



CASE STUDY



Rooftop Solar Program for Residential Sector

INDIA

1. PROJECT HIGHLIGHTS

Key Cross-Country Benefit	Key National Benefit
 <p><i>Reduce climate damaging pollution by boosting renewables in the world's third largest GHG emitter</i></p>	 <p><i>Kickstarting the solar rooftop market as long-term job creator and key industry of the future</i></p>

2. QUICK FACTS

Categories	Project Details
Project Name	Rooftop Solar Program for Residential Sector
Project Description	The Indian market for residential rooftop solar falls short of its expansion targets, not least because of too few private investments. To mobilise private capital and to facilitate investments for residential consumers, the project simplifies the access to collateral-free credit with comparatively low interest rates for residential consumers willing to invest in rooftop solar panels.
Global Public Good (GPG) Theme	Climate & environment
Sub-Theme	Climate change mitigation
Sector	Energy

Disclaimer: We based the case study on the information cited and publicly available as of May 2023. The findings – especially concerning the GPG perspective – have been concluded to our best knowledge. The views expressed are the authors' assessments and do not necessarily reflect the project stakeholders' views. Any errors that remain are our responsibility.

Country of Implementation	India
Region	South Asia
Income Category	Lower-middle income economies
Implementation-Period	2022-2027
Project Volume (planned)	US\$ 464 million
Financial source (planned)	International Bank for Reconstruction and Development (IBRD) loan: US\$ 245 million; Fund for Innovative Global Public Goods Solutions grant: US\$ 15 million; Government Contribution: US\$ 204 million
Instruments	Program-for-Results Financing
MDB Involved	World Bank
Implementing Partner	State Bank of India
Link to detailed project information¹	https://documents1.worldbank.org/curated/en/631341583490651363/pdf/Ap-praisal-Stage-Program-Information-Documents-PID-Rooftop-Solar-Program-for-Residential-sector-P171750.pdf

3. WHY THIS IS A BEST PRACTICE

- **Ambition:** The Rooftop Solar Program for Residential Sector fosters India’s broad transition in the domestic energy mix towards renewable energy sources. The expansion of rooftop solar in the residential sector is to take place nationwide and is a central building block in the national strategy to reduce climate-damaging emissions.
- **Sustainability:** The project combines the domestic boost of an emerging sector with ambitious climate change mitigation targets. It improves the domestic market in a way that ensures sustainable and remaining activities in this area as well as a long-term increase in competitiveness of the Indian rooftop solar market.
- **Scalability:** It is highly scalable, as the general approach to kickstart a private market to make GPG provision economically profitable investments for consumers is promising in many sectors of different sizes.

¹ Unless otherwise stated, the information used in this case study can be found in this source.

- **Transformability:** The project can transform the rooftop solar market so that private consumers are mobilised to conduct investments, as those investments become economically profitable. The mobilisation of private capital induces higher demand as well as higher supply, which can boost innovations. The transformative approach is enhanced by increasing consumers’ awareness towards climate change mitigation and making this GPG tangible and feasible by supporting measures that can be taken by the people themselves.

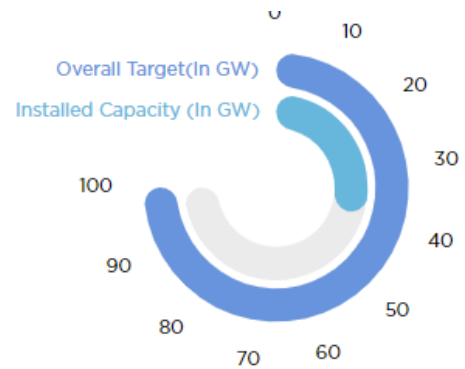
4. PROJECT INFORMATION

4.1 CHALLENGES OF GPG PROVISION IN THE COUNTRY CONTEXT

Climate change mitigation belongs to the most important Global Public Goods. As the world’s third largest emitter of greenhouse gases², India has a prominent role in providing this GPG. The country has committed to fulfilling emission reduction targets defined in the Nationally Determined Contribution (NDC). Those include the goal to produce about 50 percent of electricity from renewable energy sources by 2030.³ **One main renewable energy source is rooftop solar, which plays a crucial role in India’s strategy to reach the NDC.** The Indian government had planned to deploy 100 GW of grid-connected solar power by 2021/22, of which 40 GW should have been installed in the residential sector (Jawaharlal Nehru National Solar Mission (JNNSM)).⁴ This ambitious target of 40 GW is in the same magnitude as the UK’s expansion targets to deliver offshore wind until 2030⁵, or France’s goals to do so by 2050.⁶

The expansion in the residential sector falls short of the set targets. Currently, the residential sector makes up only about 20 percent of the total grid-connected rooftop solar photovoltaic (GRPV) installations.⁷ **There is a lot of untapped potential regarding the installation of solar in the residential sector. Activating this potential requires investments from the private sector—the owners of the buildings.** Their choice of whether to invest in this climate protection measure depends on their economic incentives:

FIGURE 1: EXPANSION TARGETS VS. INSTALLED CAPACITY (AS OF MARCH 2022)



Source: Ministry of New and Renewable Energy (n.d.)

² Climate Watch (2020): https://www.climatewatchdata.org/ghg-emissions?end_year=2019&start_year=1990

³ Government of India (2022): <https://unfccc.int/sites/default/files/NDC/2022-08/India%20Updated%20First%20Nationally%20Determined%20Contrib.pdf>

⁴ World Bank (2020): <https://documents1.worldbank.org/curated/en/631341583490651363/pdf/Appraisal-Stage-Program-Information-Documents-PID-Rooftop-Solar-Program-for-Residential-sector-P171750.pdf>

⁵ SSE Renewables (n.d.): <https://www.sse.com/media/dotp5quh/delivering-40gw-of-offshore-wind-by-2030.pdf>

⁶ Wind Europe (2022): <https://windeurope.org/newsroom/news/france-commits-to-40-gw-offshore-wind-by-2050/>

⁷ World Bank (2022): <https://documents1.worldbank.org/curated/en/339041656371255291/pdf/India-Rooftop-Solar-Program-for-Residential-Sector-Project-Additional-Financing.pdf>

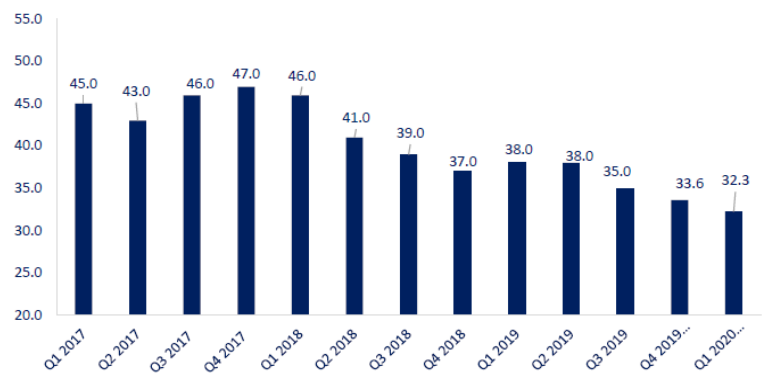
- The electricity pricing scheme in India contains cross-subsidies to the benefit of residential consumers, allowing them to consume fossil-based electricity at a relatively low price.
- Because this price does not incorporate the negative externalities of using fossil-based electricity, there is no financial incentive to switch to renewable energy production.
- One additional obstacle for GRPV installation in the residential sector are investment constraints for private consumers due to high interest rates and poor opportunities for capital accumulation.
- From a supply side, the small scale of residential solar systems is not as lucrative, which is why there are no major initiatives for supply companies to push ahead with the expansion.
- Due to the unfavourable private cost-benefit ratio and the described market shortcomings, there is an underprovision of GRPV in the residential sector.

4.2 INTERVENTION

4.2.1 Project Design and Agents of Change

The Rooftop Solar Program for Residential Sector aims to mitigate these barriers to a comprehensive GRPV installation in the residential sector. It is implemented by the State Bank of India (SBI). It aims to improve debt financing opportunities. In particular, the interest rates for private consumers if they take out a loan for this purpose are cut to below 10 percent by concessional financing. The market interest rate is between 14 and 16 percent.⁸ While the engineering, procurement, and construction (EPC) costs for rooftop solar have already decreased in the last few years (see Figure 2), the capital costs account for an increasingly large share of the overall installation costs. Concessional financing reduces this imbalance. Generally, the project aims to create an investment-friendly environment with collateral-free credits, low interest rates, and information dissemination. Additionally, supporting the capacity increase of battery energy storage systems (BESS) through investments in this field aims at increasing the power security.

FIGURE 2: INDIA ROOFTOP SOLAR EPC COST INDEX, INR/WP



Source: [World Bank \(2020\)](#)

⁸ World Bank (2020): <https://documents1.worldbank.org/curated/en/631341583490651363/pdf/Appraisal-Stage-Program-Information-Documents-PID-Rooftop-Solar-Program-for-Residential-sector-P171750.pdf>

4.2.2 Expected Results

The project follows a Program-for-Results Financing. To assess whether the desired results are achieved, precise intermediate result indicators are defined:

- 1) Amount of rooftop solar **loans** signed by SBI in the residential sector, with a target of US\$ 260 million
- 2) Amount of additional **equity** financing from private sources mobilised by SBI in the residential sector, with a target of US\$ 111 million
- 3) Amount of loans for the innovative utility-led mode or for GRPV with BESS in the residential sector, or both, with a target of US\$ 25 million **loans** signed, of which at least 40 percent is for BESS
- 4) Increase in women workforce in technical and administrative roles in at least three sub-borrowers of SBI
- 5) Satisfactory redressal of 90 percent of the received grievances⁹



The approach of mobilising private capital has already been successful in the parent project in the commercial and industrial (C&I) sector (Grid-Connected Rooftop Solar Program¹⁰). Enhancing the private GRPV installations in the short and medium run is expected to yield positive equilibrium effects for the rooftop solar market. The demand increase yields a higher competition on the supply side as well as cost degression and hence a decrease in the price for rooftop solar. The project is expected to further support the trend of lower EPC costs. Additionally, once lower interest rates are implemented through the project, this could potentially lead to an overall decline in interest rates of commercial banks. Hence, **the project can transform the Indian rooftop solar market so that private investments become economically profitable**. The transformative approach is enhanced by increasing consumer awareness around climate change mitigation and making this GPG tangible and feasible by supporting measures that can be taken by the people themselves.

5. PROJECT IMPACT

5.1 NATIONAL BENEFITS

The Indian government has a strong national benefit from fostering private investments in the rooftop solar sector, as those are necessary for the country to reach its NDCs. The government initiated this project after looking back on positive experiences from the parent programme. Besides the overarching goal of climate change mitigation, the project yields three desirable national co-benefits:

1. It fosters female labour force in this growing and promising sector and thus leverages co-benefits on gender equality.

⁹ This intermediate result indicator refers to the internal customer care and satisfaction, which is managed decentralised by the SBI branches.

¹⁰ World Bank (n.d.): <https://projects.worldbank.org/en/projects-operations/document-detail/P155007?type=projects>

2. It has a positive economic impact. Renewable energy production and the instalment of corresponding power storage infrastructure is a key future technology field. The rise in supply of these technologies that follows a rising demand—boosted through the project—helps to strengthen this sector in the Indian economy. This promises positive employment effects through job creation and potentially even a pioneering role as a driver of innovation and exporter of technology.
3. A reliable and affordable power supply is an essential component to ensure prosperity and growth in India. Making consumers more independent in their power supply could make them less vulnerable to future changes in the electricity pricing scheme and could serve as preparation for transformations in the current system dominated by cross-subsidies.

5.2 CROSS-COUNTRY BENEFITS

As is the nature of climate protection measures, taking effort to mitigate climate change has direct positive cross-country externalities and other countries equally benefit from emissions reduction in India. **The overall emissions saved in the programme are calculated to be 13.9 million tons CO₂e over the life of the programme compared to the thermal power counterfactual.** Given that India is the third largest emitter of GHG emissions worldwide, sustainably changing the grid emissions factor helps to reduce the overall emission level of the country.

In the economic benefit analysis of the project, the global benefits associated with the avoided GHG emissions amount to US\$ 269.4 million if a conservative shadow price per ton of CO₂e is used—substantially more than the US\$ 15 million for the grant by the GPG fund plus the implicit triple AAA discount in the IBRD credit line.

Moreover, the challenge to mobilise private capital for climate-friendly investments is prevalent in many countries. Hence, the project serves as a lighthouse project for knowledge transfer. Both the technological and the institutional findings that are generated in India can be applied by other countries for their respective policies. Cooperation is already taking place with a team in Nigeria planning to implement a similar project.

6. LESSONS FOR FUTURE GPG PROVISION

6.1 SUCCESS FACTORS

The expected success of the project is caused by the following characteristics. First, the **addition of the GPG fund's grant to the IBRD loan makes it more attractive for India to take up the IBRD loan.** Especially in the context of GPG provision, with the grant, the scope for concessional financing is enhanced, which benefits the residential consumers. This increases the willingness of India to take up this loan. Second, the financial resources are supplemented by **technical assistance**, which yields additional support and leeway for India in the implementation of the project.

As discussed above, there are several constraints for residential consumers to adopt clean technologies. In particular, the limited possibilities for collateral-free, low interest-credit for private borrowers and the lack of knowledge regarding the medium and long-term private benefits of this investment inhibit comprehensive private rooftop solar installations. Only a **combination of improving the credit take-up and knowledge transfer regarding the benefits of this investments can comprehensively mobilise private capital.** Especially in the context of rooftop solar power, this is an important step to empower private market participants.

Residential rooftop solar is the most important step in the energy transition story of India because, as one interviewee said, it gives ownership “in the hands of the people”. Following this approach, it is not necessary to fully subsidise the instalment, but the policy can become economically beneficial through a reduction of transaction costs and interest rates.

Compared to other GPG initiatives, the project yields a significant national benefit, because of which the Indian government has its own interest to pursue it.

6.2 HOW TO REPLICATE THE BEST PRACTICE

In addition to that, the following lessons can be learnt from the project and can be used to replicate the best practice project:

- If the rooftop solar market is well designed, national benefits and private economic interests can be aligned with GPG provision goals. This is generally desirable if GPG provision depends on private investments and private capital mobilisation. It can be achieved through a reduction of transaction costs, so that investments in residential rooftop solar become economically profitable.
- “Buying externalities” does not only have to take place through mere financial subsidies but can be established through a sophisticated market design. Inducing a demand increase, among others through concessional financing, also increases the supply of rooftop solar. This eventually reduces the private instalment costs, and the private benefit-cost-ratio becomes positive.
- The high scalability of the project in combination with the results-based financing approach makes it an attractive intervention for MDBs in countries in which functioning capital markets are ensured and in which private investments in infrastructure are worthwhile and sustainable.
- The GPG fund is an attractive—and maybe even necessary—tool to compensate for the high cross-country benefits the project yields for climate change mitigation.
- Concessional financing can serve as a main instrument to mitigate this market failure. By providing technical assistance to link the different actors in this fragmented market and identify policy-relevant intervention options, the different incentives of market participants are aligned.
- The problems of limited access to credit markets for private consumers, relatively high transaction costs, and lower profit margins for developers are prevalent in many countries trying to comprehensively retool their power supply towards renewable energies. Hence, the general mechanisms of the project are replicable in other contexts. In fact, this replication already takes place: In Nigeria, a project that is related to the Indian initiative is planned and builds on the lessons learned and success factors.

“Residential rooftop solar is the most important step in the energy transition story of India because it gives ownership in the hands of the people.”

- World Bank executive