for a 40-megawatt RESCO 4 tender for all government and private institutions. Five developers were selected and were ready to sign the power purchase agreement for a 40-megawatt capacity. They were also offered a lower tariff of $0.048 per kWh without any subsidy, which was a good tariff at that time," said Swarup.

"Due to the onslaught of COVID-19 and its unquantifiable impact on business communities, the tariff discovered under the concerned tender was considered higher and uncompetitive as expected and hence was not considered," said MPUVNL managing director Sharma.

The team that worked on these RESCO projects shared mixed feelings, "Some team members felt that we did so much but only a part of it came to light. It could have been better if the project had achieved the scale that was envisioned. It is strange because it is one of the most cost-effective programs of the country. It would have been really gratifying to see high proliferation—a challenge that is still unresolved. That is, how to scale the project and make it run on autopilot," said Vora.

The current management of the New and Renewable Energy Department has a vision for scaling up solar rooftop usage in government institutions in Madhya Pradesh. "The plan is to reach out to all possible and technically feasible government and institutional premises with a proposal to deploy solar systems to save electricity bills and conserve energy. MPUVNL is ready with discovered rates to undertake such works either in EPC mode or the RESCO model. The RESCO model would primarily cater to consumers with a contractual demand of more than 100 kW (since it is a zero-investment model and the developer makes an upfront investment, a capacity of less than 100 kW would not be financially viable for both the procurer and developer), while utilities requiring smaller systems have the option of having the system installed by MPUVNL in EPC mode. All government departments, including the federal government and their corresponding institutions, are aware of these financial models. MPUVNL through its head office and district offices are continuously following up on the proposals," shared Sharma. They are also planning regulatory changes to increase the viability of solar rooftops. "A draft amendment to the MPERC regulations on net-metering regulations is being prepared to enable rooftop deployment through virtual net metering,"[8] he added.

[8] Virtual net metering is net metering of electricity generated by a system that is located in a different place than where the energy is consumed.

Lessons

As observed from the interventions taken by the MPUVNL team led by Srivastava, MPUVNL's RESCO model for solar rooftops has worked in some areas and not in others. The project offers several valuable lessons for all the stakeholders, especially for governments looking to implement RESCO-based distributed renewable energy in their jurisdictions. Several lessons can be generalized:

1. The economics of the model deserve a very high priority. Srivastava said, "The decision of most consumers is based on cost; the environmental benefit is an additional feature, but the reason consumers choose it is the savings. So to be successful, it has to be economically viable. However, you may want to support the environment, but the environmental aspect is just an additional benefit, not the primary benefit." Thus, tangible cost savings are the primary reason for institutions to adopt the RESCO model in their premises, and the associated environmental benefits are an important value addition to the institution's efforts to transition to renewable energy.

2. Forecasting and mitigating the risks for a bankable contract led to better results. Srivastava said that program designers "should take a close look at the documents to make sure the project is safe." For example, measures such as the data room and grouping of institutions boosted the confidence of RESCO developers, resulting in a competitive tariff. The risks that were not adequately mitigated in the initial transactions, such as the lack of watertight payment security mechanisms and the inclusion of less creditworthy institutions in the bouquet, made the project vulnerable to payment defaults by institutions. Srivastava said, "The quality of institutions matters. If the institution is good, you can expect it to make its payments on time."

   In the new RESCO project SRISTI, which Srivastava is currently implementing in his department, the team has set up a single point of billing to ensure better compliance by the institutions. Paliwal, who is part of the execution team of SRISTI, said, "We are planning to have a single point of billing and payment through the administrative department. We hope this will encourage developers to participate in the bidding process as they will not have to pursue individual institutes every month for payment of bills."

   The subsidies initially promised by the federal and provincial governments to incentivize RESCO developers and procurers have ended up having a negative impact as the governments have not released the subsidies as promised, hurting the investments of solar power developers (SPDs). Srivastava said, "I think it is better not to have a subsidy." Moreover, the scheme would have survived even without the subsidy, as the SPDs would have passed on the additional cost to the institutions through tariffs and the institutions would still have made substantial cost savings as the DISCOM tariffs were much higher than the realized solar tariffs. Swarup confirmed, "Under RESCO 4, a lower tariff of $0.047 per kWh was also offered without any subsidy, which was a good tariff at that time, even though RESCO 4 could not proceed for other reasons."

3. The regulations are one of the key determinants of the outcome, as they largely determine the scale of the RESCO project that can be implemented. Given the capacity restrictions based on the sanctioned load and the capacity of distribution transformers, the current

RESCO projects are working their way around the regulations. Paliwal, who has developed a numerical basis for an ideal capacity addition based on the sanctioned load and other criteria in the current regulations, says, "When the solar capacity is planned for around 60%–70% of the sanctioned load, the beneficiaries will have maximum benefit."

4. There has been a renewed interest these days toward renewable energy systems based on gross metering instead of net metering as gross metering addresses the existing concerns of DISCOMs. Srivastava says, "With gross metering, there is no limit to what you can consume. What you import from the grid, you have to pay the same price as a normal customer. For what you export to the grid, DISCOM can set the rate depending on the time of supply." Regulators should consider a liberal policy on capacity additions as more and more DISCOMs are open to RESCO projects based on gross metering.

5. The success of this project can be attributed to the presence of an anchor agency, such as MPUVNL, which drove its execution. MPUVNL played a vital role as a market facilitator by aggregating demand from institutions and assisting the RESCO developers. This ensured that any shortcomings that might arise during the execution of the project were covered. Other RESCO models that were later implemented or tried by other states, also had DISCOM or another single nodal agency, such as MPUVNL, as an anchor entity.

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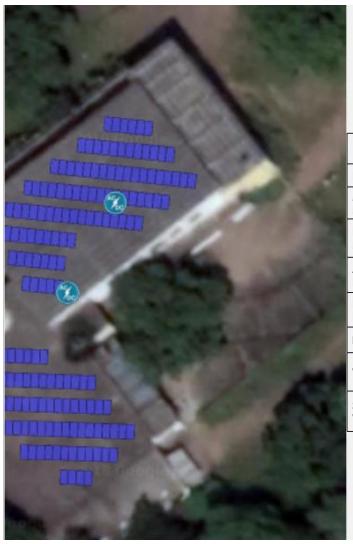
Appendix

Figure A1: Renewable Energy Services Company (RESCO) Solar Rooftop Installations in Madhya Pradesh

The RESCO 1 and 2 installations

Photo by: Madhya Pradesh Urja Vikas Nigam Limited.

Figure A2: Virtual Data Room in Madhya Pradesh Project



Data Room in MP Project

For each building

System Metrics	
Design	Site No. 1
Module DC Nameplate	80.3 kW
Inverter AC Nameplate	80.0 kW Load Ratio: 1.00
Annual Production	125.5 MWh
Performance Ratio	76.1%
kWh/kWp	1,563.7
Weather Dataset	TMY, 10 km Grid, meteonorm (meteonorm)
Simulator Version	289d7e31ae-687b6da398-dc5174fba2-57010d2c73

Components		
Component	Name	Count
Inverters	TRIO-20.0-TL-OUTD-S1A-US-480-A (ABB)	4 (80.0 kW)
Strings	10 AWG (Copper)	16 (817.8 m)
Module	Vikram Solar Limited, ELDORA VSP.72.325.05 (325W)	247 (80.3 kW)

Source: Madhya Pradesh Urja Vikas Nigam Limited.

Figure A3: Data Room Sample

S.N.	New PG	Name of Department/Institutions	District	[illegible]	Rooftop Area (sq m^	Ground area (sq m^	Total Area available (sq mt^	DTR Capacity (KVA^	Average Monthly Consumption (kWh)	Contract Demand (KVA)	*Proposed SPV Plant Capacity (kW)*	Site Coordinates (Please Modify if not found correct)	Electricity Bill /Date
1	A	CMO Nagar Palik Nigam, chandrawal Dam	Singrauli	[illegible]	300	0	300	500	36,846	381	110	24.0457019 82.6851641	
2	A	The A.E Maint Sub Division 3, Mata Mandir T.T Nagar (Supply at Kamla Park), Shyamala Hills Bhopal 462001	Bhopal	[illegible]	325		325	650	3,728	400	120	23014'40"N 77023'14"E	Sept. 2021
3	A	The Project Manager, JNNRUM Municipal Corpn, Ahamadpur 33kv, 462001	Bhopal	[illegible]	223		223	1,600	169632	600	150	23011'37"N 77027'10"E	Sept. 2021
4	A	Jujhar Ghat Treatment Plant, Damoh	Damoh	[illegible]	900	0	900		2,27,400	625	120	23.4522.96 79.3531.15	
5	A	Filter Plant Damoh	Damoh	[illegible]	750	0	750		1,28,400	750	120	23.4937.88 79.2653.97	
6	A	CMO , Nagar Palika Parishad, Juna Nagda, (Survey No. 28)	Ujjain	[illegible]	450	550	1,000		1,39,570	650	120	23.448640 75.399916	
7	A	Public Health Engineering Department Division, Umrali Road, Dist. Alirajpur (M.P.) 457887 (Behadwa Campus) Alirajpur	Alirajpur	[illegible]	7,200	1,015	8,215	415	67,850	500	100	22.11783 74.444834	
8	A	GM MPJNM Filter Plant,156-1-1 Khujner Road, Kandiya Khedi Biora	Rajgarh	[illegible]					26,185	300	150	23.9186° N, 76.9113° E	
9	A	The Executive Engineer, Narmada Project Dn. No-2 PHED, Mata Mandir Campus, Bhopal (Supply at Khatpura Shahganj)	Bhopal	[illegible]	1,673	1,200	2,873	500	51790	8,500	120	22052'17"N 77044'29"E	Sept. 2021
10	A	Commissioner office, Nagar Palika nigam, Shukla Ground bhawan, Chhindwara, 480001	Chhindwara	[illegible]	0	8,000	8,000	800	93,811	800	190	22.0290218, 78.9096999	13.10.2021

Source: Madhya Pradesh Urja Vikas Nigam Limited.

Study Questions

1. How can we establish a process for incorporating innovation into government operations that is independent of leadership changes?
2. What are the weaknesses in the implementation of this RESCO project and how can they be addressed to facilitate widespread adoption and implementation?
3. In the case of the RESCO project, do you believe that the viability gap funding measures, such as government subsidies, are necessary for successful implementation?
4. What steps can be taken to ensure the sustainability of the RESCO model without relying on viability gap funding measures?
5. How can RESCO developers ensure better project sustainability and protect their investments?
6. How can we motivate DISCOMs to be more receptive to the adoption of solar rooftops in the premises of their customers, especially in the context of India's electricity sector?

Notes: In this case study, "$ refers to US dollars. All figures are based on the exchange rate of the Indian rupee to the United States dollar on 12 July 2023 of $1.00 = ₹82.3.

Cover photo: Photovoltaic solar panels fixed on the roof of a building (photo by Paulose NK).

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