

# Assessing The Viability For Installation Of Rooftop Solar Panels For Households

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## I. Introduction

Solar energy technology is important as it's a clean source of energy that is now efficient and easy to use. It should be used in the right approach by having the generation everywhere so that it does not need to be transmitted. So generating and using it is the most efficient way forward for it.

The rooftop solar photovoltaic (PV) segment is one of the fastest growing clean energy segments across the globe due to its ability to provide reliable power for both rural and urban customers, scale up investments through entry of multiple investors, empower energy consumers and enhance their energy security while helping utilities address critical transmission and distribution losses.

We believe that rooftop solar is among the most mature models of sustainability in societal, environmental and energy terms. Rooftop solar provides an opportunity to an individual to directly invest towards its own self-reliance, in turn strengthening one's own sense of responsibility, and ultimately inching towards the greater good. By installing the panels on rooftops in rural areas, we forgo the conversion and usage of agricultural land for installing these panels.

## II. Research Objectives

Following are the questions that the research project intends to answer:

1. To examine how installation of rooftop solar helps households.
2. To identify the challenges faced by them.
3. To gauge how the Government scheme of PM Surya Ghar: Muft Bijli Yojana will help propagate the adoption of rooftop solar.

## III. Objective Analysis And Findings

### Pm Surya Ghar Yojna Scheme

The Government of India has approved the PM Surya Ghar: Muft Bijli Yojana on 29th February, 2024 to increase the share of solar rooftop capacity and empower residential households to generate their own electricity and hence provide free electricity to households in India. The scheme was launched by Prime Minister Narendra Modi on February 15, 2024. Under the scheme, households will be provided with a subsidy to install solar panels on their roofs. The subsidy will cover up to 40% of the cost of the solar panels. The scheme is expected to benefit 1 crore households across India. One of the biggest aspects of the PM Surya Ghar Scheme is the focus on mass markets, by limiting subsidies to systems upto 3kW in size. The scheme has an outlay of Rs 75,021 crore and is to be implemented till FY 2026-27. The administrative approval was granted to the scheme vide Order No. 318/17/2024-Grid Connected Rooftop dated 16th March, 2024.

There are many technical, financial and social issues in the scheme that need close scrutiny, but at a broad level, one of the interesting questions that may be raised is whether the scheme, if successful, leads to energy independence at the household level. If so, will it be desired by poor households and will it reduce energy inequality among households? It is too early to speculate on the Indian case but existing literature on the subject suggests that energy autonomy and its benefits are uncertain for households in developing countries such as India.

### Direct Benefits

#### Suitable Rooftop Solar Plant Capacity for households

Average Monthly Electricity Consumption (units)	Suitable Rooftop Solar Plant Capacity	Subsidy Support
0-150	1-2 kW	₹ 30,000/- to ₹ 60,000/-
150-300	2-3 kW	₹ 60,000/- to ₹ 78,000/-
> 300	Above 3 kW	₹ 78,000/-

### **Benefits provided**

#### **Subsidy on the Suitable Rooftop Solar Plant Capacity for households.**

1. Reduce electricity bills for households
2. Reduced electricity costs for the distribution company.
3. Increased use of renewable energy.
4. Reduced carbon emissions.

#### **Conditions for applying as a beneficiary of the scheme**

1. The household must be an Indian citizen.
2. The household must own a house with a roof that is suitable for installing solar panels.
3. The household must have a valid electricity connection.
4. The household must not have availed any other subsidy for solar panels

#### **Types of roofs suitable for Rooftop Solar (RTS) System**

Rooftop solar PV systems can be installed on any type of roof having sufficient load bearing capacity, and an even base surface. It should be vacant of any kind of towers or any other installations and should not be shaded.

#### **Advantages of Grid-Connected Rooftop Solar System**

The on-grid systems combine solar power with the electricity coming from the grid. This leads to saving on electricity bill by the consumer. It allows the utilisation of available vacant roof space with no additional land required. This scheme has a low gestation period. There is no additional requirement of transmission and distribution (T&D) lines, but in fact it reduces T&D losses as power consumption and generation are co-located. It leads to improvement in the tail-end grid voltages and reduction of system congestion. It allows long term energy and ecological security by reduction in carbon emission, and better management of daytime peak loads by DISCOM/ utility.

#### **Implementation**

Design and implementation of rooftop solar power projects require substantial coordination of several agencies, viz. Regulatory Commissions (net-metering regulation), DISCOMs (net-metering and bill settlement), Ministry and SNAs (release of subsidy), Banks (housing/ improvement loans), Urban Local Bodies (IEC for public campaign), Rooftop Owners (access to roofs), Developers/ Aggregators/ EPC Contractors (project implementation and operation), etc.

Gujarat has been in the forefront of promoting solar energy for a sustainable future, and they aspire to become a global rooftop solar capital. With this vision, they had launched the megawatt-scale Gandhinagar Rooftop Solar Programme as early as 2012, when rooftop solar was still being discussed in terms of kilowatts. Today, this programme has become a benchmark for many such programmes in India. They have also taken early-on steps to develop a skilled professional and technical workforce realizing its significance in this decentralized sector. Their experience in rooftop solar has also highlighted a wide spectrum of matters, technical, administrative and social, that need to be synchronized in order to achieve its maximum potential. Every stakeholder will have to actively involve oneself towards simplifying the seemingly complex, voluminous, and hence, overwhelming ecosystem into a much simpler one that a common citizen can follow.

#### **Supplementary Benefits of the scheme**

It is also meant to be a catalyst for India's domestic manufacturing base for solar equipment, which has struggled to counter imports until now. The scheme forbids the use of imported modules, with its DCR (Domestic Content Requirement). That, along with the 100% Indian ALMM list (Approved List of Module Manufacturers) that lists down the manufacturers whose modules can be used, ensures a bonus for Indian makers.

Finally, there is the small matter of the tremendous boost to local entrepreneurship and jobs, as the retail market invariably creates more jobs through rooftop solar.

From technicians to installers to new entrepreneurs and smaller equipment suppliers for the Balance of System (BOS), the scheme, by adding 5-6 GW of rooftop residential solar each year, could potentially provide a stimulus worth 50,000 jobs and Rs 40,000 crore of economic activity each year from here till 2028 or beyond. This is a huge opportunity for local entrepreneurship and employment for installation and maintenance.

#### **Costs**

MNRE has fixed the benchmark subsidies per kW of rooftop solar at Rs 50,000.

However, the final price is invariably higher based on the mutually agreed price between the consumer and solar vendor. For example, the final price for a 3 kW of rooftop solar varies in the range of Rs 1.45 lakh to

Rs 3 lakh based on the technology, terrain, structures used and the companies picked up by the consumer. Rates are usually higher in hill states, besides some South Indian states.

**POCKET PINCH**

- Setting up a 3 kW connection costs around ₹2 lakh
- There is a subsidy of ₹78,000, which brings cost down by 39%

Description	Quantity	Rate	Amount
Solar PV Module (Mono Perc Half Cut-DCR)**	6	15,120	90,720
Solar inverter	1	30,745	30,745
Galvanised iron structure	1	18,000	18,000
ACDB**, DCDB**, SPD, AC wire, DC Wire, connectors, ties, nuts and bolts, earthing	1	15,000	15,000
Net metering	1	15,000	15,000
Installation	1	9,000	9,000
<b>Total cost</b>			<b>1,78,465</b>
	GST @ 12%		<b>20,335.80</b>
	<b>Gross total amount</b>		<b>1,98,801</b>

NOTE RATE AND AMOUNT ARE IN ₹. IN HALF-CUT SOLAR PANELS, CELLS ARE CUT IN TWO HALVES TO INCREASE THE NUMBER OF CELLS. DCR STANDS FOR DOMESTIC CONTENT REQUIREMENT

\*\*ALTERNATING CURRENT/DIRECT CURRENT DISTRIBUTION BOX. SPD IS SURGE PROTECTION DEVICE. THERE IS A 25-YEAR NORMAL WARRANTY ON SOLAR PANELS AND SERVICE OF FIVE YEARS ON SOLAR INVERTER. SOURCE PRAKRUTI SOLAR

**Effective benefit considering Rs. 6/Wp difference in DCR & Non-DCR modules**

Project Size (KW)	Subsidy by MNRE (Rs.)	Non-DCR Modules Price (Incl. GST) @Rs. 17/Wp	DCR Module Price (Incl. GST) @Rs. 23/Wp	Additional Amount for DCR Modules	Effective Subsidy Benefit
3	43,764	57,120	77,280	20,160	23,604
5	58,352	95,200	1,28,800	33,600	24,752
6	65,646	1,14,240	1,54,560	40,320	25,326
8	80,234	1,52,320	2,06,080	53,760	26,474
10	94,822	1,90,400	2,57,600	67,200	27,622
12	94,822	2,28,480	3,09,120	80,640	14,182
15	94,822	2,85,600	3,86,400	1,00,800	-5,978

As per the current market rates the DCR Modules( Mono PERC) are priced at Rs. 22- 23/Wp approx while Non-DCR modules are priced at Rs. 16-17/Wp creating the gap of around Rs. 6/Wp which is around 30% of the price.

DCR Modules are priced around 30% higher than the Non-DCR modules which depletes the effective benefit for the projects under the subsidy scheme.

**PM Surya Ghar Yojana Solar Rooftop Calculator, How Much Space, Funds Required for Per kWh Electricity**



Now the PM Surya Ghar Yojana Portal accessible at pmsuryaghar.gov.in has provided the facility of a Solar Rooftop Calculator with the help of various aspects including the Residence State, Consumer Category, Total Available Rooftop Area, Money available to invest, required solar plant capacity and sanctioned load of the electricity.

PM Surya Ghar Yojana Solar Rooftop Calculator Link  
Solar Rooftop Calculator

**Maintenance and Upkeep**

Rooftop solar needs regular cleaning and maintenance. However, as per MNRE norms, the onus is on the solar vendors to ensure the Operations and Maintenance (O&M) of the rooftop solar structures for the initial five years.

### **Life of Solar Modules & Warranty**

The normal expected life cycle of solar modules is around 25 years. Meanwhile, its efficiency also degrades with time, typically by about 15% by the end of life. Most solar modules and inverters offer five years of product warranty. Several brands offer extended warranties too.

### **Paper work & Rooftop Installations**

Several solar vendors of EPC companies we talked to, explained that after the advent of the National Rooftop Portal, the paperwork has been reduced due to digitization. The draft norms released by the Ministry of New and Renewable Energy (MNRE) on April 15 '24 also talked about integrating more discoms and making several of their offline permissions digital for faster approvals. It also talked about integrating the disbursement of state subsidies through the portal. In the last two years, the Indian EPC players said that the portal aided in simplifying the processes, expediting approvals, and faster disbursement of subsidies to solar consumers.

In most Indian states, the local norms do not allow rooftop solar installations beyond the sanctioned load of the electricity meter of the household. For example, in Uttar Pradesh, if a residential household has a 3kW load limit, they are allowed to install rooftop solar only upto 3kW. This can be a dampener for some, as solar generation will happen only during 6-8 hours, and a higher capacity would have supported more use of electrical appliances at a power cost.

Older households that seek higher sanctioned capacity to accommodate more rooftop solar will find this process alone can take around one month. However, states like Gujarat, with the highest rooftop solar connections in India allow residential consumers to install such systems upto 5kW irrespective of the sanctioned power limit of the households under net-metering, besides a faster increase in sanctioned loads.

During the installation of rooftop solar, the solar vendor and discoms work together to convert the consumers' existing electricity meter to a bi-directional meter for on-grid solar rooftops (for which subsidies are applicable). Net-meters are bidirectional meters that measure, track and display both import (from the grid) and export to the grid of electricity. These net-meters allows bills to be prepared on the basis of the net imports or net exports. If there is any net exports that gets carried over to the next cycle. Different states have different mechanisms of metering. In some states along with net-metering, there is also a net-feeding billing options.

### **Financing**

Financing is another important part but often less talked about in the overall rooftop solar business:

For example, for a 3kW rooftop solar project, the total cost comes in the range of Rs 1.5 lakh to Rs 1.8 lakh, based on the technologies, components, services and solar inverters. Once the total cost is known, they need to check

- how much money they will get from the scheme
- how much balance money needs to be contributed by them
- this balance amount can they invest by themselves and then assess what is the payback period on that investment
- do they need to take a loan for it, and if so what rate of interest are they paying and how will that impact the total payback period for them

Getting a loan from banks can consume more time, while digital platforms (NBFCs) have emerged as new solutions to finance the smaller loans needed for such projects. These NBFCs have tied up with select installers with a good record and process loan applications much faster.

The Pondicherry government is exploring a scheme where-in the loan granted for this installation can be linked to the savings generated by installation of the solar panels. The money saved each month due to a lower electricity bill could be used to repay this loan.

### **Types of Grid Systems and Energy Storage**

There are predominantly three kinds of grid systems:

- (i) **Standalone system** where the electricity is generated by the solar panel and instantly consumed or excess electricity is stored locally in a battery to be used at a later point in time.
- (ii) **Grid connected system** where the solar panel generating electricity is connected to the main grid. In such cases the excess generation of electricity, if any, during the day is exported into the grid and during evening hours the excess electricity required is imported from the grid.
- (iii) **Hybrid system** that is connected to the grid but also has a battery back up at a local level so that first the excess power generated during the day is stored in the battery and that is used in the evening hours and if there is any excess generation or excess usage that is then transmitted to and from the grid.

An important point to note here is that success of solar electricity generation requires standalone battery storage at local levels so that it can make each unit independent of the grid and also lower the load on the grid during peak hours of usage.

### **The Consumer Side Story: Smaller, faster and cheaper**

Laxmi Narayan is a retired official based in Bhopal. Worried by the growing electricity bills for his home, Narayan in 2020 decided to install a 6kW of rooftop solar to counter the hefty monthly bills. To his surprise, his decision to opt for green energy turned out even better than he had hoped for.

He said that after switching to rooftop solar, his monthly power bills were reduced drastically. This pro-environment step taken by him also bolstered the confidence of his neighbours, many of whom soon opted for a clean energy source to power their households.

"It was around 2020 when I decided to opt for rooftop solar. Based on my power requirements I decided to opt for rooftop solar of 6kW capacity. I soon realized the power of rooftop solar when I was able to reduce the monthly power bills by around 90%. The success also encouraged several other neighbouring households to go for solar".

### **Tackling the Awareness Challenge**

Lack of awareness among consumers has always been an issue, with concerns over upfront cost, transfer of subsidies, financing, lack of understanding of the technicalities till now tripping up progress on rooftop solar.

Solar vendors in Rajasthan recently shared on social media that several prospective rooftop solar consumers filled out the online forms on the National Rooftop Solar anticipating no payment from their side due to talks of higher subsidies. During follow-ups, several of these consumers often back out when they are informed about the upfront cost.

One of the vendors highlighted that one of the common concerns among consumers is related to the viability of using ACs and other high-power consuming appliances like motors. In the on-grid solar systems, the solar system is seamlessly integrated with the grid and there is no issue in running the high power consuming appliances as any shortfall of power from solar could be compensated by the grid power synchronously. Consumers need to keep in mind that their on-grid solar system is simply providing them with an additional self-generated electricity supply that will finally reduce their overall bill.

Also another important point they need to keep in mind is that during power cuts they will still need to revert to their UPS back-up systems as the power supply from grid will not be available. So when they install solar panels they should not remove their UPS.



“Around 55 power consumers have got registered themselves for the installation of rooftop solar PV plants on their residential buildings at an awareness camp organised by the Electricity Department in Puducherry recently.” - Published - October 06, 2024 12:40 am IST - PUDUCHERRY - The Hindu Bureau

Hence it is important for discoms across the country to conduct such awareness campaigns and educate the consumers about the advantages of the scheme so that it can be adopted far and wide.

### **Commercial Considerations**

Solar rooftop projects, although simple to implement, need to be judiciously designed in order to ensure adequate returns on the investment as well as address most of the risks associated with these projects. Therefore a number of commercial arrangements need to be evaluated and addressed while financing solar rooftop projects.

These range from the returns from the project, the nature of the tariff charged, cost of electricity replaced, contract sanctity, lease arrangements, etc.

**(i) Cost of the Project:** Cost of the rooftop solar project is one of the first concerns of the rooftop solar ecosystem. Consumers need to obtain the panels at best possible rates to ensure that they get good value for their money.

**(ii) Payback period - Internal Rate of Return (IRR):** Rooftop Owners primarily install PV systems to reduce either their utility bills or to feed electricity to the grid and earn a basic rate of return. To understand whether this proposition makes economic sense, project IRRs need to at least meet market benchmarks. This IRR depends on the difference between the actual rate per kWh avoided by generating on-site power on solar rooftops. The IRR calculations depend on a wide variety of factors such as the cost of retail grid based power, cost of per unit solar power, annual escalation of cost of grid based retail power, cost of borrowing, metering system whether it is net-meter or net-feedin and the tax and fiscal benefits available to the Developer/ Generator. All of these factors have an implicit impact on the payback period and the IRR and need to be evaluated.

**(iii) Type of meter used -** The financial viability of the scheme depends on the type of meter used. For the net-meter the viability depends on the consumer tariff, and for the net-feedin meter, the feed-in tariff should be equal or higher than the solar cost for the project to be viable.

### **Virtual Net Metering**

To give access to the solar net metering facility for consumers who do not have a suitable roof for installing a solar system (e.g. residential consumers who live in apartments, consumers with shaded rooftops) there can be a facility called Virtual Net Metering. In Virtual Net Metering consumers can be beneficial owners of a part of a collectively owned solar system. All energy produced by a collectively owned solar system will be fed into the grid through an energy meter and the exported energy as recorded by that meter will be pro rata credited in the electricity bill of each participating consumer on the basis of beneficial ownership. Collective ownership of solar plants may be established through societies, trusts or any other legal entity that safeguards the interests of participating consumers, including rights which are at par with the rights enjoyed by consumers who have solar net metering with a solar system installed on their own roof.

## **IV. Conclusion**

It has been found that offering energy autonomy to households [in the case of the Surya Ghar programme the offer of free electricity (*muft bijli*) and reduction of monthly invoices from the distribution company indicating autonomy] cannot be achieved solely by legislative and regulatory acts and that the primary motivation must come from households that want to realise material benefits from energy independence.

Material benefits may be limited in the case of the Surya Ghar programme. Many state governments offer 100-300kWh of grid electricity free to households. This no-strings-attached subsidy is likely to remain more attractive to poor households. The benefits of solar in such cases will only come in after the free units of electricity are used.

To benefit from the scheme, ownership of a proper house with a roof that can accommodate solar panels is specified as a precondition to apply for the Surya Ghar programme may disqualify many poor households that do not live in a house with a good roof, or houses have shaded roof or roof with shingles. For such cases virtual net-metering is the best option to consider.

For the Discom it is advantageous for the smaller consumers to switch to solar as it brings down the load on the system during peak hours without a loss of revenue for them as they have to supply less of subsidised power. During the day consumers export their solar generated power, which the discoms need to buy at cheaper rate and they face a problem of oversupply from the solar grid. At night they need to supply power to the household when there is peak usage and this is at a higher cost. Hence discoms are happy for the lower paying consumers to switch to solar grids with battery storage as best possible outcome.

Solar energy generation coupled with energy storage at an individual level serves the long-term interest of the individual, the discom and the country. Rooftop solar is distributed generation and usage. It is the one of the most cost-efficient and effective methods of using distributed renewable energy. Hence it needs to be propagated through the right channels with the right dissemination of information.

In conclusion it can be said that despite the absence of a clear political priority of households' energy autonomy, an increase in household-level energy generation can contribute to the development of additional energy resources.

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