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THE BOTTOM LINE

This brief showcases the challenges of structuring and developing rooftop solar photovoltaic projects using the public-private partnership model. The case study focuses on the experience of the International Finance Corporation in assisting the government of Gujarat, India, in developing the rooftop solar PV model through the implementation of two citywide, grid-connected rooftop solar PV projects.

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Implementing Rooftop Solar Projects: Public-Private Partnerships in India

Why is this issue important?

Amid growing concerns over climate change and pollution, solar power is the key to solving fossil-fuel dependency

With over 65 percent of installed generation capacity in India attributable to thermal power, the production of large quantities of greenhouse gases (GHG) has raised public health concerns. And with limited domestic coal production, new thermal power plants are inevitably dependent on price-volatile coal and gas imports, leading to energy insecurity. To sustain the country's rapid economic growth while addressing concerns about climate change and pollution, in recent years India's federal and state governments have taken steps to tackle the growing energy crisis through the judicious use of abundantly available solar energy resources.

Since 2010, solar power has gained rapid acceptance in India and has made significant strides in both capacity and availability. Central and state government programs have helped increase India's solar power usage; current installed capacity is 2.6 gigawatts (GW). Within this growing solar power movement, rooftop solar collection in urban settings has started to emerge as a viable alternative for solar power generation. To meet India's recently announced target of adding 40 GW of solar rooftop capacity by 2022, the implementation of solar rooftop projects must be accelerated.

India launched the Jawaharlal Nehru National Solar Mission (JNNSM) in January 2010 to establish the country as a global leader in solar energy. JNNSM encouraged a number of states, including Gujarat, Karnataka, and Rajasthan, to develop their own solar energy policies. Given the limited availability of suitable land for ground-mounted solar photovoltaic (PV) projects, there has been growing interest in rooftop solar PV as a way to provide large numbers of people with access to green power. Rooftop solar installations, especially in urban areas, provide an excellent complement to utility-scale, ground-mounted solar projects because they utilize existing rooftop space.

Why are public-private partnerships the way to go?

Collaborations between a government and a privately owned company or organization promise both innovation and efficiency

Public-private partnerships (PPPs) may offer an effective way to promote and implement rooftop solar PV projects, particularly in emerging markets where developers and intermediaries are not fully active across the value chain of rooftop solar development. Well-structured PPPs bring to the table the best sides of the public and private sectors, delivering innovation and efficiency while also providing the right regulatory support and apportioning risks. Effectively designed PPP projects are bankable and sustainable, feature adequate preparatory activities and technical due diligence, and provide scale and equitable risk-sharing arrangements. Their success often snowballs into greater interest from the private sector, effectively transforming markets. Lessons from the PPP format can also be used to design and streamline policies, regulations, and technical standards, making future investments more feasible and sustainable. The success of PPP projects can open the doors for self-replication through innovative business models and increased participation of third parties and intermediaries.

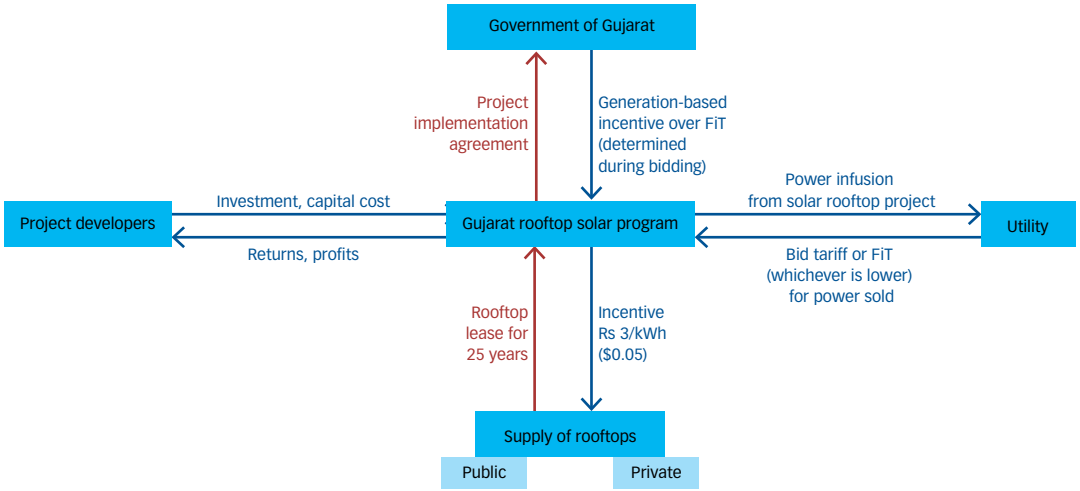
"In 2010, the government of Gujarat embarked on an ambitious mission to structure and tender a first-of-its-kind grid-connected rooftop solar PV power PPP in the state capital, Gandhinagar."

In 2010, the government of Gujarat embarked on an ambitious mission to structure and tender a first-of-its-kind grid-connected rooftop solar PV power PPP in the state capital, Gandhinagar. The groundbreaking project attracted approximately $9 million in private financing. Along with adding a power generation capacity of about 5 megawatts (MW), providing better access to power for an estimated 10,000 people, the project promised to reduce GHG emissions by more than 7 million metric tons a year. Two private firms, Azure Power and Sun Edison, each won 25-year concessions to install solar PV panels on the rooftops of selected public buildings (80 percent of the installed capacity) and private residences (20 percent). The operators were responsible for installing the panels, connecting them to the grid, and injecting the power generated from these panels into the grid. In turn, the firms received a feed-in tariff (FiT) determined during the bid process. The project was conceived on a gross-metering basis by which the entire amount of power generated would be supplied directly to the local grid at declared FiTs (figure 1).

Following the success of Gandhinagar, the government of Gujarat decided to replicate the rooftop solar model in Vadodara, a city of 2 million. In June 2014, Madhav Solar Private Limited won a 25-year concession for a 5 MW rooftop solar PPP. The Vadodara project clearly benefited from the lessons of Gandhinagar's solar rooftop program. Buoyed by two important successes, Gujarat's government is mulling over whether to replicate the concept in other cities. It is also drawing on past experience to improve the policy and implementation framework and encourage replication.

Meanwhile, on the other side of the country, the International Finance Corporation has been helping the government of Odisha (formerly Orissa) set up solar rooftop PV panels. Odisha is using a net-metering model by which rooftop systems supply power primarily to the owner of the premises. Excess generation (after netting off the consumption) feeds into the grid and is then credited to the consumer's account. Later, this excess amount is adjusted against consumption from the grid over a defined settlement period (usually a full year to account for seasonal variations in irradiance and generation). The experience of Gujarat's gross-metering model has informed the decisions of Odisha and other states, enhancing the potential of rooftop solar development.

Figure 1. Rooftop solar energy program in the city of Gandhinagar, Gujarat



Source: Authors.

Note: FiT = feed-in tariff; kWh = kilowatt-hour.

"Pilot PPP projects can play an important role in informing appropriate regulatory frameworks. This is because such projects benefit from the active participation of informed investors and real-time feedback between policy development and an investment's promotion and execution."

What are the challenges to replicating Gujarat's success with solar power in other Indian states?

Finding a workable regulatory environment is one of the biggest challenges

Replicating a rooftop solar project involves a few crucial considerations. First and foremost, policy and regulatory frameworks, including incentives, need to be clear and stable to attract investors and consumers. Pilot PPP projects can play an important role in informing appropriate regulatory frameworks. This is because such projects benefit from the active participation of informed investors and real-time feedback between policy development and an investment's promotion and execution. Relevant regulations might cover FiTs (for gross-metered systems), nonfinancial incentives such as mandatory purchase obligations, appropriate standards for metering and energy accounting, grid connectivity guidelines, and model commercial agreements for the exchange of real-time power with the distribution grid.

Major solar rooftop markets exist where governments provided firm fiscal support in the initial phases of their development. Countries around the world have spent a large amount of public money (through subsidy schemes in Japan, for example) to develop the solar rooftop market. The implementation of solar rooftop projects can be further expedited by establishing an enabling mechanism for funding from financial institutions.

In the case of Gujarat, the state's electricity regulator approved a power purchase agreement (PPA) that proved a sound basis for the replication phase. This is an optimal, often overlooked, and cautious approach to opening up a new market to the private sector. It avoids the risks inherent in fixing an unproven regulatory environment that may result in approaches that are not actually workable on the ground, effectively inhibiting investments down the line. The Gujarat solar team, meanwhile, worked with India's national regulator to develop and publish regulatory guidelines for rolling out solar rooftop projects; other, interested Indian states may adopt the guidelines with or without modifications.

Another challenge is identifying a credible and creditworthy off-taker. Rooftop PV projects that involve distributed generation are economically effective only when they are connected with the local grid, so that the excess energy (if not consumed) feeds into the local energy pool. Local distribution companies that are willing to pay and have grid space available understandably prefer to avoid possibly adverse obligations (such as higher tariffs imposed by other distribution utilities for use of their networks). In addition, off-takers may impose restrictive interconnection requirements. Before the bid process is initiated, guidelines and interconnection schemes should be developed in conjunction with distribution companies, and regulatory approvals should be obtained. (The off-taker for the Gandhinagar project was Torrent Private Limited and for the Vadodara project, the Madhya Gujarat Vij Company Limited.)

Another challenge involves reaching long-term agreements with private bodies. Given that the Gandhinagar project was envisaged as spanning 25 years, it was critical that the developer secure access to rooftops for that long. Private entities, including residential owners, were obviously hesitant about signing the necessary lease agreements. Meanwhile, the money paid for rooftop rentals pushed up tariffs. To address these difficulties, rooftop owners were given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the option to buy out the operator's interest in the installation, at a negotiated price. In addition, there was an allowance for companies to use a small percentage of capacity during downtime for operation and maintenance (O&M) as well as for relocation to other rooftops.

The project faced obstacles to expanding grid availability, even as Torrent Power Limited has a reputation for excellent availability. The private utility guaranteed minimum annual grid availability for the life of the project; if the agreement was not met, penalties would have to be paid to the solar developer. Madhya Gujarat Vij Company Limited, a state-owned company, did not provide any such guarantee. But it shared information regarding the uptime of the distribution grid, information that potential developers could use to estimate their possible loss in energy sales due to grid failure.

Another challenge was finding enough rooftops. In the Gandhinagar project, rooftops sufficient to host 80 percent of installed capacity (that is, 4 MW) were identified during technical due diligence proceedings, and bidders were assured of their availability. These rooftops were exclusively on government buildings and included those of schools, colleges, and affiliated institutions. Securing them provided a degree of comfort to investors, who were asked to find private rooftops for the remaining 20 percent of installed capacity.

With far fewer government-owned rooftops in Vadodara, nearly 80–85 percent of capacity had to be installed on privately owned rooftops. This risk was mitigated in several ways:

- Satellite images of rooftops across the city were collected from a state-owned agency and made available to potential investors.
- Rooftops outside municipal limits were included in the project scope, allowing developers to choose from a larger set.
- The developer was given a buffer of +/- 20 percent on the nominal required capacity of 5 MW, leaving it free to install anywhere between a minimum of 4 MW and a maximum of 6 MW.

Any state interested in replicating Gujarat's success must also craft a communication campaign. Long-term access to technically suitable and commercially viable rooftops is a crucial requirement for any large-scale solar rooftop development. An effective communication campaign is required to raise awareness and encourage building owners to participate. To this end, the Gujarat Power Corporation Limited (GPCL)—that is, the project implementation agency (PIA)—was advised to raise awareness of the program by building capacity among various stakeholders (government bodies, developers, rooftop owners, and communities), reaching out to rooftop owners who could participate in the scheme, and providing press releases to the general public. Relevant project-related information, requisite documentation (application forms and so on), and contact information were uploaded to a website that was specifically developed for the public. In the case of Gandhinagar, the PIA's role extended to facilitating the implementation of the project, which proved essential to the project's feasibility and to sustaining bidders' interest.

What can be learned from Gujarat's solar power projects?

Detailed technical surveys are a crucial first step

Identifying suitable rooftops in an emerging market where urban development is chaotic can prove challenging. Many factors must be taken into account: the shade of trees, adjoining buildings, and water tanks; rooftops' sizes, heights, and uses; and ownership (residential, commercial, or public). A detailed technical survey is a necessary initial step. It is particularly important to determine which rooftops are structurally sound. The roof must be able to support the weight of the solar PV system (including the system's racks and structures) and withstand the added load from wind blowing under the modules. Extensive technical surveys addressing the issues listed above were conducted as part of both projects. Findings were shared with the bidders to assist them in the process of rooftop identification and to highlight any potential technical issues.

In the case of Gujarat, installation proved to be difficult even where public rooftops were secured. And in Vadodara, where the proportion of private rooftops was much higher, the difficulty was multiplied. Where local governments are not in a position to secure rooftops or to allow higher tariffs to be borne by the off-taker, they should consider providing financial assistance to alleviate the risks taken by private sector players. Generation-based incentives were provisioned for in both Gandhinagar and Vadodara, and proved effective.

Ashish Khanna and Chandrasekar Govindarajalu were the peer reviewers of this note.