Solar Rooftop PV Regulatory and financial aspects in India

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I hereby give my acceptance to guide the above student through the dissertation work **'Solar Rooftop PV Regulatory and financial aspects in India '**.Which is a mandatory requirement for the award of EMBA degree.

Thanking you

Yours Sincerely

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Declaration by the Guide

This is to certify that the Mr. Piyush Manhas, a student of MBA Power Management batch January 2018, SAP ID 500065865 of UPES has successfully completed this dissertation report on "**Solar rooftop PV regulatory and financial aspects in India**" under my supervision.

Further, I certify that the work is based on the investigation made, data collected and analysed by him and it has not been submitted in any other University or Institution for award of any degree. In my opinion it is fully adequate, in scope and utility, as a dissertation towards partial fulfilment for the award of degree of MBA Power Management.

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Signature of the candidate

Acknowledgement

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Executive Summary

Indian power generation has been dominated by coal as primary source of fuel for quite a few years. In a way it was and is still considered as the key for ensuring the needs of Indian power sector. Out of the total installed capacity of 288.7 GW as of March 2016, 194 GW (68%) is from coal and natural gas. However since last few years the sector has undergone a lot of changes. With CO2 reduction being the trend followed globally, India which was the third largest emitter of CO2 had to consider other options for reducing its carbon footprint. To add to this effect depleting coal resources, rising tariffs, poor financial condition of utilities made matters further worse. The option that was left with increasing power demand by the industry was to develop sustainable alternative for clean electricity generation. With this the Government came up with Jawaharlal Nehru National Solar Mission in 2010 aiming capacity addition of 100GW through grid interactive solar PV. Indian solar market especially solar photovoltaic has seen significant growth after launch of JNNSM.

Government came up with different schemes & regulations, financial support to promote solar PV electricity generation on a larger scale. But there are some issues with large scale solar PV projects some of the main reasons being the huge capital cost required, large land area requirements and obtaining their clearances was time consuming process, getting banks loans was difficult as the technology was new, lack of transmission infrastructure for off taking the electricity generated through solar parks. To make this sector more investor friendly financing schemes like generation based incentives, viability gap funding, sale of electricity via REC were introduced but couldn't bring the results as per the expectation. Industry soon realised theuntapped potential of generating electricity from solar PV by using the building rooftop space. With this it set the target of achieving 40 GW out of 100GW from this particular segment. With the stage set for solar roof top system which is expected to bring revolution in the sector. This report gives detailed insight in some of the aspects of solar rooftop segment in India.

Starting with the programmes and schemes initiated by government a detailed summary of the solar rooftop regulations of 15 states has been given. This gives an overview of the regulatory atmosphere that exist here to an investor, developers and industry experts. In order to determine regulations of a state best suited for implementation of solar rooftop system a comparative analysis among solar rooftop regulations of states has been done by defining certain parameters, assigning scores and ranking the states as per highest scores. A technology never succeeds unless it gets a commercial & financial push. In depth study has been made to determine which business model is best suited for different entities involved like Distribution companies, domestic consumers, project developer, and investors. Cost economics behind two most widely used metering schemes: Net & Gross has been analysed by considering an example of domestic consumer. This exercise clarifies why net metering scheme is the most widely accepted over gross metering. Moving deeper into the financial aspect of the solar rooftop system financial modelling of a rooftop project has been done to determine how much financially viable are solar rooftop projects given a choice for an investor. With solar rooftop still an initial stage of implementation phase it a wise option to consider experiences of other countries that have undergone such phase before. The study focuses mainly on the technical issues pertaining to grid integration & business models adopted world-wide for successful promotion of solar rooftop. Certain conclusions were derived from the studies & exercises conducted which can be perceived as the reason of this segment not picking up its pace & recommendations have been mentioned to overcome them and help in achieving target of 40GW by 2022.

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List of Abbreviations

MNRE	Ministry Of New & Renewable Energy
DISCOM	Distribution Company
RTSPV	Rooftop Solar PV
REC	Renewable Energy Certificate
RPO	Renewable Purchase Obligation
GERC	Gujarat Electricity Regulatory Commission
FIT	Feed In Tariff
PPA	Power Purchase Agreement
SERC	State Electricity Regulatory Commission
MW	Megawatt
MU	Million Units
TPDDL	Tata Power Delhi Distribution
CERC	Central Electricity Regulatory Commission

1. Introduction

Indian power sector is facing unprecedented challenges with the growing economy; a rapid increase in electricity demand on one hand and supply constraints and increasing costs of major fuels, such as coal and natural gas used for power production coupled with growing concerns about climate change and greenhouse gas emissions from the use of fossil fuels on other. Providing energy security and energy independence to billion plus population is also on the government agenda. It has been established that to meet power demand, India needs to have a basket of energy resources. Renewable energy is being seen as a transformative solution to meet energy as well as economic challenges, both globally and nationally. However, the large-scale deployment of renewable energy technology will involve a combination of interventions involving policy and regulatory mechanisms, technological solutions and institutional structures. In recent years, particularly with the adoption of the National Action Plan on Climate Change, the Jawaharlal Nehru National Solar Mission, and solar policies by several states, India has taken several steps towards increasing the share of renewables in its energy mix. There is an increasing focus on the development of solar energy in India for a variety of reasons, including our limited conventional energy reserves, their local environmental and social impacts, energy security issues, energy access, and tackling the challenge of climate change. Solar photovoltaic (PV) technology, in particular, is emerging as an extremely attractive option, particularly with abundantly available solar resources, modular technology and zero fuel costs over 25-30 years of the project life. Considering this, the Government of India has recently expressed its intent to achieve 100 GW of solar capacity in the country by 2020, of which 40 GW is expected to be achieved through decentralized and rooftop-scale solar projects.

Though India is at a nascent stage as far as implementation of solar Rooftop systems are concerned, still 21 states have come up with their Solar Roof top regulations of which some are still in draft. Karnataka, Gujarat, Tamil Nadu, West Bengal were some of states who took the initiative of implementing solar Roof top Projects. Keeping in to consideration experiences of these states in solar rooftop segment Forum of Regulators came up with Solar Rooftop Net metering model in August 2013. All remaining states were recommended to come up with their state specific solar Roof top Net metering Regulations.

To be specific concept of distributed generation through solar rooftop is a Smart Grid concept as in involves connection of solar rooftop system directly to the grid. It calls for Net meters having smart metering features that can measure & provide the exact units consumed/ injected in to the grid. As the solar rooftop systems will be grid connected it is essential to consider technical parameters & interconnection standards ensuring grid stability.The Ministry of Power, GoI launched a Smart Grid Vision and Roadmap for India in Sep 2013 that envisages transformation of the entire Indian power system to smart grids by 2027. A National Smart Grid Mission is also expected to be set up soon. One of the important directives of this roadmap is to make rooftop solar mandatory for connected loads greater than 20kW. With the new government announcing its plans to revamp the National Solar Mission and also not impose anti-dumping laws, the solar sector is definitely looking up.

In the past, there have been mainly two planks of rooftop policies through which the government has tried to grow this market – 1) capital subsidies and 2) accelerated depreciation. Capital subsidy model has been used by MNRE and SECI but has failed because of poor implementation and lack of funds. It is expected that subsidy mechanism will be eliminated in coming months. Going forward, greater provisioning of debt-financing and net-metering are expected to be the main policy tools in the sector.

Background

India"s solar market, especially solar photovoltaic, has seen significant growth after the launch of the Jawaharlal Nehru National Solar Mission in 2010, with an installed capacity of over 3 GW in just four years. The Government of India is determined towards achieving 100 GW of grid interactive solar power capacity by 2020, of which 40 GW would be deployed through decentralized and rooftop-scale solar projects. Rooftop solar PV would play a prominent role in meeting energy demands across segments. It has already achieved grid parity for commercial and industrial consumers, and fast becoming attractive for residential consumers as well. As a result, multiple state governments have taken necessary steps to kick-start implementation of rooftop solar PV projects.

However, it is challenging to scale-up such programmes until:

- Solar technology is easily available and accessible in markets as a complete package
- Consumers are fully aware of service levels and actual economic benefits that can accrue
- Market is prepared to take on deployment and services even after subsidies are taken off
- Consumers, policymakers and investors have decision tools that aid decision-making
- State governments have policies and state regulators have conducive regulations on net metering/feed-in-tariffs.

Objective of project

To provide roadmap for each state for achieving the target capacity set by MNRE through solar rooftop.

To commoditize rooftop PV and proposes business, operating, financing and cost recovery models that may be appropriate to tap this huge customer-side market

To provide insight to developers & investors regarding the existing regulatory & commercial environment available for development of solar rooftop

To look deeper into the various aspects of roof top solar PV segment with the objective of developing a strategic action plan to eventually develop the roof top solar PV systems as commodity and consumer product, free from government subsidies and policy driven market.

Towards the strategy formulation, the study looked in to key issues, such as

- Techno-commercial viability
- State solar rooftop regulations
- Quality and standardization
- Financing Schemes
- Challenges& way forward

Scope & Coverage

This report provides insight to the summary of the solar rooftop regulations of 15 states. This gives an investor, project developer a brief of important regulations pertaining towards implementation of project. A comparative analysis of solar rooftop regulations gives a clear picture of the states that has best regulatory framework as far as solar rooftop implementation is concerned Right business model & different financing schemes determine the commercial viability of solar rooftop system. An

exercise has been to check the grid parity status of solar rooftop system in some selective states. Business model appropriate for different categories of consumers have been described with proper justification. The success of solar rooftop Implementation depends greatly upon the metering schemes. The report covers the cost economics involved for two metering schemes: Net & Gross. An exercise is done considering an example and certain conclusions are derived for the metering scheme to be adopted. Financial modelling of 5MW solar rooftop project in Gujarat is done to get an idea of the profits & returns that are expected by a developer with specific business model and financial parameters defined by a particular state. A developer, investor can correlate the results derived from this model with those of any other state. A study of solar rooftop experience in international countries is also carried out which gives idea regarding the technical and other commercial issues involved in its successful implementation Some final conclusions are derived regarding the further roadmap of rooftop solar sector in India.

2. Literature Review

Solar rooftop implementation was started by European countries which was later on adopted by USA and Japan. With growing pressure on India regarding sustainable development Government planned to adopt solar rooftop technology in 2012. To standardize and streamline the process FOR came up with Net metering regulations in 2014. States came up with their net metering regulations as per the guidelines defined in FOR model. While doing further analysis solar rooftop regulations of 21 states was referred along with MNRE schemes that promoted implementation of solar rooftop.

Regulatory & Commercial provisions for solar rooftop segment

Electricity Act 2003

In exercise of powers conferred under Section 181 read with Sections 61, 66 and 86(1) (e) of the Electricity Act, 2003 (Act 36 of 2003) and all other provisions enabling it in this behalf, State Electricity Regulatory Commission has come up with Regulations for Net Metering and grid connectivity of grid connected Rooftop & Small Solar Photovoltaic systems.

As per Electricity act 2003 Section 61(h), (i)

The Appropriate Commission shall, subject to the provisions of this Act, specify the terms and conditions for the determination of tariff, and in doing so, shall be guided bythe promotion of co-generation and generation of electricity from renewable sources of energythe National Electricity Policy and tariff policy

As per Electricity act 2003 Section 66

The Appropriate Commission shall endeavour to promote the development of a market (including trading) in power in such manner as may be specified and shall be guided by the National Electricity Policy.

As per Electricity act 2003 Section 86 (1e)

Functions of State Commission: promote cogeneration and generation of electricity from renewable sources of energy by providing suitable measures for connectivity with the grid and sale of electricity to any person, and also specify, for purchase of electricity from such sources, a percentage of the total consumption of electricity in the area of a distribution licence

Renewable energy act 2016

Clause 16 (1): 16. Renewable Energy Resource Assessment

The Ministry shall, within one year from the notification of this Act, complete a detailed resource assessment study for all renewable energy resources including all electric and non-electric applications such as utility scale electricity generation, distributed and decentralized electricity and energy generation (such as rooftop PV, solar pumping), heating, cooling, transportation, fuels etc.

CERC Tariff order (16-17)

Determination of generic levelised generation tariff for the FY 2016-17 under Regulation 8 of the Central Electricity Regulatory Commission (Terms and Conditions for Tariff determination from Renewable Energy Sources) Regulations, 2012.

3. Research Methodology

A step by step approach was adopted to analyse the environment for implementing rooftop solar system in India. Following methodology was used to derive conclusions about the possibility of achieving target of 40GW by 2022 set by Government.

It involves analysing the regulatory framework laid out by states & centre to promote rooftop solar PV and to determine the financial aspects of successful models being adopted by some states in the country. A survey of some international experiences has also been made which will be helpful in shaping the future path for the renewable sector of country especially solar.

Analysing the Regulatory Framework

Selection Of States

For first part of study 21 states were selected based on the rooftop solar policies that they have come up with, their geographical terrain. The solar rooftop policies of all states have been summarized first and then compared. States of comparison are:

Gujarat, Andhra Pradesh, Maharashtra, Tamil nadu, Karnataka, Kerala, Rajasthan, Madhya Pradesh, Orissa, West Bengal, Uttar Pradesh, Delhi, Bihar, Chhattisgarh, Telangana, Himachal Pradesh, Punjab.

Selection of parameters

A careful selection of parameters was made as per their relevance & significance in the implementation of rooftop solar system in country. Most of the parameters were selected from the state solar rooftop policies proposed by their respective state regulatory commissions.

Comparative Analysis

Comparative analysis was made among states by assigning scores to each state on basis of eleven parameters shortlisted and then multiplying them with respective weights assigned to them we got the final ranks on the basis of which one can decide how supportive is the state solar rooftop regulation for achieving the targets.

Determining suitable metering scheme for different electricity consumer segment

A sample domestic load has been determined and tariff of APDISCOM is used to derive monthly electricity bill. Three cases were considered for analysis of whether Net metering or Gross metering is beneficial.

Following cases were considered for Analysis:

Case 1: Generation is more than Consumption

Case 2: Generation is equal to Consumption

Case 3: Generation is less than Consumption

Results are plotted on a graph in order to derive certain conclusions by using MS Word.

Financial Analysis of third party owned model

Selection of State & business model

Gujarat was selected for this exercise since its one of the first states who took the initiative of implementing solar rooftop system and had done with third party owned model which so far has been the most successful model in implementing such projects on comparatively larger scale. Vadodara 5 MW solar project was selected as its still in commissioning phase.

Financial modeling

Gujarat State Discussion paper 2016, GERC tariff regulations 2016-17 & CERC renewable tariff regulations 2016-17 were referred for the secondary data.

Financial modelling has been done using MS Excel. Key results like the levelised tariff, Profits, IRR, Payback period, DSCR has been determined in this exercise.

International Experiences

Indian power sector has built up its structure & regulations on the basis of the experiences in other developed countries and renewable sector is no different. Indian power sector is banking on the experiments being tried up in other developed nations so that it can develop it suiting to its needs.This exercise involves selection of countries that have experience in the solar rooftop PV segment and also those like India are coming up with a plan for transition towards renewable energy and sharing their experiences.

Selection of International Countries

Depending on the expertise and large scale installation of solar rooftop projects, geographical area following countries/cities are selected starting with USA, Japan, Germany

4. Overview of Indian Rooftop Solar PV Sector in India

The Indian solar PV market has seen significant growth with the installed solar PV capacity, rising from 40 MW to more than 3,000 MW in the last four years. With Government declaring target of 175 GW by 2022 it is expected that the distributed generation (rooftop Solar PV) at the consumer end will drive solar power capacity additions given the acute power shortages in several states. The following Figure provides state wise installed capacity of rooftop Solar Pv system till May 2015.

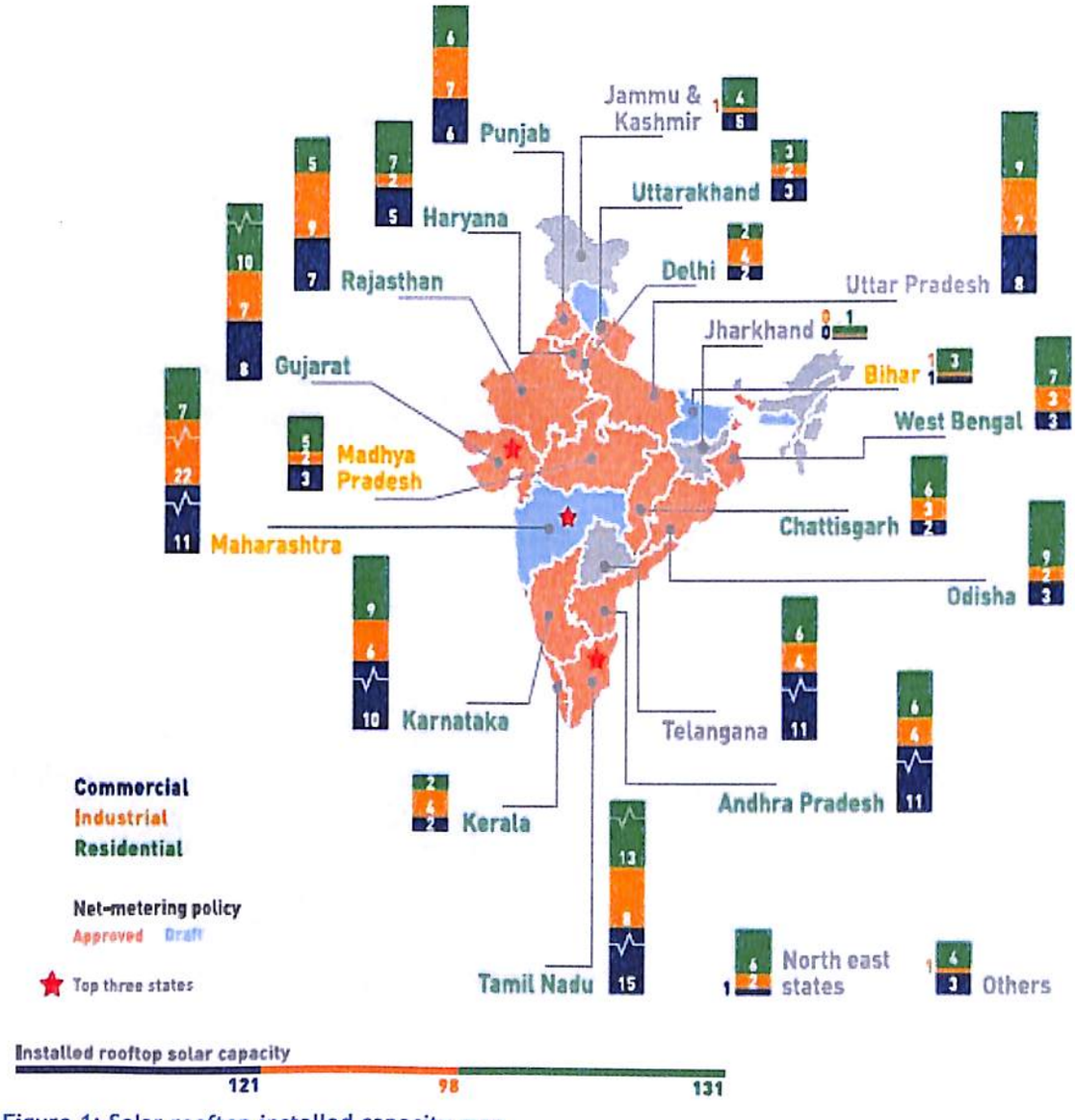


Figure 1: Solar rooftop installed capacity map

The total Installed capacity stands at 350MW with Maharashtra leading followed by Tamilnadu& Gujarat. The pace of development on solar rooftop sector has been very slow due to lack of Government support & regulatory framework. Although things are

seeming to pace up a bit with Government setting up a new target of 40GW and all supporting the initiative by coming up with their Solar rooftop policies.

Support Mechanisms made available by Central & State Government for promotion of Solar Rooftop PV.

Direct capital subsidy: Direct capital subsidy aimed at tackling the up-front cost barrier, either for specific equipment (PV modules) or total installed PV system cost.

REC scheme: Allows customers to purchase green electricity based on renewable energy from the electricity utility, usually at a premium price.

Renewable Purchase Obligation (RPO): A mandated requirement that the electricity utility source a portion of their electricity supplies from renewable energy.

Tax credits: Allows some or all expenses associated with PV installation to be deducted from taxable income streams.

Accelerated depreciation
A company can claim 80% depreciation in the first year of installation. This benefit is equivalent to 25% of the capital cost and can be claimed by profitable corporate entities but is generally unavailable to IPPs. This distortion in the level-playing field is not healthy for the growth of rooftop market.

Net metering: The system owner consumes solar electricity and receives retail value for any excess electricity fed into the grid, as recorded by a bi-directional electricity meter and obtained over the billing period.

Gross Metering: The System owner sells the entire electricity generated from solar PV into the grid to the Discom & gets compensated at FiT rate pre decided

Interest rate subvention
The central government is working with KfW, Asian Development Bank (ADB) and World Bank to provide financing support in the form of interest rate subvention for rooftop solar in India9. This scheme will provide debt at a lower cost of about 8.50% in comparison to the current cost of 12-12.5%. More than $2,100 million is known to have been committed by these developmental banks for the scheme.

State Policies
Gujarat, Tamilnadu, Karnataka were some of the first states which came up with their Solar rooftop policies. Currently 21 states have come up with their solar rooftop policies of which some are still in draft.

The overview of all the 21 state policies will be given in the subsequent chapters.

Institutional Structure

Entities responsible for implementation of rooftop solar PV projects are shown in below figure

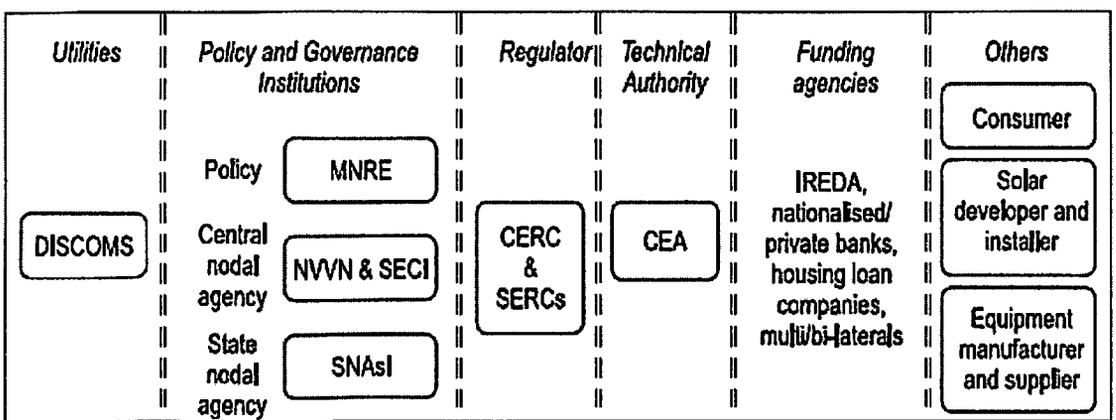


Figure 2: Entities involved in RTSPV projects

The roles & Responsibilities of each are briefed in the below table:

Table 1: Roles & Responsibilities of Stakeholders

Stake Holders	Roles	Expectations
Consumers	System owners, power consumers	• Cost • Power availability • Installation process • System quality, aftersales service
Utilities(Transmission & Distribution)	To provide and operate grid power and grid network	Grid stability and safety for transmission and distribution utilities. Impact on revenue of distribution utility due to generation at the consumer end
Investor/financier	To provide finance (equity/ debt)	• Return on equity • Loan repayment/debt recovery
Government	Promote clean energy. Provide electricity access to all. Establish policy framework for market and industry development	Outlay on government support mechanisms Providing affordable power to all Citizen
Electricity regulator	Regulate power tariff. Promote RE as per Electricity Act 2003 mandate. Provide regulatory support for clean energy market	• Determining power tariff • Maintaining grid code standards • Regulation of distributed Generation
System developer	Development of project	Stable market Government

	Provide EPC services AMC services	permissions andregulations
Stake Holders	**Roles**	**Expectations**
Manufacturer	Equipment supplier	• Quality • Access to technology • Competitive market • Stable market demand
Central and state nodal agencies	To implement government schemes	• Timely execution of project • Disbursement of subsidies • PPA with utility/developer/ roof owner

Solar rooftop programmes & Schemes

Rooftop PV & Small Solar Power Generation Programme

In order to give a thrust to rooftop PV and other small solar power plants connected at distribution network at voltage levels below 33 kV envisaged under Phase I of the Jawaharlal Nehru National Solar Mission (JNNSM), the **Ministry of New and Renewable Energy** (MNRE) launched a programme on generation based incentives. The programme is referred to as „Rooftop PV & Small Solar Power Generation Programme" (RPSSGP).

The key features of the programme are as under:

- The projects should be designed for completion before March 31, 2013.
- The local distribution utility in whose area the plant is located, would sign a Power Purchase Agreement (PPA) with the Project Proponent at a tariff determined by the appropriate State Electricity Regulatory Commission (SERC).
- Generation Based Incentive (GBI) will be payable to the distribution utility for power purchased from solar power project selected under these guidelines, including captive consumption of Solar Power generated (to be measured on ACside of the inverter). The GBI shall be equal to the difference between the tariff determined by the Central Electricity Regulatory Commission (CERC) and the Base Rate, which will be Rs 5.50 per kWh (for Financial year 2010-11), which shall be escalated by3% every year.
- GBI shall be payable to the distribution utility for period of 25 years from the date of commissioning of the project. IREDA has been designated as„Programme Administrator" by the Ministry of New and Renewable Energy for administering

the generation based incentive programme for rooftop PV and other small solar power plants

Table 2: RPSSPGP project capacity limits

Project Category	Capacity Limit
Projects connected at HT level of distribution network with installed capacity of 100kW and upto 2 MW	90MW
Projects connected at LT level of distribution network with installed capacity lower than 100kW	10MW

For payment of bills of the Rooftop PV and Other Small Solar Power Projects through letter of credit or by cash within two working days (except holidays 11 under N.I. Act), a rebate of 2% shall be allowed. Where payments are made other than through letter of credit within a period of one month of presentation of bills by the generating company, a rebate of 1% shall be allowed

- Interest on loan is assumed at 12.5% considering the recent „base rate" of 7.5% specified by State Bank of India. Loan repayment period is considered as 10 years.

Rooftop Solar PV for Warehouse Scheme

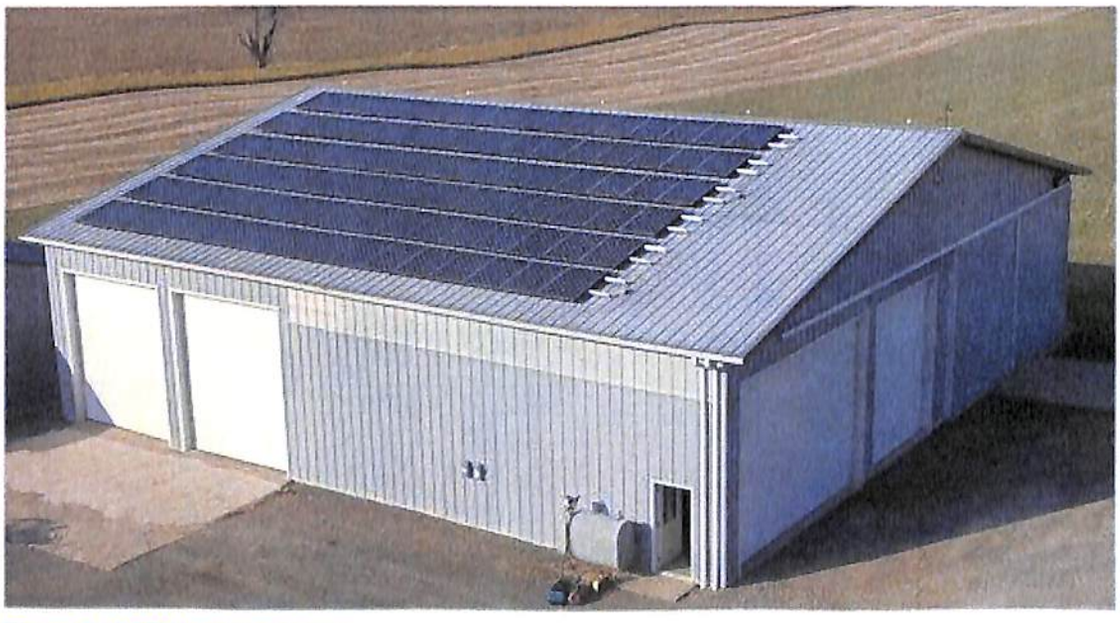


Figure 3: RTSPV on warehouse

To promote solar for warehouse facilities, Solar Energy Corporation of India (SECI) has released Request for Submission (RfS) document for implementation of grid-connected rooftop solar PV power scheme - for warehouses (SECI/Cont./RWS/75/2015) on 16 April 2015. The following are the highlights of the RfS document:

1. SECI plans to involve solar project developers (bidders), warehouse owners and discoms in specific states to implement the phase 1 of rooftop warehouse scheme (RWS), under which SECI aims to install an aggregate capacity of 73MWp.
2. Under the scheme, selected installer will sign a 25-year power purchase agreement (PPA) at a fixed tariff of INR 5.50/kWh with the discom, and install the PV plant on selected warehouse rooftop, paying the warehouse owner a rent of INR 0.50/kWh under a 25-year rent agreement.
3. To make the PV installation viable at INR 5.50/kWh, SECI will offer subsidy of up to INR2.00/kWh to the installers for 8 years. To select the installers, SECI has asked interested parties to submit bids, and parties bidding the minimum subsidy support (lesser than of INR 2.00/kWh) would be awarded the projects in specific states. The quoted subsidy by the successful bidder will be available for a period of 8 years with a cap of 17% CUF i.eRs. 29.50 lakhs/MW/year.
4. SECI has identified government-owned corporations such as Food Corporation of India and Central Warehousing Corporation who can rent out rooftop and on-ground space in their warehousing facilities. Private warehouses can also offer their rooftop space to successful bidders, with rent agreements lasting 25 years.
5. In exceptional cases, SECI may approve installations with power purchase agreements (@ INR 5.50/kWh) of successful bidders with private parties other than the discoms, while releasing subsidy at the bid rate.
6. The selected states for implementation of this scheme are:

1. Andhra Pradesh (5MWp)
2. Haryana (10MWp)
3. Punjab (20MWp)
4. Telangana (5MWp)
5. Tamil Nadu (5MWp)

6. Uttar Pradesh (5MWp)
7. Apart from the states mentioned above, solar projects to be set up in warehouses in Other states account for 23MWp.
8. Under the bidding process, a bidder can submit bid for 50% (no more, no less) of tendered capacity only for each state. Accounting for bids for various states, a bidder can apply for projects upto a maximum aggregate capacity of 15MWp.
9. The size of each project shall be in the range of 500kWp to 5MWp.
10. A successful bidder"s scope of work includes design, procurement, installation, testing, commissioning, insurance, monitoring and maintenance the PV plant for 25 years.
11. The deadline for submitting the bid documents is 2:30pm on 14 May 2015. The bids will be opened on the same day at 3:00pm.
12. The cost of procuring bid document from SECI is INR 26,250 (non-refundable), while INR 56,180 will be paid by a bidder to SECI as processing fee.
13. Eligibility criteria for bidding:
    - Technical criteria: The bidder should have installed at least one 50kWp PV plant in the past 6 months.
    - Financial criteria: Either the annual turnover of the bidder in one of the last 3 years should be more than INR 5.0 crore per MWp of the bid submitted, or net worth should be greater than INR 3.00 per MWp.
    - Net worth has to calculate in the following manner: Net worth = (Paid up share capital) + {(Free reserves – Share premium) +Share premium of listed companies)} – (Revaluation of reserves)-(Intangible assets) – (Miscellaneous expenditure to the extent not written off and carry forward losses.
    - The bidder shall have to submit a bid bond @ INR 20.00 lakhs per MWp in form of bank guarantee. Additionally, a payment bank guarantee of INR 20.00 lakhs per MWp has to be submitted.

    SECI will charge INR 18.90 lakhs (taxes extra) as service charges for site visits, inspection, monitoring, etc.

The installed PV plants have to maintain a CUF in the range of 15% to 17%. During grid failure, the SPV system stops generating. Any instances of grid failure need to be mentioned in the monthly report and those instances need to be certified by local DISCOM. Then the period will be excluded in calculation of CUF. The modules used for the PV plants must be procured from Indian manufacturers only.

State wise solar rooftop regulations

The summary of the solar rooftop regulations of 21 states has been given in Annexure I

Important observations in Solar Rooftop Regulations

With a considerable energy deficit, favourable energy policy & resource constraints for conventional energy the stage seem to be set for rapid growth in Indian renewable energy sector. The government has set target of 175 GW by2022 of which 40GW is through Solar PV Roof top. In some states like Gujarat, West Bengal, Tamil Nadu emphasis had already been given on energy generation from solar roof top. Shortly after announcement of revised targets a few more states came up with their Solar PV roof top energy generation policies.

Comparative analysis between the NET metering / Solar rooftop regulations of 20 States in India can be made on the basis of following factors:

- Eligibility Criteria
- Billing & Accounting
- Subsidy & Incentive mechanism
- Metering schemes
- REC (open access) & RPO fulfilment mechanism.
- Interconnectivity Standards

The roof top policies prepared by different states provide frame work for Solar rooftop installations. It enables to harness more contribution of solar power in to the current energy mix of India. It provides clarity regarding the processes and arouses investors & customers interest in the Solar Roof top power generation scheme.

Eligibility Criteria

Defining this parameter is very essential as it determines whether one qualifies for the scheme. An eligibility criterion is formed considering legal & technical aspect.

Most of the states have kept criteria involving:

1. Location of solar roof top solar system to be installed
2. Compliance of Interconnectivity & other Technical standards
3. Individual & cumulative capacity limits.
4. Ownership

Only those customers are allowed to have such system who are under the area of distribution licensee such that licensee will be accountable of the interconnection,

O&M, billing & facilitating the process. The scheme has been introduce with a specific target to be achieved through solar generation which is 40GW.Thus the scheme is aimed at particular customers who can contribute to achieve it hence its essential to define the capacity limits of the solar system to be installed. By defining the capacity limits the focus is on the rooftop area that generator have. The capacity limits of roof top have been defined between 1KWp to 1MWp by most of the state. Some states like Andhra Pradesh, Orissa have not defined the lower limit. Taking Grid stability in to consideration the SERC"s have defined Distribution Transformer Capacity limits & cumulative electricity that can be injected in to grid as percentage of Sanctioned load of individual consumer. If all the consumers started injecting the net/gross solar generated electricity units in to the grid it may overload the system causing instability. The distribution transformer capacity limits are different with respect to each Discom in the state. Grid penetration limits are defined so as to deploy solar rooftop systems in a phased manner and it also enables early applications from eligible & interests consumers to avail opportunity for having this system. Both Self owned & Third party owned system installations are eligible as this will provide greater flexibility from consumer"s point of view. This will promote the scheme as the owner will rent the area to power developer and using his expertise will generate the solar energy for commercial benefits.

Metering Requirements

Most of the states have opted for Net metering. Gujarat has implemented Gross metering scheme while Uttar Pradesh, Karnataka, Union territories & Andhra Pradesh have opted for both NET & Gross metering schemes. The major focus in the regulations pertaining to metering is their connectivity standards, Functionality, Accuracy class, Scope of work & cost.

Almost all states have mentioned the connectivity standards will comply with CEA regulations 2006(Installation & operation of meters). Delhi has mentioned Accuracy class of 0.2s while Madhya Pradesh has defined accuracy class of 1. States like Maharashtra, Madhya Pradesh, Delhi have mentioned functionalities like MRI (Meter Reading Instrument) & AMR (Automatic Meter Reading) for ease of billing process & accuracy improvement. The check meter functionality of meters however differs

from state to state as per the capacity limits eg: for Uttar Pradesh check meter mandatory for capacity > 50KWp & Rajasthan its > 250KWp.

Emphasis has also been made on TOD metering in some states like Delhi, Haryana TOD metering has important significance for energy accounting & billing purpose.

Almost all states have defined the scope of installing & procuring meters lies with respective Distribution licensee (ie. up to the point of net metering) and the generator may procure the meters but they must be certified by Licensee before installation.

For all states except Maharashtra the meter cost will be borne by the consumers.

For net metering scheme it is essential to have 2 separate meters (one bi directional & one unidirectional) for measuring net energy units & solar generated units.

JERC has defined list of approved vendors for procurement of required meters as per functionality by all union territories. This approach is well suited to bring in Standardization.

Billing & Energy accounting:

In states having option of gross metering scheme the injected units will be paid back by distribution licensee at Feed in tariff rate. FIT rate is different for consumers availing accelerated Depreciation benefit and those who are not availing Accelerated Depreciation benefit.

As far as States adopting Net metering scheme, excess (net) units generated through solar PV are credited over the next billing cycle and are compensated against the units consumed during that period. This cycle continues till entire financial year and then the unadjusted units are redeemed at either the Average cost of service of Discom or at APPC rate defined by the Discom approved by respective SERC egTelangana, Delhi. While in some states like Tamilnadu excess units are redeemed at retail tariff rate according to consumer category.

Some states have capped the maximum limit of accumulated unadjusted units as percentage of load demand of consumer for eg In Maharashtra draft policy the excess unadjusted units at the end of settlement period considered are 10% of Load demand.

In states like Kerala, Punjab, Orissa, Madhya Pradesh consumers availing TOD metering, excess units generated at a particular time interval will be compensated against units consumed at same time interval.

Subsidy & Incentive mechanisms:

Solar systems have still not achieved grid parity but are on course of achieving it. Thus they end up having tariff rates around Rs 6-7 which is costly than tariff rates of Rs 3-4 from conventional energy generation systems. In such situation in order to promote the energy generation form Roof top Solar PV systems its essential for both Central & State Government to provide subsidies and other financial incentives for generators, Discoms etc.

In states of Delhi, Kerala, Punjab, Uttar Pradesh, Madhya Pradesh, Telangana the solar generator is exempted from cross subsidy, Wheeling, banking charges & electricity duty.

States like West Bengal, Assam, Orissa have not clearly defined the incentive schemes for solar rooftop generators. While Tamilnadu has defined Generation based incentives with proper timelines, which makes policy attractive preposition for home owners. Andhra Pradesh, Uttarakhand, Haryana, Punjab, have mentioned of grant from MNRE on capital cost. Except Delhi & Uttarakhand who have specified grant of 30% all the other states have failed to mention the grant percentage. Telangana have mentioned constraints for MNRE grant (20%) depending on the installed capacity (min 3 KW) & respective consumer sector (Domestic).

Although the capital subsidy structures of both Kerala and Tamil Nadu are similar, the process of claiming this subsidy varies. The nodal agency of Kerala, ANERT already have the funds preapproved from both the MNRE and the Govt. of Kerala and is responsible for disbursing the funds to successful projects. However, TEDA, the nodal agency in Tamil Nadu does not assume responsibility in obtaining the MNRE subsidy and leaves it entirely unto the developers.

Tamil Nadu, Rajasthan, & Union territories have declared incentives for Distribution Licensee & Developers in the form of CDM benefits. More clarity in the subsidies & incentives provided by the Government will help to arouse confidence, interest of Consumers & developers to install Solar Roof top system.

REC & RPO Mechanism:

In states of Maharashtra, Orissa, Assam, Union territories, generator availing Net metering scheme is not eligible for REC mechanism, while all other states have given freedom to undergo REC mechanism subjected to criteria defined in CERC regulations 2010. West Bengal, Karnataka, Union Territories have defined rates of energy purchase under REC mechanism at APPC determined by the licensee, while in Tamilnadu REC can be bought at solar tariff defined by TANGEDCO. Benefit has been given to Discoms under RPO regulation in states like Haryana, Punjab where solar energy units consumed by consumer who is not obligated will qualify for RPO compliance of Licensee. Regulations in Maharashtra state that excess unadjusted units if purchased by licensee will qualify for its RPO.

Interconnectivity Standards:

Defining Interconnectivity standards are important for long term grid stability point of view and helps Discoms to prevent congestion enabling ease of billing. Most of the states have defined interconnection voltage levels depending on installed capacity of solar PV system except Andhra Pradesh, Assam, Haryana, Madhya Pradesh and Bihar.

All states have specified generators, developers to comply with CEA 2013, 2006 regulations & standards specified by state Discom. Auto /Manual isolation switch recommended for system having Battery backup in regulations of Maharashtra, Haryana, Bihar and Punjab.

Standardization is essential for interconnection of solar roof top systems with Grid.

Punjab has also defined the scope of O&M of Solar Grid connected system. From solar roof top system up to net metering it lies with Consumer or developer while from net meter to grid it lies with Licensee.

5. Comparative Analysis of State Solar roof top Regulations

Methodology:

- Defining Parameters for Comparison
- Defining the range of marks to be assigned to each parameter.
- Assign the marks to every state as defined across every parameter.
- Assigning weights to every parameter depending on its impact on solar rooftop implementation
- Finding out the total marks for each state regulation.

State with highest marks will be considered having consumer friendly regulation aimed at promotion of Solar rooftop on a greater scale with tears to come.

Defining parameters &scale

1) Grid penetration as percentage of Distribution transformer capacity

More the percentage value better the capacity of Solar roof top that can be installed &connected to grid. The maximum & minimum values are 50% and some states have not defined their grid penetration limit.Thus we"ll assign marks accordingly:

50% & above: 10

10% to 50%: 5

Less than 10% or not defined: 0

2) Eligibility Criteria for installing Solar rooftop.

It identifies the consumers that are allowed under these regulations to install Solar rooftop. Generally all consumers of a particular distribution company are eligible but some constraints are defined by some state depending on the voltage level, Rooftop area, Category of Consumer, First come first serve basis etc.

All consumers under Area of Discom: 10

Consumers eligible with above mentioned constraints: 0

3) Upper limit on energy that can be banked.

More the number of energy units that can be banked greater the flexibility the consumer has to utilize the solar system.

90% and above: 10

Less than 90%: 5

Not defined (-): 0

4) Open access:

When open access is allowed then generator can sell the renewable energy generated to consumers outside Distribution licensee or can consume renewable generated at a different location.

Allowed (Y): 10

Not allowed (N): 5

Not defined (-): 0

5) Individual capacity limit:

This is important from grid stability point of view as the distribution network has specific power carrying capacity. Normally the range is between 1KWp-1MWp which is quiet good for Domestic & commercial consumers.

It though preferable that lower limit is not defined such that even the customer having small rooftop area can think of installing this system.

Range defined 1kwp-1mwp: 10

limitation on minimum or maximum capacity: 5

Not defined(-): 0

6) Metering scheme:

Generator can sell the entire energy generated from solar rooftop into the Grid there by earning maximum, but this doesn"t help in reducing load demand. Such scheme is called Gross metering.

In case of net metering scheme the solar energy generated is consumed first & the surplus energy units are injected in the grid. Thus the generator is incentivised with net units injected back into the grid.

Now, both schemes have their advantages, gross metering is more suited for domestic consumers having fewer loads& tariff hence its profitable for them to sell the entire units generated, whereas for commercial & industrial consumers having his tariffs & load demand self-consumption is a better option.

Both Net & gross allowed: 10

Net metering: 5

Gross metering: 0

7) **Incentive.**

Giving Incentives is another way of promoting Solar roof top system. Incentives can be in the form of Subsidies on capital cost given away by MNRE & state Government, Generation based incentives to solar generator, Feed In tariff for 25 Years, Viability gap Funding. For this schemes most states have declared subsidy from central & State Government, it"s been decided that developer can avail subsidy that is least out of the two mentioned above. Along with this generator has also been give incentive of GBI & FIT.Subsidy from MNRE has been revised to 15% of capital cost for all states.

MNRE+ State subsidy: 10

Either MNRE or State subsidy: 5

Not mentioned (-): 0

8) **Tariff for Excess units generated.**

For generators availing Net metering scheme the excess units that are left after adjustment over settlement period are redeemed at a particular tariff rate. The rates defined are different for different states. Generator can avail maximum benefit if the rates are in the following order: Feed in tariff rate, Retail tariff rate as per consumer slab, Average cost of service to discom, average pooled power purchase cost.

FIT rate: 10

Retail tariff orAverage cost of service to discom: 5

Average pool power purchase cost or not defined (-): 0

9) **Interconnection voltage levels.**

Defining interconnection voltage levels is essential form grid stability point of view. This stream lines the interconnection & billing process.

Voltage levels defined: 10

Voltage levels not defined: 0

10) Renewable Energy certificate

Some states allow generator to sell the solar energy generated via REC mechanism such that is provides generator flexibility to sell renewable energy in open market at considerably high rate.

Selling thorough REC allowed (Y):10 Selling through REC not allowed(N): 0

11) Ownership.

Two business models that are being followed are Self-owned system & Third party rooftop ownership model. In third party ownership model owner gives his rooftop space on rental basis to a developer and gets compensated by the lease incentive in his bill.

Both Self &third party ownership allowed: 10

Either of both models allowed: 5

Not defined (-): 0

Assigning weights to different parameters

Parameters that will positively trigger the implementation of rooftop solar system are given high weightage while those having moderate impact are given moderate weightage and parameters that essential but do not affect the implementation of solar rooftop that much are given less weightage.

Parameters having high weightage: 20%

1) Incentive offered to generators/developers
2) Tariff for excess units injected in grid

Parameters having moderate weightage: 10%

1) Grid Penetration limit
2) Maximum energy that can be banked
3) Individual capacity limit

Parameters having low weightage: 5%

1) Eligibility criteria for Solar rooftop
2) Open Access
3) Metering scheme
4) Interconnection voltage levels
5) REC Qualification
6) Ownership Model

Table 3: State parameters

PARAMETERS	Andhra pradesh	Assam	Bihar	Chattisgarh	Delhi	Gujarat	Haryana	Himachal	JERC	Karnataka	Kerala	Madhyapradesh	Maharashtra	Orissa	Punjab	Rajastan	Tamilnadu	Telangana	Uttar pradesh	Uttarakhand	West bengal
Grid penetration limit as %of DT capacity	50%	15%	15%	•	15%	•	30% at LT. 15% at HT	15%	30%	•	50%	•	15%	30%	30%	30%	30%	•	15%	•	•
Eligibility	All consumers	All consumers	All consumers	•	•	All consumers	All consumers at vtg level below 11Kv	All consumers	All consumers with 1/3 ph supply	•	•	•	•	•	•	•	•	•	•	All consumers	Govt dept & Acedemic institiutions
upper cap on energy that can be banked	90%	90%	90%	•	Not defined	•	90%	90%	Not defined	Not defined	Not defined	•	10%	90%	90%	80%	90%	•	•	•	90%
open access allowed?	Y	•	•	N	•	N	Y	Y	Not defined	N	Y	•	•	•	•	Y	•	•	•	N	Y
Individual capacity limit	1MW for 3ph, 3KW for 1ph	1-500 KWp	1Kw-1Mw	50 kw - 1MW	minimum 1Kw	•	1Kw- 1 mw	max limit 1 mw	500Kwp-1MWp	1kwp-1mwp	Max 1 mwp	•	•	Max 1MWp	1Kw-1Mw	Max 1 MW	•	•	1kwp upto Sanctioned Load	max 500kwp	not less than 5KW
Metering Scheme	Net/Gross	Net	Net	Net	Net	Gross	Net	Net	Net & Gross	Net & Gross	Net	Net	Net	Net	Net	Net	Net	net &gross	net &gross	Net	Net
Incentive	MNRE+(20% from state upto 3 Kw)	Not defined	•	•	30% of capital by MNRE	lease incentive/unit generated + PPA at FIT for 25yrs	Rs 0.25/unit for excess units injected.	Central or State subsidy	15-30% MNRE+ CDM	State & Mnre Subsidy	MNRE Subsidy	•	MNRE+State subsidy	•	MNRE+ State	Not defined	GBI+State/Mnre	State +MNRE	Not defined	Mnre 30%	Mnre 30%
tariff for excess units injected	Average cost of service to discom	•	carried forward to nextbilling cycle	•	APPC	Levelised tariff for 25 yrs	Retail Rate	•	Retail Rate	Fixed tariff rate of 9.56 without subsidy & 7.2 with subsidy	•	•	APPC	Retail rate	Retail rate	units>30:Retail rate else FIT rate. Rs 9.63 without AD, Rs 8.42 with AD.	Retail rate	Gross ACSD NET:APPC	Retail tariff	FIT, Rs 9.2 without AD, Rs 8.15 with AD	Retail tariff
Cumulative capacity	•	3MW	10MW	•	•	•	200Mw		•	•	•	•	•	•	•	50MW	•	•	•	•	•
Inter connetion voltage levels	Not defined	Not defined	Not defined	Not defined	Defined	Not defined	Not defined	Not defined	Not defined	Not defined	Defined	Not defined	Defined	Not defined	Not defined	Defined	Defined	Not defined	Defined	Defined	Defined
REC Qualification	Y	N	Y	•	Y	•	Y	Y	N	Y	•	Y	N	N	Y	Not defined	N	Not defined	Y	Not defined	Y
Ownership allowed	self/third party	•	•	•	•	Third party	•	•	•	self/third party	•	•	•	•	Self	•	Household owner	•	•	self/third party	Institutional consumers only

Table 4: Comparative Analysis Score Sheet

Parameters	Weights	Andhra pradesh	Assam	Bihar	Chattisgarh	Delhi	Gujarat	Haryana	Himachal	JERC	Karnataka	Kerala	Madhyapradesh	Maharashtra	Orissa	Punjab	Rajastan	Tamilnadu	Telangana	Uttar pradesh	Uttarakhand	West bengal
Grid penetration limit	10.00%	10	5	5	0	5	0	5	5	5	0	10	0	5	5	5	5	5	0	5	0	0
Eligibility	5.00%	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	0	10	10	0
maximum energy banked.	10.00%	10	10	10	0	0	0	10	10	0	0	0	0	5	10	10	5	10	0	0	0	10
open access	5.00%	10	0	0	5	0	5	10	10	0	5	10	0	0	0	0	10	0	0	0	5	10
Individual capacity limit	10.00%	10	5	10	10	5	0	10	5	10	10	5	0	0	10	10	5	0	0	10	5	5
Metering Scheme	5.00%	10	5	5	5	5	0	5	5	10	10	5	5	5	5	5	5	5	10	10	5	5
Incentive	20.00%	10	0	0	0	10	10	5	5	10	10	5	0	10	0	10	0	10	10	0	5	5
tariff for excess units injected	20.00%	5	0	0	0	0	10	5	0	5	10	0	0	0	5	5	10	5	5	5	10	5
Inter connetion voltage levels	5.00%	0	0	0	0	10	0	0	0	0	0	10	0	10	0	0	10	10	0	10	10	10
REC Qualification	5.00%	10	5	10	0	10	0	10	10	5	10	0	10	5	5	10	0	5	0	10	0	10
Ownership allowed	5.00%	10	10	0	0	0	5	0	0	0	10	0	0	0	10	5	0	5	0	10	10	5
	Scores	95	50	50	30	55	40	70	60	55	75	55	25	50	60	70	60	65	25	70	60	65
	Final Scores	8.5	3.5	3.75	2	4.75	5	6.25	4.75	5.75	7.25	4.25	1.25	4.5	5	7	5.25	6.25	3.5	5	5.5	5.5

Determining rank of states.

From above table we have the scores for the state solar rooftop regulations of all states.

Summary of State scores

Table 5: State Ranks

States	Scores
Andhra Pradesh	8.5
Karnataka	7.25
Punjab	7
Tamil nadu	6.25
Haryana	6.25
Union territories	5.8
West Bengal, Uttarakhand	5.5
Rajasthan	5.25
Gujarat, Orissa, Uttar Pradesh	5
Delhi, Himachal	4.75
Maharashtra	4.5
Kerala	4
Bihar	3.8
Assam, Telangana	3.5
Chhattisgarh	2
Madhya Pradesh	1.25

Conclusion

It is evident from above table that Solar Rooftop regulations of Andhra Pradesh have more clarity form developer, investor point of view.

States having scores below 5 have defined important parameters like Grid penetration, Incentive structure but lack to mention other relevant aspects that solar rooftop regulation must have.

The actual implementation & commissioning of projects may vary depending upon various other factors like Government initiatives, Market condition, financial condition of Discom, advancement of Technology which is dynamic in nature.

On the basis of ranks obtained we can perform comparative analysis for some states at macro level taking parameters like AT& C loss, state peak deficit, RPO Target, Discom financial condition. These are some of the parameters that will determine the success of solar rooftop in a particular state.

Table below specifies the parameters of state for FY 14-15.

Table 6: State parameters considered for Solar rooftop success

States	Parameters				
	AT&C loss(%)	Peak Deficit(%)	RPO Target	Financial condition of Discom	Regulatory Policy
Andhra Pradesh	12.2	-11.8	0.25	Profit	8.5
Delhi	18.59	0.1	0.35	Profit	4.75
Gujarat	13.1	2.7	1	Profit	5
Madhya Pradesh	23.28	11.3	1	Loss	1.25
Maharashtra	18.71	5.5	0.5	loss	4.5
Tamil nadu	22.35	-5.4	0.05	loss	6.25
Rajasthan	26.54	1.2	1	Loss	5.25
West bengal	29.9	-0.8	0.4	Profit	5.5

State having maximum AT &C losses, High peak deficit, high RPO targets, good financial condition of discom, supportive regulatory framework have great scope of solar rooftop implementation.

Table 7: Overall ranking of states for implementation of solar rooftop

	Weights					
	0.2	0.2	0.02	0.2	0.2	
States	AT&C loss(%)	Peak Deficit(%)	RPO Target	Financial condition of discom	Regulatory Policy	Ranks
Andhra Pradesh	0	10	0	10	10	6
Delhi	5	0	0	10	0	3
Gujarat	0	0	10	10	10	4.2
Madhya Pradesh	10	0	10	0	0	2.2
Maharashtra	5	0	10	0	0	1.2
Tamilnadu	10	10	0	0	10	6
Rajasthan	10	0	10	0	10	4.2
West bengal	10	10	0	10	10	8

Above ranking is being done using same methodology. Equal weights had been assigned among five parameters. West Bengal, Andhra Pradesh, Tamilnadu have great scope for successful implementation of solar rooftop.

6. Commercial Aspect of Solar Rooftop in India

Basic Business models

The basic business models adopted in India as far as solar rooftop is concerned are as follows

Self Owned model (CAPEX Model)

The most common business model for solar deployment in India today is to simply sell either a complete plant, usually by an Engineering, Procurement and Construction company (EPC), or individual components (such as modules or inverters) to an installer or end customer. The plant owner pays 100% of the PV system cost upfront. This model is pursued by the majority of solar companies. The main drawback of the CAPEX model is that the plant owner needs to be able to finance the entire plant. Solar has a heavily front loaded cost structure, with a high initial investment and very low operating costs. A customer might not have the required liquidity to finance a system upfront or get the best debt terms. A key USP of this model is that it allows industrial and commercial consumers to own the system and claim tax depreciation benefits. With regards to smaller consumers, this business model has not achieved scale in India yet. This might be due to the cost. However, a lack of customer awareness and sales channels also plays a key role. Another concern is that the customer who buys the plant might not always have the skills to maintain it properly. In a city such as Delhi, where the household income is high, such a model could work with residential consumers as well. Standardization, aggressive marketing and information campaigns, easy availability of PV equipment, credible product guarantees and operation and maintenance plans as well as consumer finance are needed to provide a conducive market environment. The model can be bolstered through e.g. the emergence of rooftop aggregators or agents that can connect customers and installers, offering lower PV costs to groups of customers and functioning as sales channels for installers or equipment manufacturers.

Third Party Owned Model (RESCO Model)

Under a RESCO model, a third party investor comes in to invest into a PV plant on a rooftop and sells solar power to a power consumer. There is no investment required from the consumer. If solar power is viable, as discussed before, the consumer can benefit from savings on the electricity bill right from the start. Under this model, the

investor and the consumer agree on a tariff (per kWh of solar power) and timeline of a power purchase agreement (typically between 15-25 years). Operations, repair and maintenance of the system could be carried out by the RESCO company rather than the consumer. This model becomes more feasible with larger project sizes as the transaction costs would prevent most investors from investing into individual small plants. The model is applicable particularly to such commercial and industrial consumers who are not willing or able to invest but are ready to commit to an attractive long-term power purchase agreement. To make this model attractive for the consumers, the investor should offer a solar tariff lower than the current grid electricity tariff. Equally, the escalation of the solar tariff should be lower than the expected escalation of the gridelectricity tariff. The key concern in this model is the credit-worthiness of the power off-taker (and hence the bankability of the project). To invest into a power plant on someone else"s premises and sell power exclusively to them under a 15 or 25 year PPA requires a lot of faith in the customer. The key USP of this model is that the consumer gets electricity at a tariff lower than the grid tariff without having to invest into the plant. The consumer, moreover, has very limited risks no hassle and does not need to get involved in a new solar business case. Hence, the investor should find it easy to convince consumers to go solar and save without spending.

Local Micro Utility Model

One way to reduce the off-take risk for a RESCO investor is to give solar power generators easy and cheap access to the distribution grid and allow them to sell power to third parties. Then, solar power developers could rent large, bundled roof spaces from building owners in a designated area, install PV systems and sell the power generated to the rooftop owners, other consumers or the DISCOMs at a pre-negotiated tariff. Having more off-take options would greatly reduce the risk to the project developer and improve the bankability of the project.

The project developers would particularly target those consumers who might not have the resources or would be unwilling to invest in rooftop solar. Developers can offer building owners a lease income on their rooftop space. This model allows project developers to bundle rooftop space in a community and thereby minimize the legal, commercial and technical transaction costs by increasing the size of individual plants. This makes the model especially useful for the deployment of solar for residential consumers. Through economies of scale, the cost per kWh of solar power can be

significantly reduced and made viable for residential rooftop owners. Building owners will be able to generate new income through leasing their roofs for a period of time (e.g. 15 years). Renting homes is common in Delhi. The tenant might be disinterested in investing into a PV system that might have a payback period and a lifetime significantly exceeding the lease period. Such a leasing model would incentivize landlords who are renting out a building, to still make available their rooftops for PV plants. Such a model can be combined with the RESCO model, wherein the project developer could sell power back to the building owner as well. In such a case, the lease for the rooftop might be waived in favour of a lower solar power tariff. The key drawback in this model is the shifting of building owners from time to time. In case the owner of the building sells the building and the new owner would not like the roof to be utilized for solar, the project developer might have no other option but to shift the system to another location. Shifting an existing system to another roof would create significant additional costs and would push back the viability of solar. Another challenge to the model is a current lack of regulatory support for selling distributed power directly to end customers or utilities in Delhi. They key USP of this model is that it unlocks a greater number of residential rooftops for PV systems, by providing economies of scale to the developers and an easy income opportunity to a rooftop owner. The city of Gandhinagar in Gujarat, has initiated a pilot project that has some characteristics of the solar rooftop leasing model described above.

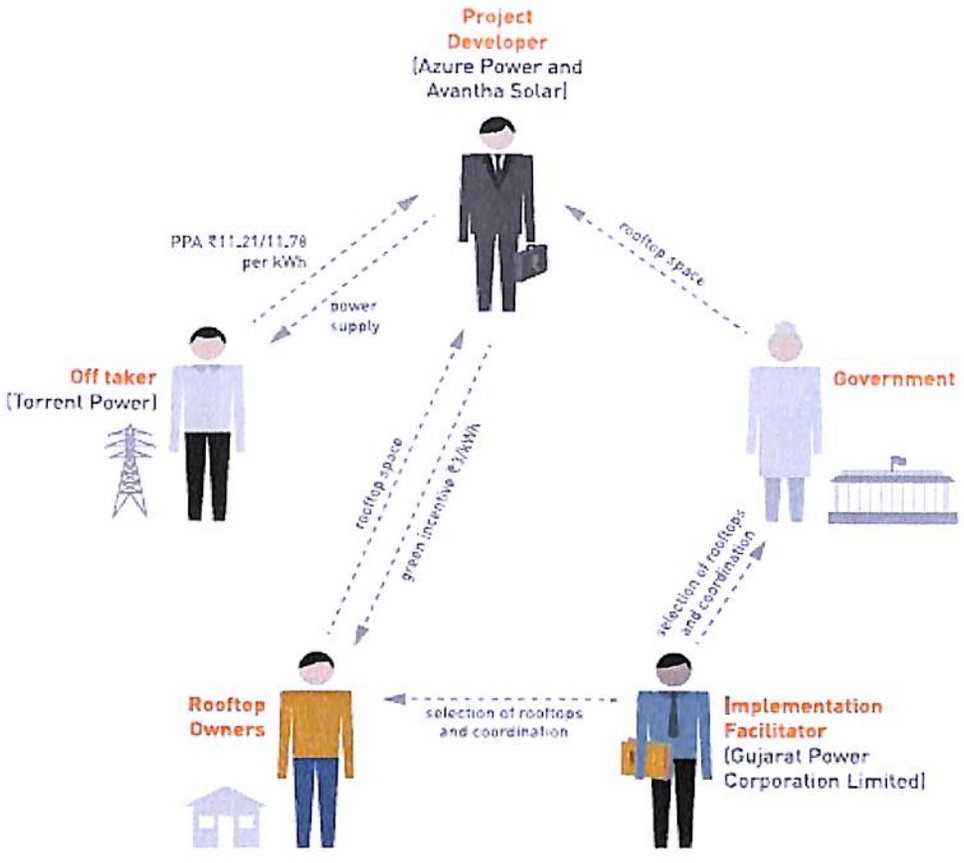


Figure 4: Local micro utility model

OPEX Model

Under this model, the developer directly signs a power purchase agreement (PPA) with the consumer which is usually at a tariff that is lower than that of the central grid.. This approach is attractive because it is independent of unpredictable government policies and offers flexibility in approaching consumers.For the consumers, this model presents an opportunity to lower their energy costs, secure energy supply (especially if it is a captive power plant) and meet renewable energy goals without investment.

Metering Schemes

Metering plays an important role in helping us to understand the performance of **solar energy systems.** Two methods of recording grid connected solar energy production are known as Gross & Net Metering. Grid connection describes the arrangement where the energy produced by solar PV systems is sent to the electrical network by systems connected to it. The alternative would be a standalone power system that charged batteries. Grid connected systems avoid the need to store energy in a battery, thereby reducing the cost of the system. In addition, you can draw electricity from the network if the power from your solar system is insufficient, at night for example.

Net metering

Net metering describes a metering arrangement where only „excess" solar electricity is sent to the electricity network („export"). Power is first sent to the appliances and lights in your house, and if excess remains, it is exported to the outside electricity network and its amount recorded. The saving reduces your bill in two ways: (1) results in a lower use of electricity from the network, and (2) small payment for the exported amount. Under this arrangement, cabling for the solar system does not need to go to the main meter box, but can go to the nearest sub-board.

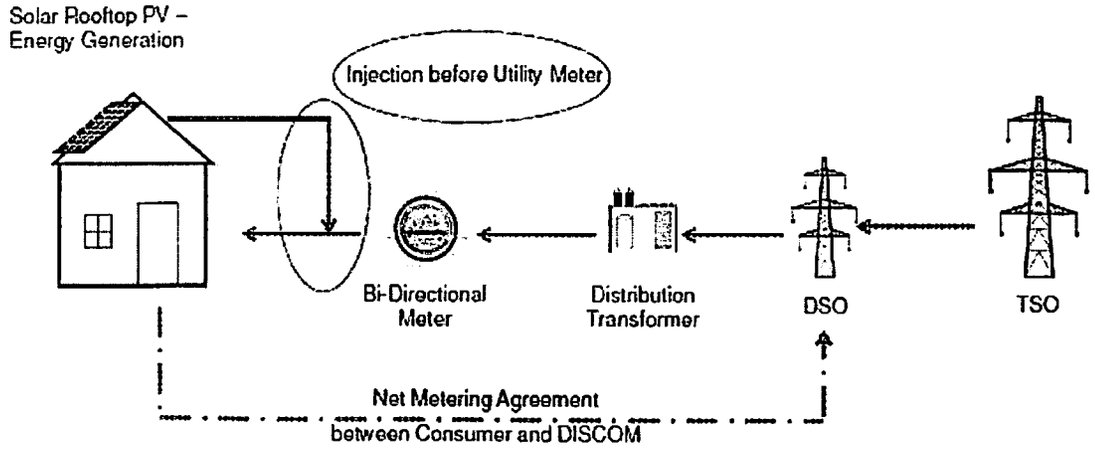


Figure 5: Net metering scheme for voltage less than 415V

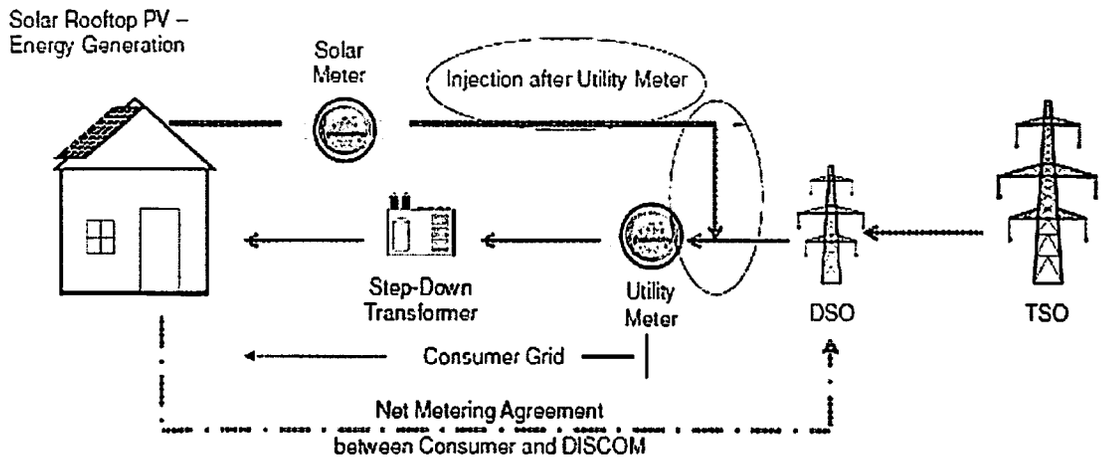


Figure 6: Net metering for voltage level above 415 V

Gross metering

Gross metering describes a metering arrangement where all solar electricity generated is exported to the outside electricity network through an independent meter. You would continue to have a separate meter that records how you use power. Gross metering is considered a good way to encourage householders to invest in solar, because the amount received is very obvious, and it is possible to easily offer a premium rate to householders for solar production. Under this arrangement, cabling for the solar system must go to the main meter box, or the location of the gross meter.

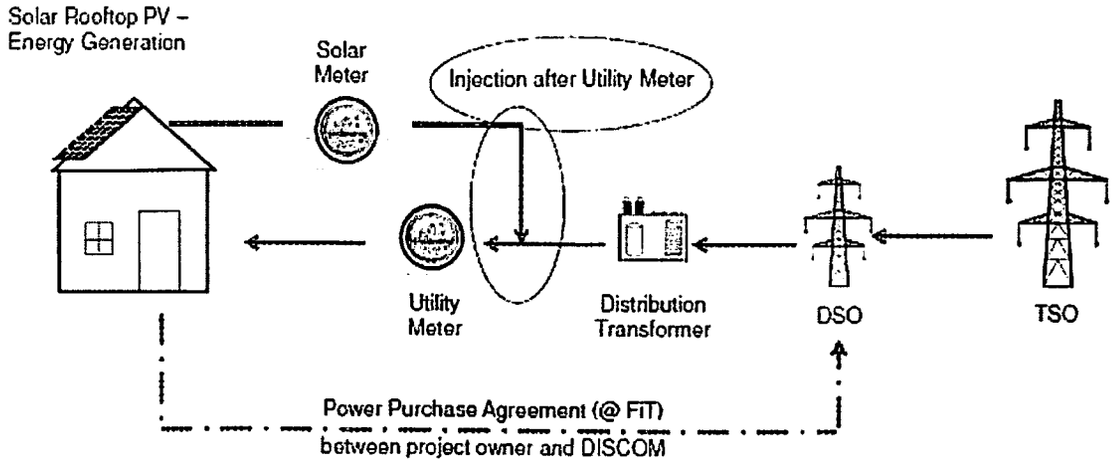


Figure 7: Gross metering scheme

Business Models depending on Metering Schemes & Ownership

On the basis of the two business models & metering schemes employed we get four primary business models are explained below:

Model 1: Only Sale of Electricity to Utility And Self-Owned Model

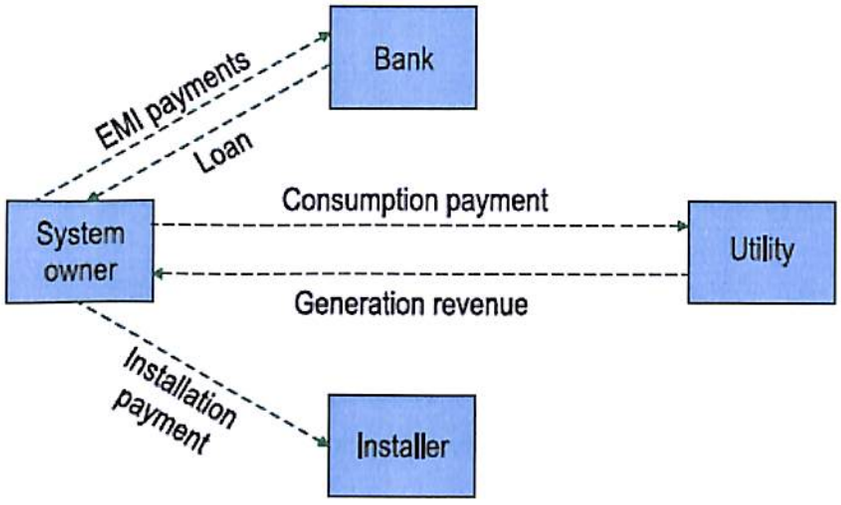


Figure 8: Revenue flow in gross metering and self-owned model

In this mechanism, the rooftop PV system is owned by the roof owner. Theentire electricity generated by the rooftop SPV system is supplied to the grid and in return,the system owner gets compensated at a predetermined regulated tariff.

Model 2: Only Sale of Electricity to Utility and Third Party Owned Model

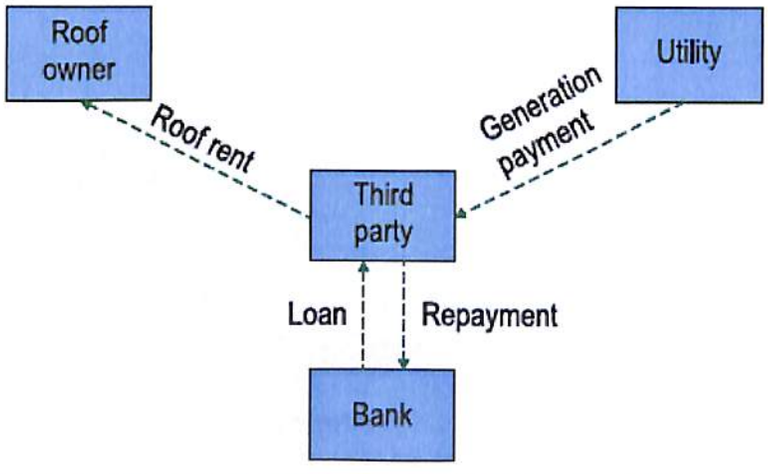


Figure 9: Revenue flow in gross metering and third party owned model

Under this mechanism, the rooftop SPV system is owned bythe system integrator/a third party. SPV systems are installed on rooftops (government,residential, public, commercial, industrial, and institutional buildings). In this model, thesystem owner signs a long term lease agreement with roof owner, invests in equipment,sets up the

projects, and sells the generated energy to the grid. Gandhinagar RooftopSolar Programme is an example of this model.

Model 3: Self-Consumption and Supply to Utility Grid and Self-Owned Model

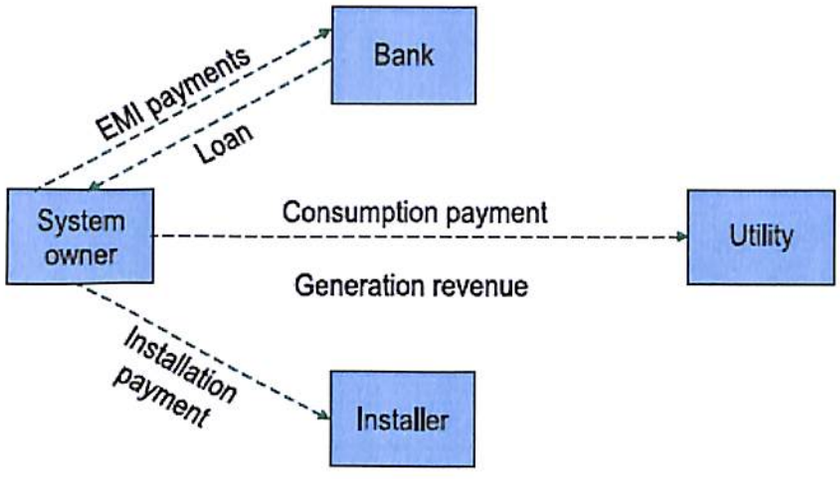


Figure 10: Revenue flow in net metering and self-owned model

In this model, the rooftop SPV system is owned by the roof owner.The generated electricity is supplied to roof owner"s end-use loads and the surplus poweris fed into the grid. The utility can purchase the surplus power or provide banking facilityfor a particular period of time.

Model 4: Self-Consumption and Supply to Utility Grid and Third Party Owned Model

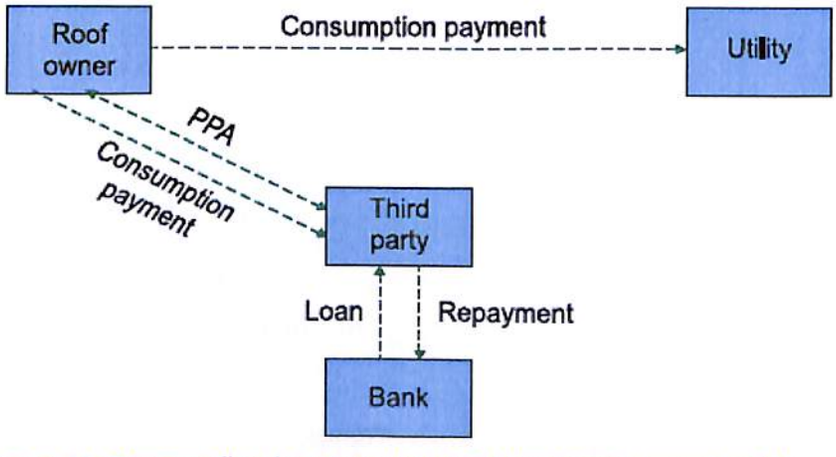


Figure 11: Revenue flow in net metering and third party owned model

In this model, the third party owns the system. The generated electricity is supplied tothe roof owner"s end-use loads and the surplus power is fed into the grid. The utility canpurchase the surplus power or provide banking facility for a particular period of timeOther possible option could be that the developers/third parties lease out solar PVsystems to interested roof owners. The rooftop owners in turn pay

developers/thirdparties a monthly lease rent. The electricity generated from such a system is used to meet the households"/rooftop owner"s energy needs with excess being fed into the grid on netmetering basis. The leasing company generates revenues by lease rentals and by claimingdepreciation on the capital cost of the PV systems, with associated direct tax benefits.

Financing For Solar Rooftop

Current Scenario

Bank financing for solar rooftop projects continues to be a major barrier towards achieving target of 40GW by 2022. It is understood that Department of Financial Services, Ministry of Finance, has advised all Public Sector Banks (PSBs) to provide loans for grid connected solar rooftop projects as home loan/home improvement loan. So far, nine PSBs, namely, Bank of India, Syndicate Bank, State Bank of India, Dena Bank, Central Bank of India, Punjab National Bank, Allahabad Bank, Indian Bank and Indian Overseas Bank have given instructions to their branches. However, this has not yet become operational at the field level as no branches of these banks are providing such loans. Reserve Bank of India has included renewable energy projects under Priority Sector Lending for which bank loans up to a limit of Rs. 15 crore will be available to borrowers for renewable energy projects including grid connected solar rooftop projects. For individual households, the loan limit is Rs. 10 lakh per borrower. This too is not yet operational at the field level.

It was proposed in a meeting with the banking sector that MNRE should prepare and widely circulate a Reference Manual for banks covering different aspects of Grid Connected Solar Photovoltaic Rooftop Power Plants including technical details, performance standards, cost, State policies and net metering regulations etc. Procedures for loan application, processing, securitization and time-bound approval need to be laid down and widely publicized by the banks. Capacity building programmes for Bank officials should also be conducted. An award scheme can be instituted for best performing banks/officials. It was also agreed in the meeting that a Working Group of about five banks will be formed to discuss the roadblocks and possible solutions for financing of rooftop solar PV projects. The regulatory issues that may be required to be taken up with Reserve Bank of India / Department of Financial Services, or any other Govt. agencies, will also be formulated by this Group. Early action by all concerned agencies is necessary for timely implementation

to meet the goals set by Government. The subsidy mechanism is seen as highly ineffective due to limited availability of funds. A new rooftop policy based on net metering is on the anvilThe solar industry believes access to finance, not sops, will be key for rooftop installations to take off, as it remains unruffled by the government"s recent proposal to cut subsidy. Despite the provision of subsidies, solar rooftop installations have performed way below targets. Of the 358 MW rooftop solar projects sanctioned by Ministry of New and Renewable Energy (MNRE), only 42 MW of rooftops have been installed so far. The subsidy mechanism is seen as highly ineffective because not enough funds are made available, delaying or entirely stalling projects. Also, there is a demand for standardization guidelines for installations and grid inter-connectivity instead of channel partners, though this mechanism helped to ensure quality to some extent. Large players such as Tata Power Solar are reported to be building a strong position in the EPC market. Tata claims leadership position in industrial and commercial rooftop segment with a market share of 15 per cent.

The industry does welcome the RBI"s recent move to bring the renewable sector under the ambit of priority sector lending but it now wants the financing process to be free of hassles. Currently, simple consumer financing solutions for solar installations are largely unavailable in the market. Many consumers may not have the liquidity to pay for the entire solar system upfront. This capital expense will have to be financed by scheduled commercial banks, non-banking finance companies or co-operative banks in the same way they will finance a car loan or any other personal loan.

Securing debt funds from commercial banks is complex and costly issue. Banks considers following aspects while deciding the interest rate:

1) Credit worthiness

2) Risk associated with Off taker (Discoms)

3) Building ownership and type of business model

4) Size of project

Banks end up charging high interest rates as the financial conditions of discoms is poor, causing uncertainty of payment,limited appraisal expertise and experience of solar rooftop projects. Some banks have kept criteria that project size for raising debt

should be more than 5MW as they think small projects may not generate adequate cash flows.

Financial Benefits derived from Business Model

Third party owned model does not allow roof owner to avail certain financial benefits, such as tax benefits, capital subsidy, etc. capital subsidy or low interest loan or their combination.

For residential consumers, Accelerated Depreciation (AD) benefit will not be applicable for third party owned model, AD benefit may be applicable. In third party owned model,there would also be additional benefits, such as economy of scale, and centralized O&Mnetwork.

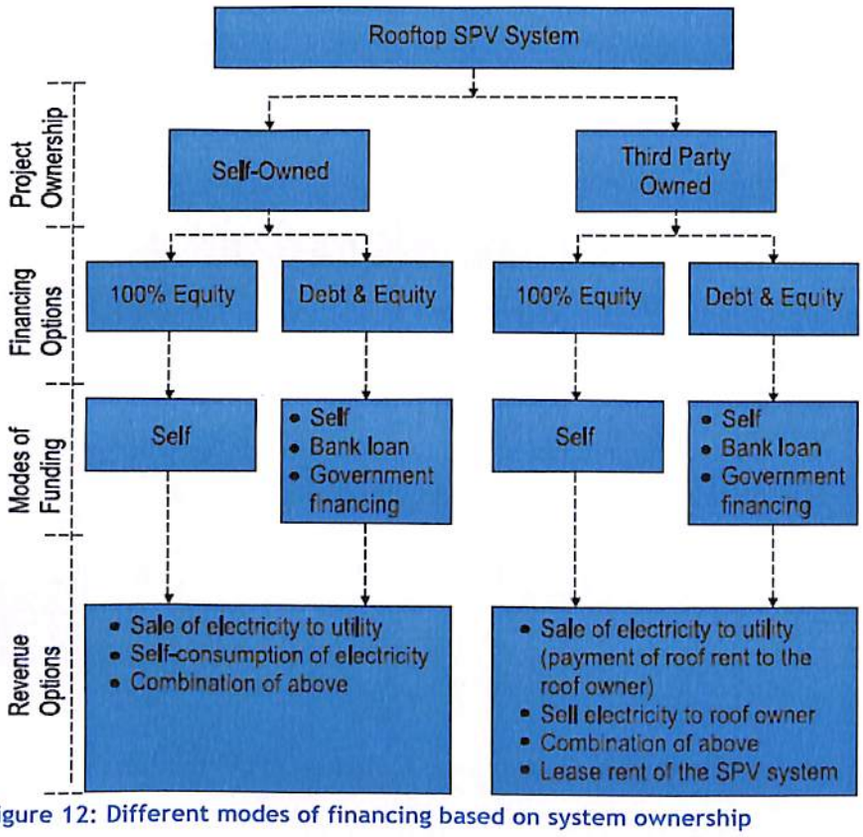


Figure 12: Different modes of financing based on system ownership

IREDA Loan Scheme

Power minister Piyush Goyal on Tuesday launched the Indian Renewable Energy Development Agency (IREDA)"s loan scheme for rooftop solar power projects in the country. The scheme will provide loans at interest rates between 9.9% and 10.7% with a repayment period of nine years.

The loan can be availed by project aggregators, developers for a minimum aggregated project size of 1MW and sub size of 20KW. The scheme has been formed by drawing credit lines from German development bank KfW and Japan International Cooperation Agency.

Commercial viability of solar rooftop

India"s rooftop solar market capacity is expected to reach 1500 MW by 2018, from 285 MW as of October 2014, driven mainly by commercial and industrial segments. The government is focusing on enabling the market, not managing it by cutting subsidy on rooftop solar plants to 15 per cent from 30 per cent due to decline in price of solar panels, large target set for rooftop solar power plant and limited availability of funds for subsidy. On the other hand, though, the economic viability of this solar segment has been rapidly increasing. Around 7 to 8 Indian states have achieved grid parity in commercial rooftop. With Accelerated Depreciation (AD) benefits, a same percentage of states see viability in industrial segment. As of now Maharashtra and Delhi have achieved grid parity in Industrial segment. This makes a subsidy-free scheme possible with a focus on easy consumer financing options.

To get clarity regarding the states that have achieved grid parity as far as solar rooftop is considered commercial & Industrial tariff rates of some states for FY 15-16 have been compared with the CERC tariff for solar Roof top.

Table 8: Commercial & Industrial tariff rates of states

State	Maharashtra	Karnataka	Delhi	Andhra Pradesh	Uttar Pradesh	Rajasthan	Punjab	Madhya Pradesh	Gujarat
Commercial tariff	8.38	7.95	8.8	8.54	7.3	7.15	6.75	6.15	4.7
Industrial Tariff	7.01	5.85	7.9	6.38	6.75	6.25	5.85	5.7	4.7
Without AD	7.04	7.04	7.04	7.04	7.04	7.04	7.04	7.04	7.04
With AD	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35	6.35

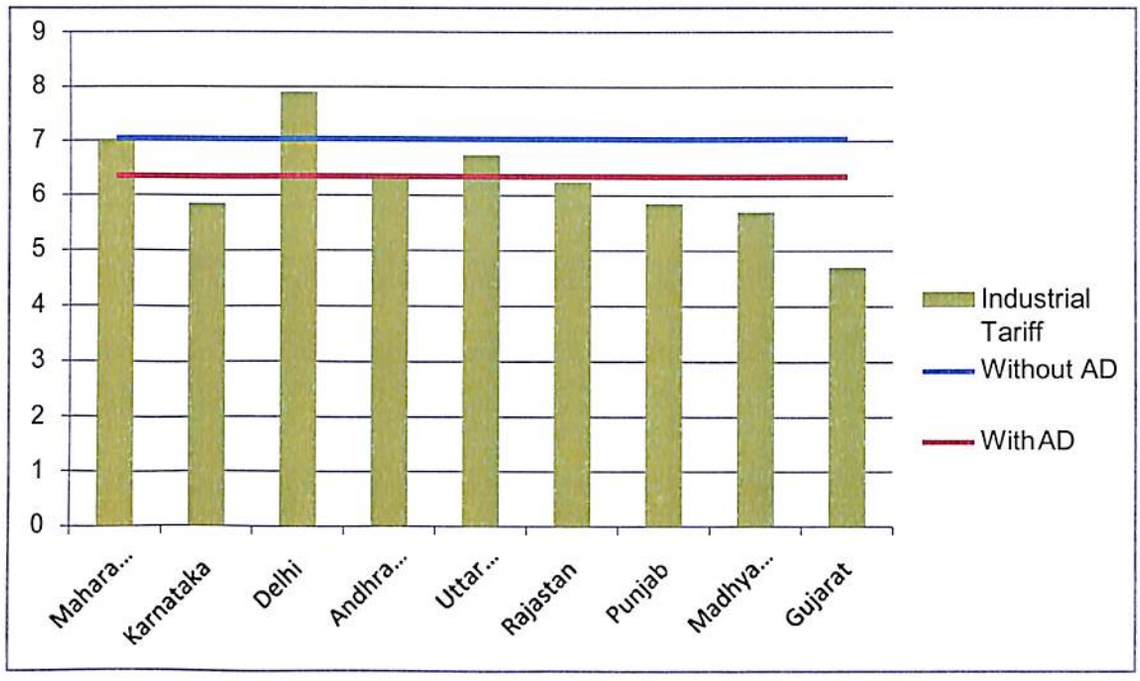


Figure 13:Grid parity for Industrial consumers

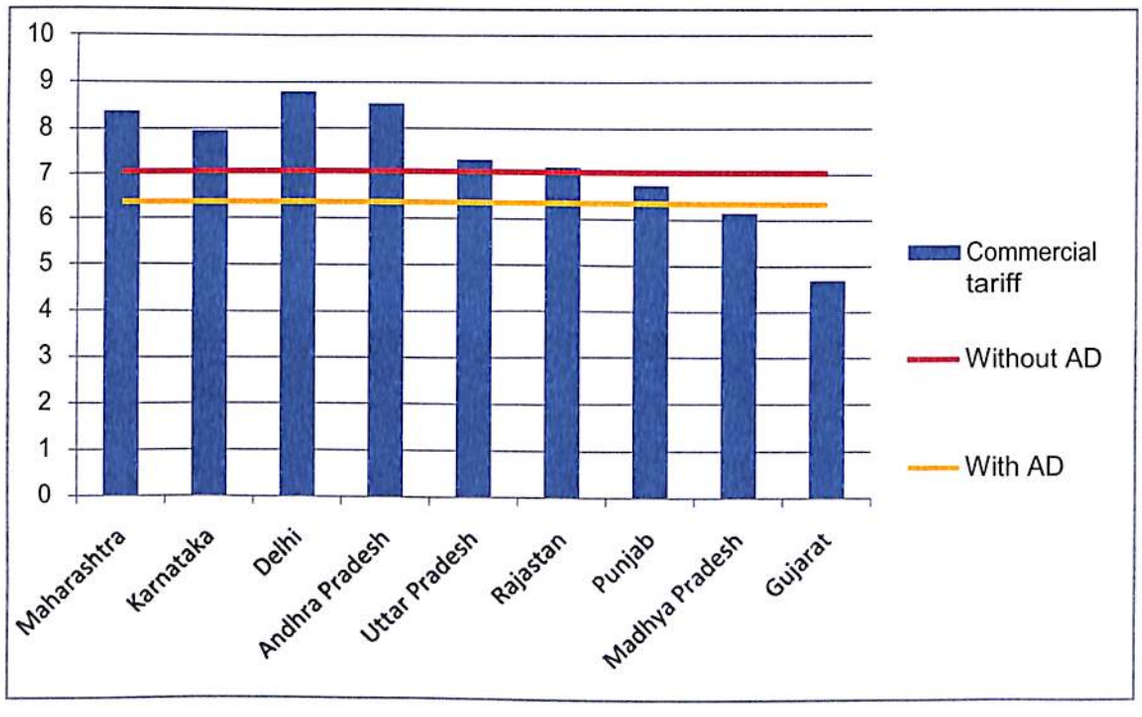


Figure 14: Grid parity for Commercial consumers

So, rooftops are already viable without subsidy for the commercial and industrial segments in several states. These two segments account for more than half of capacity addition so far. The residential segment, which is seen having a bigger potential, is also expected to be viable in the next few years. Power tariffs in residential segment are now subsidized across the country. The challenge in the commercial segment lies

in getting access to the roof area for 20-25 years. The commercial rooftop space, like in a hotel or a hospital in India, is a valuable real estate with many competing uses and thus becomes hard to dedicate the space for solar project for a longer period in a contracted arrangement.

7. Cost economics of Metering Schemes for domestic consumer

In order to get maximum returns from a Rooftop SPV sizing is very important factor in order to illustrate this the following cases have been worked on to calculate the payback period in each situation. The purpose of this exercise is to give insight to consumers regarding the solar rooftop metering scheme that would be beneficial to them.

Assumptions:

Tariff order of Andhra Pradesh is considered.

Average pooled power purchase cost of AP Discom: Rs 3.38/unit

Cost of 1KW solar PV = 1.1 lacs

Net meter cost =Rs 2000

Registration charges: Rs 3000

Subsidy from MNRE : 15% of Capital cost.

Table 9: Domestic consumer Load details

Appliance	No	Watt	Working hrs	Total Wattage	
Tubelight	4	40	6	960	
Fans	4	60	8	1920	
Refrigerator	1	180	24	4320	
Televison	1	80	8	640	
Geyser	1	1500	1	1500	
A/C	1	2500	6	15000	
			Total	24340	W
			Daily consumption	24.34	Units/day
			Monthly Consumption	730	Units/month

Table 10: Domestic Tariff Details

Units	Rate(Rs)
0-50	2.6
51-100	3.25
101-150	4.88
151-200	5.63
201-250	6.38
251-300	6.88
301-400	7.38
401-500	7.88
>500	8.38

Net Metering

Table 11: Consumption > Generation

Solar Installation detailsGeneration details & Payback period

Capacity	1	Kw
Cost of system	110000	Rs
Registration cost	3000	Rs
Net meter cost	2000	Rs
Inter connection charge	2000	Rs
MNRE Subsidy	15%	
Net Cost	100500	Rs

Generation per day	4	units
Generation Per month	120	units
Consumption per month	730	units
Net energy consumed	610	units
Energy charges payable for 610 units	3928.8	Rs
Energy charges payablefor 730 units	4934.4	Rs
Savings per month	1005.6	Rs
Savings per year	12067	Rs
Payback period	8	yrs

Table 12: Consumption = Generation

Solar Installation details

Capacity	6	Kw
Cost of system	660000	Rs
Registration cost	3000	Rs
Net meter cost	2000	Rs
Inter connection charge	2000	Rs
MNRE Subsidy	15%	
Net Cost	566950	Rs

Generation details & Payback period

Generation per day	24	units
Units generated Per month	730	units
Units consumed per month	730	units
Net units injected	0	units
Monthly bill for 730 units	4934.4	Rs
Revenue from net injected units	0	Rs
Total Monthly benefit	4934.4	Rs
Total yearly benefit	59212.8	Rs
Payback	10	Years

Table 13: Consumption < Generation

Solar Installation detailsGeneration details & Payback period

Capacity	10	Kw
Cost of system	1100000	Rs
Registration cost	3000	Rs
Net meter cost	2000	Rs
Inter connection charge	2000	Rs
MNRE Subsidy	15%	
Net cost	940950	Rs

Generation per day	40	units
Units generated Per month	1200	units
Units consumed per month	730	units
Net units injected	470	units
Monthly bill for 730 units	4934.4	Rs
Revenue from net injected units	1588.6	Rs
Total Monthly benefit	6523	Rs
Total yearly benefit	78276	Rs
payback	12	years

GROSS Metering

The same exercise can be done for **Gross metering** Scheme with same solar installation details

Assumptions

Feed in tariff rate is considered as 9Rs /unit

Case 1: Consumption > Generation

Table 14: Generation details & Payback period of Capacity: 1 Kw

Generation per day	4	units
Generation Per month	120	units
Consumption per month	730	units
Energy charges payablefor 730 units	4934.4	Rs
Monthlyrevenuegeneratedat FIT Rate	1080	Rs
Yearlyrevenuegeneratedat FIT Rate	12960	Rs
Payback Period	8	Yrs

Case 2: Consumption = Generation

Table 15: Generation details & Payback period of Capacity: 6 Kw

Generation per day	24	units
Units generated Per month	730	Units
Units consumed per month	730	Units
Energy charges payablefor 730 units	4934.4	Rs
Monthlyrevenuegeneratedat FIT Rate	6566.4	Rs
Yearlyrevenuegeneratedat FIT Rate	78796.8	Rs
Payback Period	7	Yrs

Case 3: Consumption < Generation

Table 16: Generation details & Payback period of Capacity: 10 Kw

Generation per day	40	Units
Units generated Per month	1200	Units
Units consumed per month	730	Units
Energy charges payablefor 730 units	4934.4	Rs
Monthlyrevenuegeneratedat FIT Rate	10800	Rs
Yearlyrevenuegeneratedat FIT Rate	129600	Rs
Payback Period	7	Yrs

Observations:

The graphs of the above three cases for Net Metering system indicate that as capacity of rooftop system increases the payback period increases which is not desirable from customers point of view. Thus Net metering scheme is preferable for generators/consumers having low rooftop space available for installation of Solar PV.

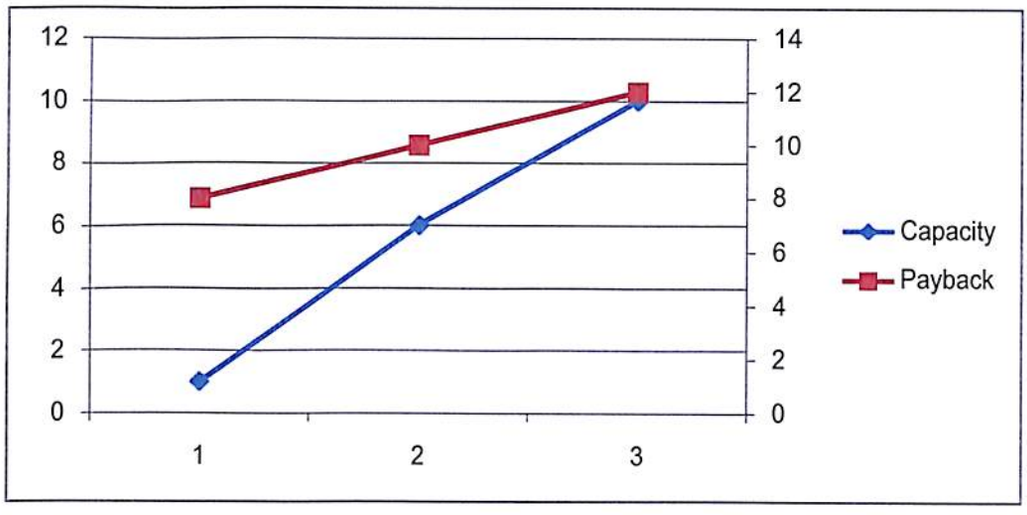


Figure 15: Net metering Capacity Vs Payback

From above values it can be concluded that with increase in the capacity the payback period decreases marginally or remains constant. Gross metering scheme is preferable for generators/consumers having more rooftop space for installation of solar PV.

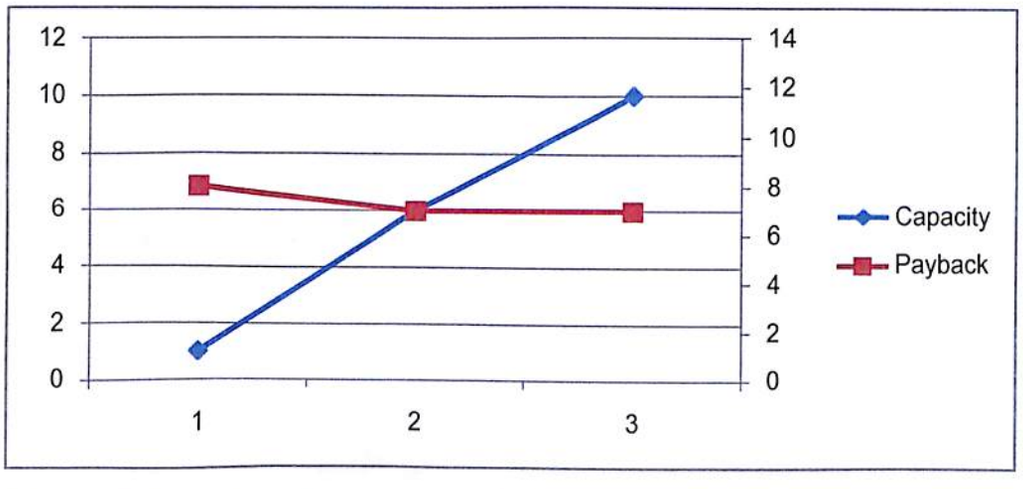


Figure 16: Gross metering Capacity vs. payback

In above example of net metering system if a capping is applied to the number of units that can be injected into the grid as percentage of sanctioned load then the payback period will increase as the revenue earned will reduce and this will discourage consumer for opting solar rooftop option.

8. Financial Modelling of 5MW solar roof top project at Vadodara, Gujarat

Financial models are a key element in most major business decisions. A financial model is prepared whenever any organisation is considering project finance, bidding for a project, evaluating acquisition target, carrying out monthly financial planning, conducting capital structure studies, etc.

They are useful tools that allow business options and risks to be evaluated in a cost-effective manner against a range of assumptions, identify optimal solutions in evaluating financial returns and understand the impact of resource constraints to make the most effective business decisions.

Highlights of 5MW solar rooftop Vadodara Project:

a) Major Entities involved:

Gujarat Power Corporation Limited (GPCL): Bid Process Coordinator(Nodal Agency) to carry out the bidding process for the selection of the Selected Bidder(s) for supply of power from the Projects.

GERMI: Bid process co-coordinator wherein it has invited bid for selection of Rooftop Solar Power Project Developer.

International Finance Corporation (IFC): International financial institution which offers investment, advisory, and asset management services.

Madhav Group: Solar Rooftop Project developers, selected by competitive bidding process who will build, finance, own, operate and maintain the Rooftop Solar Units.

Rooftop Owner: Provide their roofs to rooftop solar project developer for setting up solar power unit on Long-term basis.

MGVCL: Off taker in this program and will purchase the clean power generated from this projects

b) Implementation model

PPP-Public Private partnership model implied.

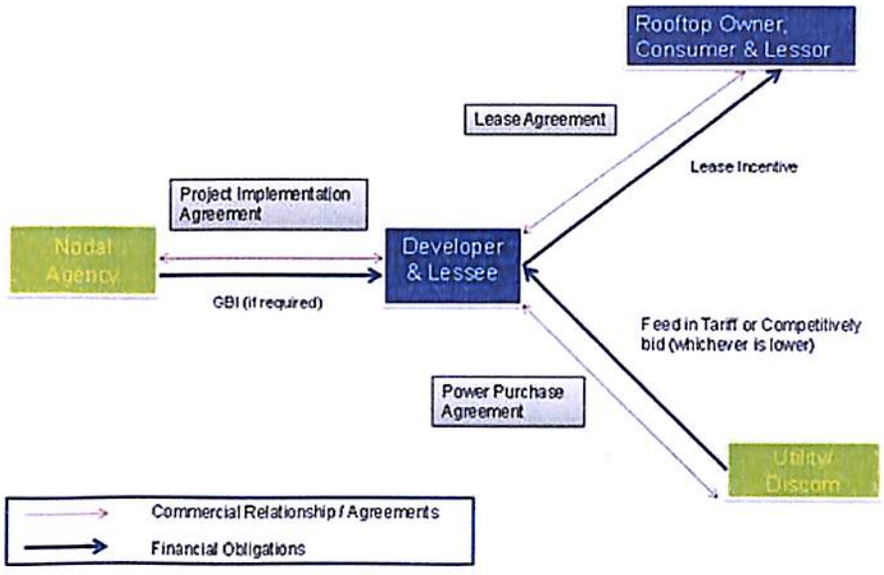


Figure 17: Vadodara project business model

c) Commercial Agreements

PPA signed for: 25 Yrs

Offtaker:Madhya Gujarat Vidyut nigam Ltd

Developer: Madhav Group

Selection Process: Competitive Bidding

Tariff Finalized: Rs 10.76 per unit

Green Incentive to roof top owners: Rs 2 per unit generated

Assumptions for financial modelling

Operation and Maintenance Cost and its Escalation

The operation and maintenance of a photovoltaic power plant mainly involves cleaning of the photovoltaic modules at a regular interval.The typical operation and maintenance cost of photovoltaic power plants is considered to be INR 10.75 lakh/MW/annum. This number has been arrived considering honourable APTELs direction. The annual escalation of the operation and maintenance cost is considered to be 5.72% annually.

Capacity Utilization Factor

Capacity Utilization Factor (CUF) can be calculated based on the energy output of the plant. the CUF of Gujarat is considered 19%.

Annual Degradation Factor

The performance of the PV system doesn"t remain constant through its life it is affected by external factors like surrounding atmosphere, handling etc. The acceptable annual degradation in the performance of the grid-connected photovoltaic system is 1%.

Auxiliary Power consumption

A photovoltaic power plant consumes minimal energy for auxiliary purposes. Auxiliary power may be required for air-conditioning in inverter and control rooms, cleaning water softening and pumping system, security night lighting and general office lights and fans. Auxiliary power consumption is considered as 0.25%of total energy generation.

Debt Equity Ratio

Gujarat Solar tariff order 2012 has considered debt equity ratio of 70:30 which is continued further.

Interest Rate on Loan

India"s growth cycle is on the upward trend and inflation is strongly correlated to growth. In the current scenario, the base rate of SBI is 9.85%. A reasonable mark-up of 300 basis points on this base rate would result in an effective interest rate of 12.85%

Working capital

One month"s expense on operation and maintenance expenses, and receivables equivalent to two month"s energy charges for sale of electricity calculated on a normative CUF.

Interest on working Capital

gap between the long-term loan and working capital loan rate is typically between 150 and 250 basis points. The working capital is decided based on different parameters, and hence, interest rate on working capital is decided 12.00%.

Return on Equity

ROE post tax is 14%. GERC allowed income tax as 20.008% for 10yrs(Tax holiday) and corporate tax of 33.99% from 11^{th} year onwards.
ROE Pre-tax for first 10yrs= (ROE post tax)/(1- tax for 10yrs) = 17.5%
ROE pre-tax for next 15 years= (ROE post tax)/(1-tax for next 15 yrs) = 21.21%

Discount Rate

Discount rate = 0.7*Rate of interest*(1- Corporate tax rate)+0.3*Return on Equity

= 10.13%

Depreciation rate

The value base for purpose of depreciation shall be based on the capital cost of the asset; salvage value of the asset shall be considered as 10% and depreciation shall be allowed up to maximum of 90% of the capital cost. Depreciation of 6% per annum is considered for the first 10 years, and 2% for the next 15 years.

Capital Cost

As per CERC Bench mark capital cost for FY 15-16 march 2015.

For Kw scale capital cost is 80,000 Rs per unit. So total cost for 1 MW is rs 800 Lacs/unit. Considering capital subsidy of 15% the total cost per MW is Rs 680 Lakhs.

Lease Incentive:

As per Vadodara model the project developer will rent the roof of owners and will pay them a lease incentive of 2 Rs/unit generated from their solar roof top PV. The developer will account for this incentive through his tariff to the off taker (Discom) with whom he signs PPA.

Assumptions as per CERC & GERC discussion paper2015/GERC tariff order 2012

Table 17: Assumptions

Plant Cost	Capital Cost	680	Lakh Rs
	O & M cost	10.75	Lakhs/Mw/yr
	Maintenance & Spares	15%	of O&M
	Escalation in O&M	5.72%	
Performance Parameters	CUF	19%	
	Performance degradation	1%	
	Auxiliary Consumption	0.25%	
	Capacity of Plant	5	Mw
	Useful life	25	Yrs
	Total units generated	83.22	Lakh units
Financials	Debt Equity ratio	70:30	
	Debt Employed	1991.26	Lakh Rs
	Equity Employed	853.40	Lakh Rs
	Loan tenure	10	yrs
	Interest rate on Loan	12.85%	
	Insurance Cost	0.35%	
	Interest on working capital	12%	
	Rate of Depreciation- 10 yrs	6%	
	Next 15 yrs	2%	
	MAT for 10 yrs	20.01%	
	Corporate tax (11-25 yrs)	33.99%	
	ROE	14%	
	ROE pre-tax for 10 yrs	17.50%	
	ROE pre-tax for 15 yrs	21.21%	
	Present value Annuity factor	8.96	
	Discount Rate	10.13%	
Construction Schedule	Depreciation Limit	90%	
	Salvage value	10%	
	Duration	6	
	Start date	01-Jun	
	End date	01-Dec-14	

Results

Table 18: Financial modeling result

Parameter	Value	Unit
Total Project cost	3453.97	Lakh
Levelised Cost of tariff	10.42	Rs/unit
Payback period	13	years
Project IRR	16.37	Percentage
Equity IRR	20.37	Percentage
Average DSCR	1.25	

From the above values it can be concluded that project is financially viable as Debt service coverage ratio is greater than 1.

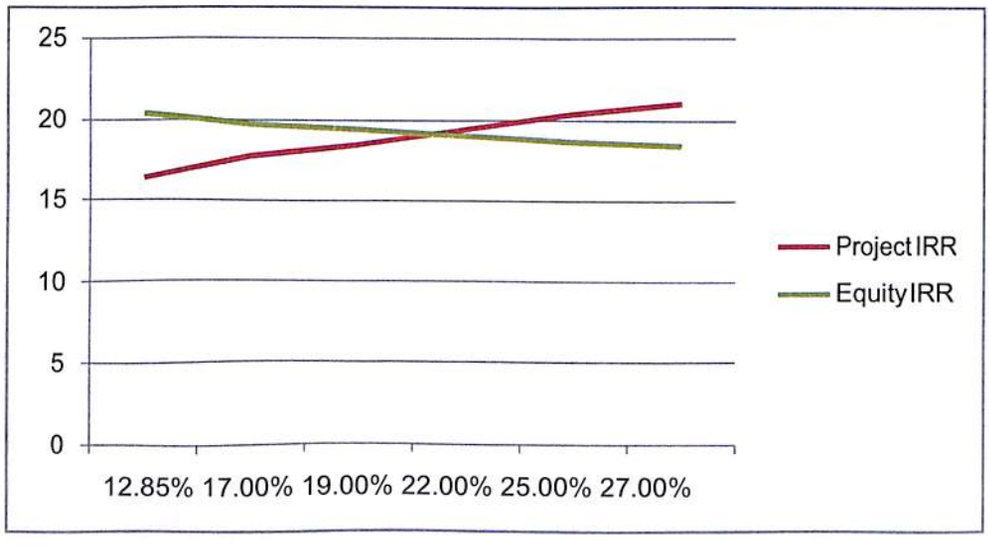
The payback period is 12 years which can be reduced to around 8-9 years with Accelerated Depreciation benefits and capital subsidy provided by Government.

From developer and investor point of view investing in such project with such high return on equity is a good option to consider.

8.3.1 Sensitivity Analysis

In sensitivity analysis we analyze how a certain parameter varies with change in other parameters. By taking some random values of a specific parameter a trend curve can be obtained to derive certain crucial inferences.

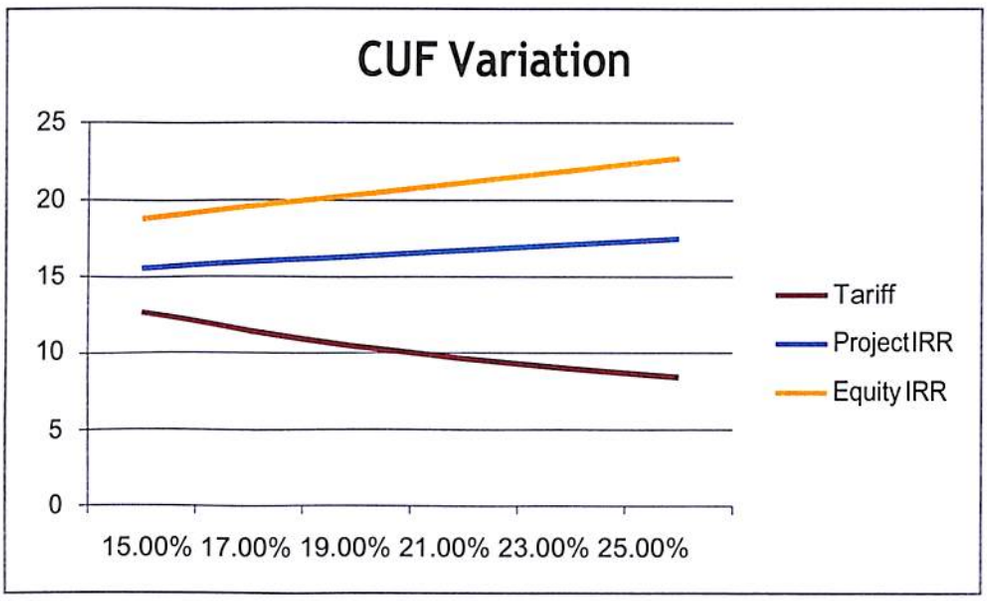
Figure 18: Interest on Loan VS Project & Equity IRR



As per above graph with increase in interest on loan the Equity IRR decreases whereas project IRR increases as debt component increases from the total capital. At a

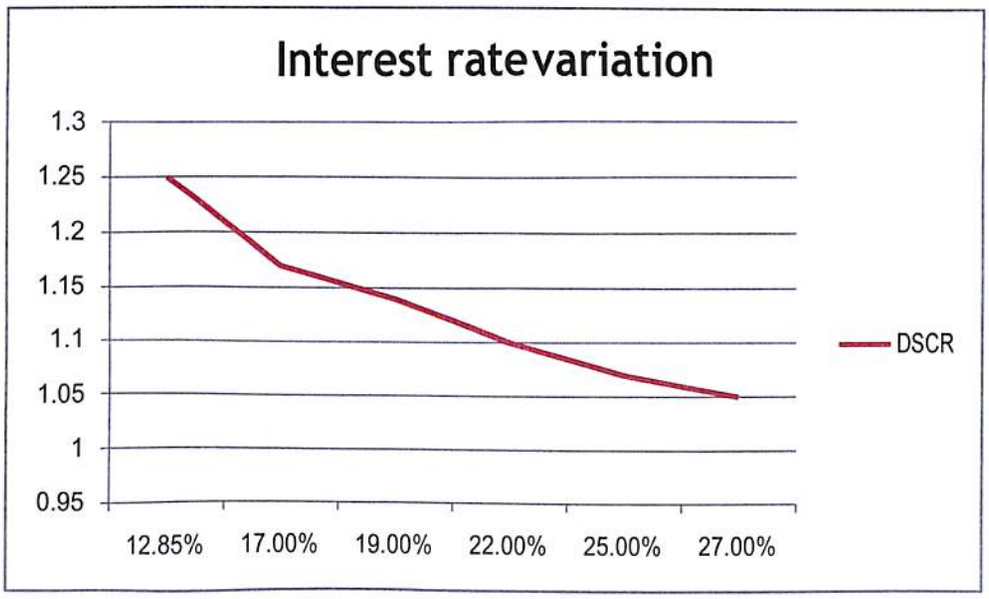
certain point both project & equity irr become equal. When interest on loan surpasses project irr equity irr drops lower than project irr.

Figure 19: CUF Vs tariff, Project & Equity IRR



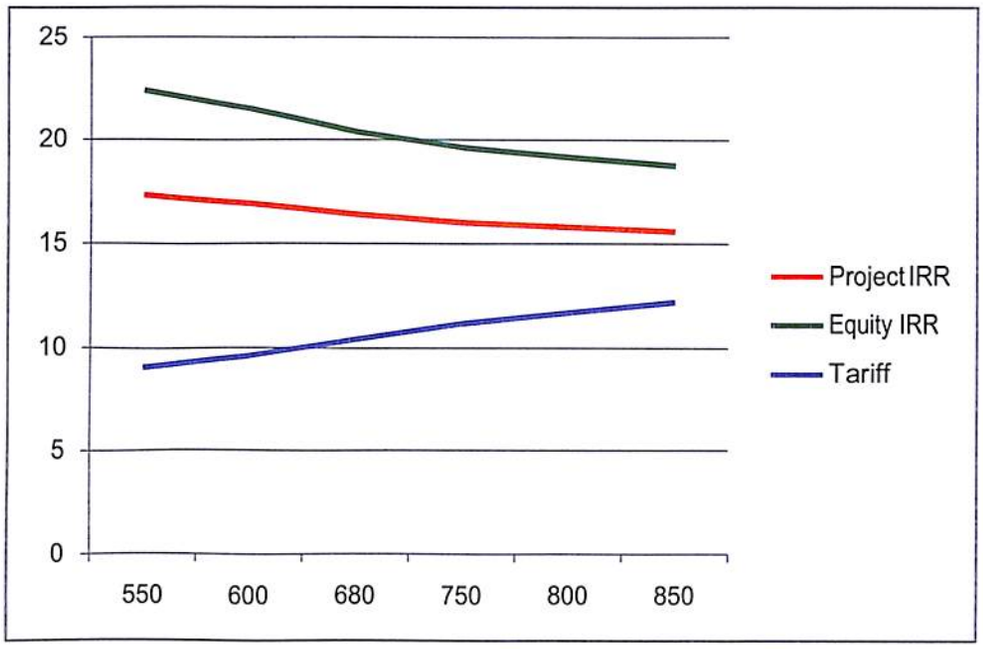
As the Capacity utilization factor increases number of units generated will increase causing more revenue and tariff rates will drop. With increase in revenue both project & equity internal return rates will increase.

Figure 20: Interest rate Vs DSCR



Debt service coverage ratio is the ratio of cumulative cash flow available for debt service to cumulative debt service over the life of project. DSCR ratio greater than 1 signifies that cash flows are sufficient to cover the debt of a company. With increase in loan interest rate the debt amount will increase reducing DSCR ratio.

Figure 21: EPC cost Vs Tariff, Project & Equity IRR



With increase in EPC cost of solar rooftop tariff will increase for constant life period. As EPC cost increases the total Debt component will increase which will reduce Equity IRR. Even if tariff increases the change in capital cost is huge thus it also reduces project IRR.

9. International Experiences

Germany

Germany has installed around 32 GW of PV systems by end of 2013. Feed-in tariff was introduced for PV electricity that is adjusted in the electricity bill of the consumers. With the decrease of PV price, Germany introduced the "Corridor" concept in 2011. It is a method, which allows feed-in tariff levels to decline according to the market evolution. The more the market was growing during a defined period of time, the more the feed-in tariff levels were lowered. Self-consumption premium was paid above the retail electricity price. The premium was higher for self-consumption, i.e., above 30 per cent. In 2012, the premium was cancelled when feed-in tariff levels went below the retail electricity prices.

Market Integration Model

Opposite to self-consumption incentives, Germany pushed PV producers to sell electricity in the electricity market through a "market premium". The producer can decide to sell its electricity in the market any period of time, instead of getting the fixed tariff. The producer receives an additional premium on top of the market price. As the penetration of PV is more than 5 per cent of the electricity demand, the behaviour of utilities can be seen as a mix of an opposition towards PV development and attempts to take part to the development of this new business. Companies such as E.ON have established subsidiaries to target the PV on rooftop customers.

Issues & Challenges

- Rise in the amount of renewable energy have threatened business models of utilities & the coal sector.
- Fall in pricing - and tariffs - has applied to solar PV because widespread installation and cost reduction of solar PV, which began as the most costly renewable power technology by far, happened more quickly than anticipated.
- Germany has not replaced its FIT with net metering. It has, however, added a program in recent years called self-consumption, which incentivizes onsite consumption of solar power. Excess power that is not consumed onsite is remunerated by the utility at a feed-in tariff rate.

- Flat feed in tariff rates have led eventually to rise in the tariff rates of the residential consumers. The Government is spending much of its fortune in covering up the subsidies.
- The Co2 emission has shoot up as during the night hours coal is the only non-subsidized fuel available that can cater to the base load. The utilities due to loss of revenue are opting for cheaper brown coal to add further impact on CO2 emission.
- The economics of German solar have only made sense up till now because they cover up tax from all types of energy (even other renewables), and then use the proceeds to subsidize solar panels. Utilities are forced to buy distributed solar power at rates several times the electricity's market value, causing massive losses.

In 2014, Germany has set the framework for the country's integration of renewables into the energy industry. The well-proven FIT scheme will be gradually replaced by the direct marketing model, where PV system operators have to sell their electricity on the free market and only receive a market premium on top of each kWh produced.The utilities further increase the tariff rates to cover up for the taxes & subsidies they have paid. Thus the consumers not having the solar PV face the ultimate consequences. Which means it's both a massive market distortion and a regressive tax on the poor.

50.2 Hz problem:

In 2008,Germany's existing low-voltage interconnection standards stipulated that distributed generation be automatically disconnected if system frequency exceeded 50.2 Hz. During a light load condition, if system frequency rose above 50.2 Hz more than 3 GW of PV generation could be lost the system could become unstable and result in a system collapse under such conditions In 2012, Germany rectified the problem by implementing a new low-voltage interconnection standard. Additionally, Germany instituted a field retrofitting effort that involved changing the pre-programmed over-frequency trip settings in PV inverters. About 315,000 PV systems sized 10 kW or larger are scheduled to have their inverters either retrofitted or replaced within four years. regulators to require the installation of "smart inverters" on all new solar generators in the region to ensure their smooth integration into the electric grid.

JAPAN

The total cumulative installed capacity of PV in Japan has reached 10.5 GW by the end of 2013. The cumulative annual growth rate during the 11 year period of 2002 to 2013has been phenomenal (about 27 per cent). The major reason for the consistent and sustainable growth has been the new feed-in-tariff policy of the government of Japan, which was introduced in 2009 and strengthened in 2011 (Figure 25). With the start of the Feed-in Tariff (FiT) programme, the market for public, industrial application, and utility-scale PV systems grew fast.Local Governments in Japan are renting rooftops for solar power generation. Roof rentals are a way to use unused rooftop space and rent it to electricity generation companies, who pay rent out of their income from selling the electricity generated, creating an obvious incentive for both leasers and lessees. The idea arose as a new business model following the introduction of the government's feed-in-tariff system in July 2012. Feed-in-tariffs systems involve long-term contracts to buy electricity from renewable energy producers to promote investment in renewable energy.

USA

USA has a total installed solar PV capacity of approximately 7,272 MW by March, 2013. The main driver for accelerating the US PV market are the tax credits and rebates granted by the federal US government for initial years. Apart from the federal push, some states as a complementary measure also offered net-metering to promote self-consumption of solar electricity. Renting rooftop SPV system is also popular among residential consumers in USA. Currently, SPV installation in USA is slowing down, as utilities have reached and exceeded renewable energy obligations. Some utilities have started opposing PV development, especially the net-metering systems, due to two reasons. The first reason is that the RPS targets of the utility have already been met and the other reason is that the self-consumptionfrom solar generation is a revenue loss for utility. In recent years, rooftop and other distributed solar energy generation has become an established global market, and is rapidly becoming a significant contributor to a number of regional energy markets. Stakeholders involved in solar energy business are utilities, commercial and residential consumers, developers, manufacturers, banks and regulators. Stakeholders make daily choices that create different business options. The initial cost of solar PV system acts as a

major barrier for its deployment. To overcome this barrier various types of government subsidies, tax incentives/rebates, and financing

Dubai

The Dubai Energy and Water Authority (DEWA) is to bring net metering to the Emirate through the launch of Shams Dubai. Applicants must then appoint consultants and contractors from a pre-approved list in order to apply for a no-objection certificate, after which DEWA will approve plans and inspect installations to ensure they are compliant. Electricity generated by the projects will be used against the building"s energy demands and any excess will be distributed to DEWA"s national grid in exchange for credit used against utility bills. The rooftop PV program is to be rolled out on a net metering basis, with no direct subsidy paid to facilitate solar uptake. The effective tariff is expected to be around US$0.12/kWh. Customers receiving smart meters approved by DEEWA will pay for their smart meter, instead of paying for the connection to the utility.

10. Summary of Findings& Recommendations

Conclusion

1) With most of states coming up with their regulations, stage is set for solar rooftop segment to meet its target capacity. Andhra Pradesh is leading the way as far as regulatory environment is concerned but some states like Madhya Pradesh, Chattisgarh, Bihar, kerala, Maharashtra need to bring in more clarity regarding certain parameters like grid penetration limit, energy banking, tariff rate for units injected.

2) Net & gross metering schemes both have certain advantages and disadvantages. Providing permission for both schemes is best suited for India as for domestic consumer earning revenue at FIT rate is more profitable. For Industrial & commercial consumers who have high grid tariff rates net metering proves to be viable option.

3) Local micro utility model has experienced recent success in Gujarat and with financial modeling the levelised tariff rate of Rs 10.42 per unit makes it viable for consumer than generating electricity through diesel generators ranging from 11 to 17 Rs per unit.But as compared to RESCO and CAPEX model per unit cost is high as number of inverters installed increase per consumer and the lease charges contribute further to tariff escalation.

4) India is still lacking in the implementation technology due to lack of awareness among consumers.Solar rooftop PV is achieving grid parity in some states is a good opportunity for regulators to transform market from being incentive driven to market driven. Phasing out subsidy is a welcome step as delays in its disbursement from Centre has been one of the key deterrents to development of solar rooftop market.

5) State solar rooftop regulations fail to address the benefit sharing mechanism in a case where a solar rooftop is installed on a cooperative housing society having multiple tenants. The discom is obligated to provide benefits of surplus units injected to the society as a single entity.

Rooftop market segment is poised to grow as rising conventional tariffs are coupled with falling solar tariff prices, introduction of net metering policies by states, and financial support and mechanisms from Government.

Suggestions

1) Net meters to be installed should have smart meter features. This will help to determine the solar power generated and can be used for load forecasting and better management of Load by Distribution companies.

2) Now that MNRE has defined Solar Rooftop targets for every state, it should now come up with detailed plan & specific targets for distribution companies.

Case Study for Delhi

The area under 3 Discom"s of Delhi are determined

Zones under BRPL: South ,west& Central , South east Delhi

Area = 250+420+129+25+14 = 838 sq km

Zones under BYPL: East, Shahdara & North east :

Area = 64+60 =124 sq km

Zones under TPDDL: North, North west

Area = 60+440 = 500 sq km

Total area: 1483sq km

According to the Delhi master plan statistics build up area of Delhi = 47% of total area ie (.47*1483) =697 sq km.

Area available for roof top say 5 % = (697 *0.05) =34.85 sq km which is equivalent to 34850000 sq mtr. A typical 1kw solar PV requires around 10sq mtr of area for installation thus in 34850000 sq mtr, 3485000 kw of solar PV system can be installed which is equivalent to 3.48 GW.This is the approximate solar rooftop PV potential in Delhi whereas MNRE has set a modest target of 1.1 GW by 2022. Considering 1 kw capacity generates 4 units per day the total units generated would be around 14 MU per day which is equivalent to around 3850 to 4000 MU annually.

Total requirement of Delhi Discom's for fy 14-15

BRPL: 11166 MU, RPO target 0.25%= 27.9 MU, met through REC cost= 10.1 Rs/Kwh total=28.3 cr

BYPL: 6295 MU, RPO target 0.25%=15.2 MU, met through REC cost= 10.1 Rs/Kwh total=15.4 cr

TPDDL: 7090 MU, RPO target 0.3% = 21.83 MU, at 9.3rs/unit total = 20.3cr rs

Total requirement: 24551 MU

Thus Delhi can generate 15-16 % of its annual requirement through rooftop solar system.It can also save cost which it is spending in buying REC"s.

3)Both Net & Gross metering schemes must be allowed in states as Gross metering will be more domestic consumer friendly while Net metering is more beneficial to commercial & Industrial consumer.

4) More clarity is required in case of subsidy that can be availed by developer in a specific state. The State renewable Development Agency should avail the funds from central Government prior which will boost developer"s confidence.

5) Open Access & sale of electricity through REC must be open to all solar rooftop generators as this will provide flexibility to the generator and will provide option for obligated consumers to fulfil their RPO targets.

6) To improve economic viability of solar rooftop in domestic& SME sector more innovative financial solutions, a robust FIT mechanism, standardization of of power purchase agreements and clear rules for grid access is required.

7) The respective state regulatory commission must define clear RPO targets to state discoms and other obligated entities and should evaluate the performance and impose higher penalties in case target is not achieved.

8) Rather than providing subsidy MNRE should provide low cost debt funds to developers and owners.

9) In order to promote solar rooftop installation State government must promote Green Buildings in commercial sector first. This can be done by increasing FAR (Floor Area ratio) of commercial buildings. By this owners will get more built-up space for implementing solar rooftop . This step has been taken up by West Bengal.

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Annexure I

Summary of State Solar rooftop Regulations

Srno	State	Date	Metering	Eligibility Criteria	Metering Requirements	Billing/Energy Accounting	Subsidy/Incentive	Open Access/REC/RPO Benefit sharing Mechanism	Interconnectivity Standards
1	Andhra Pradesh	2015	Net & Gross	All individual consumers of AP Discom(s) will be eligible for projects of capacity upto 1 MWp.Net Metering facility shall be allowed for 3 Phase & 1 Phase consumers upto 3 KW.	Implementation, metering, billing, settlement, payment(s) will be looked over by APEPDCL within 30 days from issue of this policy, & to be followed by all DISCOMS in the State APDISCOMs will bear 50% of cost of meter for net metering for Solar Roof-top System of capacity up to 3 KW for those who commission it before 31.03.2014	The DISCOMs will charge tariff for surplus/injected units will be as per the average cost to serve of the Discom determined by APERC for the year of comissioning and will remain same for next 25 years. and is applicable for projects comissioned in this operating period of 5 yrs.	Eligible Developers can avail the relevant subsidies from MNRE through NREDCAP. The sanction and release of the subsidy will be as per the guidelines issued by MNRE from time to time.Exemption from crossubsidy, electricity duty, wheeling charges & Distribution loss if power is injected at 33Kv or below.	All projects developed with mentioned incentives will be eligible for REC benefits subject to applicable regulations/orders of the appropriate commission. Intra-state Open Access clearance for the whole tenure of the project or 25 years whichever is earlier will be granted as per the APERC	Interconnection voltage levels Not Specified
2	Assam(draft)	Jul-14	NET	All Consumers that consume electricity of Distribution Lisencee.	Net meter installed at interconnection point & Solar meter installed at delivery point. Both compatible with MRI. Check meter mandatory of capacity >20KWp.	The electricity generated by the grid interactive solar system of an eligible consumer shall not be more than 90% of the electricity consumption by the eligible consumer at the end of the settlement period.Solar System should be installed in its own premise, can be self owned or third party.	Not defined	If Consumer is not an obligated entity then electricity generated & consumed by him will qualify for accounting towards RPO of such consumer. If consumer is not an obligated entity then energy generated will qualify for accounting towards RPO of Distribution Lisencee. Grid interactive Net Metering injection will not be eligible for REC.	Comply with CEA regulations 2014. Individual capacity should be within 1 KWp to 500 KWp. Cumulative capacity shall not exceed 3MW and 15% of Distribution Transformer capacity.
3	Bihar	Feb-15	NET	All Consumers of electricity of Distribution Lisencee of state.Capacity of Solar PV should be between 1 KWp to 1 MWp and equal to its sanctioned load.	The metering system shall be as per the provisions of CEA regulations 2006. Check meters mandatory for capacity more than 20 KW.	The electricity injected through rooftop solar system by an eligible consumer shall not be more than 90% of the electricity consumption by the eligible consumer at the end of the settlement period else it will not be compensated neither it'll be carried forward in the next settelment period by Distribution Licensee.	Eligible consumer shall be exempted from banking and wheeling charges and cross subsidy surcharge.	Quantum of electricity consumed by eligible consumer, who is not defined as obligated entity, from the rooftop solar system under net metering arrangement shall qualify towards compliance of Solar RPO for the distribution licensee. Issuance of renewable energy certificate shall be as per the eligibility criteria specified under CERC reuglations 2010.	Technical specifications, standards, metering connection as per CEA regulations 2013, 06, 10. Battery backup is permitted. Separate wiring for Inverter is provided with Auto/manual Isolation switch. Cumulative capacity of max 10MW allowed per year or upto 15% of Distribution Transformer capacity.
4	Chattisgarh	Aug-13	NET	All consumers of Discom. Capacity limits 50KW to 1MW.	Solar & grid meter as per CEA regulations 2006, comply with TOD metering. Installed & maintained by Licensee at the cost of Roof top owner/Developer.	Excess injected units will be compensated as per levellised tariff.	Exemption from electricity Duty	Not Defined	50-100 KW ; 415 V 3 ph. 101-1000KW - 11Kv 3 ph.Annual energy injection must not be greater than 49% of annual energy generation.

Srno	State	Date	Mete ring	Eligibility Crite ria	Mete ring Requirements	Billing/Energy Accounting	Subsidy/Incentive	Open Access/REC/RPO Benefit sharing Mechanism	Inte reconnectivity Standards
5	Delhi	2014	NET	All customers of Discoms on First come first serve basis. The individual capacity of Renewable Energy system installed at the Premises of any consumer shall not be less than 1KWp.	Meters to adhere to Standards as specified in CEA Regulations 2006,2010. Accuracy Class Index to be same or better than existing meter. Solar Generation Meters 0.2s Class. RE meter and Net Meter to be procured and installed by Discom. Net meters under ambit of Time of Day tariffs to be time of day compliant, MIR & AMR Compliant.Check Meters mandatory for capacity > 20KW.	Surplus units shall be carried forward to the next billing period as energy credit and will be adjusted against the energy consumed in subsequent billing periods within the settlement period. The Consumer shall be paid for net energy credits which remain unadjusted at the end of the financial year at the rate of Average Power Purchase Cost (APPC) of the Distribution Licensee after issuance of the true up order of the relevant year by the Commission.	No deemed generation charges payable to the Renewable Energy Generator or consumer of the premises. Exemption from wheeling, banking, cross subsidy and other charges for a period of Five years.30% of capital cost as subsidy provided by MNRE.No PPAC charges.	REC can be availed as per the eligibility criteria specified under CERC Regulations, 2010. The quantum of electricity generated under these Regulations shall qualify towards compliance of Renewable Purchase Obligation (RPO) for the distribution licensee if Renewable Energy Generator is not an obligated entity.	Upto 10 KW- 240V , 1 ph. 10-100 Kw ,415 V, 3 ph. Above 100Kw , HT/EHT. Must Comply with CEA 2010 Regulations, State supply/distribution code.
6	Gujarat	Sep-11	GROSS	All consumers of Discom with individual capacity less than 1 MW.	Metering to adher with CEA regulations 2006,2010.	PPA will be signed between developer & offtaker(Discom) at a Levellised tariff for 25 yrs	Exemption from wheeling, banking, cross subsidy surcharge.	Renewable energy generation to fulfill RPO compliance of obligated entities.	upto 6Kw : 230 V, 1 ph. 6-100 KW : 415 , 3ph. Above 100 kw: 11KV
7	Haryana	Nov-14	NET	All Consumers consuming electricity of Distribution Lisencee are eligible. Solar System should be installed in its own premise.Individual capacity should not exceed 1MW .	Bidirectional meter required for finding net energy injected or consumed along with generation meter. Accuracy to be decided by lisencee.Cost of adding or replacing meters shall be borne by customer.TOD meter is installed if the cunsomer is under ambit of TOD tariff.Metering must comply with CEA regulations 2006,2010.	Electricity generated from a rooftop solar system shall be cumulatively capped at 90% of the electricity consumption. The consumer shall receive a net import/export bill. If export exceeds the import such surplus energy (in KWh/KVAh) injected by the consumer shall be carried forward to the next billing period as energy credit. No interest shall be payable on this energy credit.	Subsidy, if any, for Rooftop Solar Grid Interactive System based on Net Metering shall be in accordance with the prevailing policy of the Central/State Government or any other agencies such as IREDA/HAREDA/BEE	Electricity consumed by consumer who is not an obligated entity under net metering will qualify towards compliance of RPO of lisencee. Generator who generates above 250KW may enter into a power purchase agreement with the licensee serving that area or go for third party sale through open access. For open access consumers, the facility of net metering shall not be available.	CEA Regulations 2013, 2010,2006. Fof inverter with battery backup manual isolation switch required. Grid penetration of 5% (200MW)of Distribution Capacity allowed.
8	Himachal (Draft)	Jan-15	Net	consumers of electricity in the area of supply of the distribution licensee.Capacity should not exceed 1MWp provided its also less than 80% of sanctioned contract demand	Net meter as well as solar generation meter shall be installed and maintained at the cost of eligible consumer by the distribution licensee and these meters shall be compliant to Meter Reading Instrument (MRI) or through wireless & to TOD tariff requirements.Net meter should have accuracy class index same or better than existing one.	Net export of power will be adjusted in the consumers next billing period as per the tariff decided by comission depending on the subsidy/Grant given by central & State govt.If amount of subsidy+Grant is less than 50% of capital cost then excess units will be compensated at retail rate irrespective of time.if amount of subsidy/grant exceeds 50% of capital cost then rate is 50% of normal tariff(retail) rate .licensee shall charge the demand charges, including the additional demand charges for peak load hours and the contract demand violation charges,	No deemed generation charges. Exemption from wheeling ,banking, Cross subsidy surcharge for period of 5 yrs.	Generator can sell power under REC mechanism if it complys with CERC regulations 2010.Net metering regulatiions will not be applicable to such generators.The quantum of electricity generated under these regulations shall qualify towards compliance of Renewable Power Purchase Obligation (RPPO) of the distribution licensee provided generator is not an obligated entity.	Voltage levels not defined. Must comply with CEA regularions 2013, 2010, 2006. cummulative capacity must not exceed 30% of Distribution transformer.

Srno	State	Date	Metering	Eligibility Criteria	Metering Requirements	Billing/Energy Accounting	Subsidy/Incentive	Open Access/REC/RPO Benefit sharing Mechanism	Interconnectivity Standards
9	JERC	2014-	NET & GROSS	Capacity should lie within 1Kwp-500kwp, technology approved by MNRE. Solar System is located in the consumer premises & Interconnected and operated safely in parallel with the Distribution Licensee network	Gross/Net metering facility.Solar Power Generation facility will have a solar power export meter to be arranged by the Solar Power Generator from the approved vendor list of the Distribution Licensee for metering the solar power that is being fed to the Grid. The meter shall be installed by the Distribution Licensee. If any Consumer chooses to have a net metering the same shall also be allowed, and in that case the existing service connection meter shall be replaced with a bidirectional energy meter by the Distribution Licensee	The Distribution Licensee shall raise invoice for the net electricity consumption after taking into account any electricity credit balance remaining from previous billing cycle. Prosumer is under the ambit of time of day tariff, as determined by the Commission from time to time, the electricity consumption in any time block shall be first compensated with the electricity generation in the same time block during the billing cycle, such excess injected Solar Power units of electricity shall be carried forward to next billing cycle as electricity units credit and may be utilized to net electricity injected or consumed in future billing cycle.	MNRE grant-15-30%. The proceeds of the carbon credit from approved CDM Project shall be shared between the project developers and concerned Distribution Licensee. 100% of the gross proceeds on account of CDM benefit to be retained by the developer in first year after the date of commercial operation of the generating station.	Net-metering injection is not eligible for REC. In case the Consumer / Prosumer opts to claim REC for the Power Generated from the Solar Project, then the Electricity sold to the licensee will be at average cost of Procurement of Power as decided by the commission by the tariff order for each year	variation in the rated capacity of the system shall remain within a range of 5%. Comply with CEA Regulation 2013. The inverter standard shall as per IEEE 519..cumulative solar capacity allowed at a particular distribution transformer shall not exceed 30% of transformer capacity.
10	Ktka	May-14	NET & GROSS	All individuals residential/commercial/Govt buildings are eligible for RTSPV within prescribed capacity limits (5KW-1MW).	Metering will be in compliance with CEA 2006 Regulations(installation & operation of meters).Has to be approved by ESCOM.	Surplus energy injected into the grid will be paid by ESCOM as per Tariff determined by KERC/CERC.	Fiscal benefits by the way of State /MNRE would be nodal agency KREDL.	Under REC mechanism generator can feed energy to ESCOMS at APPC determined by KERC. Min capacity 1MW.	upto 5KWp- 240V, 1ph. 5-50KWp:415V, 3ph. >50KWp: 11 KV.
11	Kerala	Jun-14	NET	All customers of state discoms having capacity less than 1 MWp. A consumer having electric connections in different premises owned by him shall be eligible to install separate solar energy system in each of such premises.	2 meters – solar meter and net meter to be installed as per CEA Regulations 2006. Consumers having ABT compliant meters with net metering facility not required to install additional net meter· Solar meter and net meter must have the facility for downloading the meter readings using MRI or wireless equipment. The licensee may collect the security deposit and meter rent for the solar meter and net meter provided by it to the eligible consumer.	The banking facility is available surplus units. The eligible consumer in time of the day (ToD) billing system can use the quantum of electricity banked by him, first in the normal period and the balance in the peak period and in the off peak period in succession & shall be entitled to avail only 95% of the total electricity wheeled for his consumption in the other premises and the balance 5% of the electricity shall be adjusted towards the distribution losses.	NO open access charges, wheeling charges, electricity duty & T&D losses will be applicable. ANERT being the nodal agency for making available the subsidy from MNRE or any other central agency.	The quantum of electricity shall qualify for accounting towards RPO of the consumer or the licensee as under the KSERC Regulation, 2010. exempted from banking charge and cross subsidy surcharge. The eligible consumer shall have the right to avail open access within the area of supply of the licensee provided his wheeled capacity exceeds 500 units in a month.	All new domestic buildings having a floor area in between 2000 sq.ft to 3000 sq.ft should have 500W solar PV· system. All the buildings above 3000 sq.ft should have at least 1000W solar PV system. Upto 5kW: 230 V, 1ph. 5-100Kw: 415 V ,3ph. Above 100kw: 415, 3ph.

Srno	State	Date	Metering	Eligibility Criterin	Metering Requirements	Billing/Energy Accounting	Subsidy/Incentive	Open Access/REC/RPO Benefit sharing Mechanism	Inte reonnectivity Standards
12	Maharashtra (Draft)	2015	NET	Consumers in the area of supply of the Distribution Licensee. Capacity shall not exceed Contract Demand.	2 meters : 1- Net meter which is bidirectional , 1 or 3 ph. 2- Solar generation meter Distribution lisencee will procure meters.Consumer can procure energy meter and will present it to Distribution lisencee for installation. Location for interconnection will be decided by Distribution lisencee. Meters should support MRI & AMR functions. Eligible Consumer shall bear all costs related to setting up of Rooftop Solar photovoltaic system excluding metering and interconnection costs.	Energy units credited upto 10% of units generated annually will be compensated as per Avg Power purchase cost as per SERC. Units mor than 10% will not be compensated.	Eligible Consumer can avail subsidy or incentives if offered by the Central / State Government on the capital cost of the Rooftop Solar PV system. Maharashtra Energy Development Agency (MEDA) will be the Nodal Agency	DL can be able to achieve its RPO by purchasing surplus unadjuste d energy units of consumer. Not Eligible for REC.	capacity < 8KW - 230 v,1 ph. capacity < 80kw- 415v, 3ph. Upto 1MVA- HT connection. Inverter will be provided with Auto/manual isolation switch. Cumulative capacity utilized at a particular distribution transformer does not exceed 15% of the rated capacity
13	MP	Nov-14	NET	Distribution licensee shall offer the provision of net metering arrangement in its area of supply on non-discriminatory and first come first serve basis considering target capacity & rated capacity as specified under under regulations	Bidirectional meters of class 1 accuracy. MRI & AMR compliant cost of new/additional meter (s) shall be borne by the eligible consumer and installed & owned by the distribution licensee.	Any cumulated excess generation over consumption in any other time block in a billing cycle shall be accounted as if the excess generation occurred during the off-peak time block.	self-owned or third party owned installed on eligible consumer premises, shall be exempted from banking, wheeling and cross subsidy.	electricity consumed by the eligible consumer, who is not defined as obligated entity, from the renewable energy system under net metering arrangement shall qualify towards compliance of Renewable Purchase Obligation (RPO) for the distribution licensee.The issuance of renewable energy certificate shall be as per the eligibility criteria specified under Central Electricity Regulatory Commission Regulations 2010.	As per CEA regulations 2006, 2010,2013 & SERC regulations.
14	Orissa (Order)	Nov-14	NET	All consumer of electricity in the area of supply of the distribution licensee are eligible Maximum individual capacity is upto 1 MW.	2 meters to measure solar generation & other to measure import/export. Meters should be MRI/AMR Compliant. Cost of connectivity and all other related cost for setting up the meters etc, have to be borne by the eligible consumers under guidance of the concerned distribution licensee.	Electricity generated from a Solar rooftop PV project shall be capped cumulatively at 90% of the electricity consumption, from the date of COD to the end of the financial year.The carry forward of excess energy generation will be allowed for same FY excess generation (above 90 per cent) at the end of the financial year would be considered as free energy.The imported energy shall be eligible for normal ToD benefit.Systems can be self-owned or third party owned.	Not Specified	Solar Energy generated by Net-metering/ bi-directional metering project is not eligible for REC. The energy generated by an eligible consumer, who is not defined as an obligated entity from the rooftop solar PV projects under net-metering arrangement shall qualify as deemed RPO for the distribution licensee/ bulk supply licensee.	OERC Distribution (Conditions of Supply) Code, 2004. CEA Regulations, IEEE 519.
15	Punjab	Aug-13	NET	Any consumer in the area of supply of distribution licensee having solar PV of capacity ranging from 1 KWp up to 1 MWp in his premices operating safely & in parallel with distribution licensee network	2 meters: Net meter(Bi directional) & Solar meter (Uni directional) Should comply with CEA 2006 regulations.Installation & maintenance underscope of lisencee.Meter cost borne by cunsomer.	net units generated or consumed by a consumer will be credited or compensated in the next billing cycle or will be charged as per the applicable tariff rate decided by comission depending on the slabs. Surplus units under TOD metering shall be accounted as if injected during non peak hours. Electricity generated from a rooftop solar system shall not exceed 90% of the electricity consumption by the consumer in a settlement period	Eligible consumers can approach PEDA for grant of applicable MNRE, Government of India grant. Exempted from banking and wheeling charges and losses, cross subsidy and additional surcharge	quantum of electricity consumed by eligible consumer, who is not defined as obligated entity shall qualify towards compliance of RPO for the distribution licensee. The issuance of renewable energy certificate shall be as perthe eligibility criteria specified under CERC regulations 2010.	Standards should comply with CEA 2013,2010 regulations. Inverter will have Auto/manual isolation switch. Cumulative capacity shall not exceed 30% of DT capacity & 80% of Sanctioned load.

Srno	State	Date	Mete ring	Eligibility Crite ria	Mete ring Requirements	Billing/Energy Accounting	Subsidy/Incentive	Open Access/REC/RPO Benefit sharing Mechanism	Inte rconnectivity Standards
16	Rajasthan (Notification)	Feb-15	NET	Consumers should consume electricity of Distribution Lisencee. Solar System should be installed in its own premise. Individual capacity should be within 1KWp to 1MWp.	consumers having ABT compliant meters shall not be required to install additional net meter.Check meters mandatory for capacity > 250Kw.	separate meters to measure solar energy generated & Energy injected in grid. Excess energy injected > 50 units then compensation innnext billing cycle as per feed in tariff rate. If less than 50 units then units are accumulated till they cross 50 and then they are compensated in the billing cycle.If consumer leaves system then credit units will be redeemed at FIT rate.	CDM benefits shall be retained by Distribution Licensee provided that, the entire CDM benefits obtained by the Distribution Licensee shall be fully passed on to the consumers through ARR	The quantum of electricity generated & consumed by an Eligible Consumer, who is not defined as obligated entity, shall qualify towards compliance of RPO for the distribution licensee in whose area of the supply the Eligible Consumer is located. Exemption from Wheeling & Cross subsidy surcharge.	upto 5KW-230V 1ph, (5-18.65)kw-415V 3ph, above 18.65 Kw -HT/EHV Cumulative capacity shall not exceed 80% of sanctioned load and 30% of Distribution Transformer capacity
17	TN	Nov-13	NET	All Domestic consumers Government/Local Body buildings are eligible. Both existing and new solar rooftop /Solar systems which comply with tariff categories in retailtariff orders are eligible for Net-metering. local distribution level on the basis of first come first served.	Solar generation & net meter to be installed. Solar generation meter is optional for consumers NOT availing GBI. Compliant with CEA Regulation 2006, 2013. Solar check meters mandatory for 20kW and above. Separate meters shall be installed in case of hybrid generators.Assessor to take readings of both types of meters in case of consumer availing GBI.For Domestic Rooftop Solar generators, the consumer meters shall be replaced with suitable meter(s) for net metering by the distribution licensee at the cost of the consumer/generator.	A new type of meter-card to record the readings to be provided by distribution licensee that shall have generators bank account number to which GBI will be credited directly by TEDA. Every monthly/bi-monthly reading communicated to TEDA by licensee through email with copy to consumer. Electricity exported is capped at 90% of the electricity consumption by consumer at end of settlement period. Excess generation treated as lapsed.Excess energy consumed is billed as per tariff applicable to that category of consumers. No carry forward of energy allowed to next settlement period in following yr.	GBI of Rs 2/unit for first 2 yrs. Rs 1/unit for next 2 yrs & Rs 0.5/unit for subsequent 2 yrs for systems installed before 31 march 2014. 100% Electricity tax exemption, Demand cut exempted for captive use. Eligible to avail CDM benefits. Chief Minister"s Capital Subsidy program offers INR 20,000/kW along with Rs 30000/KW from MNRE. It is not clear if both incentives will be simultaneously applicable or not.	Net metering injection NOT eligible for REC. Energy adjusted against net-metering arrangement qualifies as deemed RPO for the licensee. Wheeling & Banking charges will be applicable for captive/Third party sale as per TERC rates.Obligated entities may fulfill their SPO (Solar purchase obligation by captive generation or buying from third partysolar power developers or Buying REC , Purchasing power from TANGEDCO at solar tariff.	upto 10KWp- 240V. 10-15 KWp: 240/415V. 15-50 KWp-415V 3 ph. 50-100KWp : 415 V. above 100KWp- 11KV. connectivity to rooftop solar/solar systems shall be restricted to 30% of the distribution transformer capacity
18	Telangana	2015	Net & Gross	consumer should have 3 phase supply service connection	A single bi-directional meters shall be installed for export and import	Tariff for schemes under gross for connections at 11 kv & below will be the average cost of service of the discom as determined by TSERC.Tariff applicable for Net metering scheme will be at APPC by TSERC.Both systems subjected to monthly billing & settlements.banking of 100% energy will be permitted. Banking charges at the rate of 2% of energy delivered at the point of drawal.Unutilised banked units to be reedemed at APPC determined by TSERC.settlement of registered surplus energy will be carried out on a half yearly basis.	Exemption from paying Distribution charges, wheeling ,'transmission, crosssubsidy, electricity duty.The State Govt. will provide 20% subsidy for installation of roof top system upto 3 KW capacity in domestic sector only. This will be in addition to that eligible Central Financial Assistance.	Doesn"t mention RPO commitments for obligated entity.	Not defined
19	UP (Notification)	Mar-15	NET & GROSS	All consumer of electricity in the area of supply of the Distribution Licensee with Minimum limit 1 KWp & Maximum limit is upto the sanctioned load demand are eligible.	Comply with CEA (Operation & Maint Regulations 06), Check Meter mandatory for capacity > 50KWp. Metering cost, cost of evacuation system & Interconnection to be borne by eligible consumers along with Application & Registration Fees.	In Case of Gross metering injected units will be compensated on the basis of tariff approved by UPERC.In case of net metering surplus units will be credited and utilize for electricity units consumed in nextbilling cycle.If units consumed are more then DL raises Invoice & shall continue to pay charges such as fixed/ demand charges, Government levy etc. Can be self-owned or third party owned.	Exemption from Wheeling & Cross subsidy surcharge. No deemed generation charges payable.	The energy generated by an eligible consumer, who is not defined as an obligated entity from the rooftop solar PV projects under net & Gross metering arrangement shall qualify as deemed RPO for the distribution licensee.Generator is free to sell power under REC mechanism as per the provisions & eligibility specified by CERC Regulayion 2010.	upto 5KW- 240 V 1 ph 5-50 KW : 415V, 3 ph. 50kw - 1 Mw, 11KV ,3ph. Comply with CEA regulations 2013,2010, IEEE 519 standards. Cumulative capacity must not exceed 15% of DT capacity.

Srno	State	Date	Metering	Eligibility Criteria	Metering Requirements	Billing/Energy Accounting	Subsidy/Incentive	Open Access/REC/RPO Benefit sharing Mechanism	Interconnectivity Standards
20	Ukhand	Aug-13	NET	All individuals, Residentials/Commercial/Govt offices/Industries are eligible for roof top solar. Capacity for system with battery backup is 210Wp to 100KW. Without battery backup : 5KW to 500KW.	Meters: Bidirectional. To be finalized in consultation with Discom.	PPA needs to be signrd between building owner & 3 party/ Discom as applicable. Agreement needs to be signed on monthly basis. Sutaible payment security mechanism to be provided by Discom/Nodal agency.	MNRE may provide one time subsidy upto 30% of benchmark cost as per following rates: 0.2-1 KWp:240, 1-10KWp: 220, 10-100 KWp: 200. upto 5 KWp: 160, 5-100KWp: 140, 100-500 KWp : 130.	In case roof top system is owned by Utility the electricity utilized by discom can be used to fulfill solar RPO.	Connectivity will be at 33 or 11 KV 3ph or 1ph depending on system installed. For capacity up to 50KW LV connection, 3ph. For capacity above 50KW HV ,3ph connection. Capacity should be equal or more than 10KW to feed surplus in to Grid.
21	WB	Aug-10	NET	Only certain specific institutional consumer categories as mentioned in the regulation (such as govt offices, hospitals etc) are eligible. Of capacity not less than 5kWp.	Bi directional flow of electricity shall be measured either by two separate meters 1, 3phase or export-import meter. The net meter for measuring the energy injected from Solar PV sources shall be provided by the licensee against applicable meter rent along with the connection of the meter. The connectivity from the roof-top Solar PV sources upto the meter shall be at the cost and responsibility of the consumer(s) and shall be in accordance with the guidance of the licensee.	Quantum of injected and consumed is read and net is billed. If injection is in excess, it is carried forward to the next billing cycle . Slab tariff, as per applicable tariff order under the Tariff Regulations, shall be applicable for the net energy supplied by the licensee in a billing period. The MOU / PPA to be signed between the licensee and seller of such roof-top Solar PV sources shall include necessary terms and conditions of meter reading, meter-rent, billing, payment, payment security arrangements, rate of delayed payment surcharge etc	Not Defined	Eligible consumers shall have open access, subject to availability of adequate transmission facility to any transmission licensee's system within the State on payment of various charges like Open Access charge, wheeling charges, T&D loss. By way of purchasing renewable energy from any renewable sources in the area of supply of the licensee under REC mechanism at a price not exceeding the Pooled Cost of Purchase of such distribution licensee	connectivity at LV or MV or 6 KV or 11 KV or any other voltage of the distribution system of the licensee as considered technically and financially suitable by the licensee will be allowed. Injection shall not be more than 90% of the consumption

Annexure II

Financial Modeling Details

Interest during Construction

Months	1	2	3	4	5	6
SD	01-Jun-14	01-Jul-14	01-Aug-14	01-Sep-14	01-Oct-14	01-Nov-14

CAPITAL AVAILABLE	%	100%	90%	80%	65%	45%	20%
CAPITAL REQUIRED	%	10%	10%	15%	20%	25%	20%
CAPITAL REQUIRED	INR LAKHS	340.0	340.0	510.0	680.0	850.0	680.0
EQUITY EXHAUST	INR LAKHS	340.0	680.0	356.2	0.0	0.0	0.0
DEBT COMPONENT	INR LAKHS	0.0	0.0	153.8	680.0	850.0	680.0
CUMULATIVE DEBT	INR LAKHS	0	0	153.8	833.8	1683.8	2363.8
INTERST	INR LAKHS	0	0	1.6	8.9	18.0	25.3

Total IDC	53.9	Lakhs

Depreciation

Project cost	3453.92
Depreciation Limit	90%
Depreciable cost	3108.53

Depreciation	
Year	Percentage
10	6%
15	2%

	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
SL Method	Depretiation	207.2	207.2	207.2	207.2	207.2	207.2	207.2	207.2	207.2	207.2	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1
	Cumulative	207.2	414.5	621.7	828.9	1036.2	1243.4	1450.6	1657.9	1865.1	2072.4	2141.4	2210.5	2279.6	2348.7	2417.7	2486.8	2555.9	2625.0	2694.1	2763.1	2832.2	2901.3	2970.4	3039.4	3108.5

Interest On Working Capital

Debt Employed	2417.74
Loan tenure	10
Interest rate on Loan	12.85%
Total Installment	120
Principal each installment	20.1

Years	1	2	3	4	5	6	7	8	9	10
Principal Amount	241.8	241.8	241.8	241.8	241.8	241.8	241.8	241.8	241.8	241.8
Opening Balance	2417.74	2175.97	1934.19	1692.42	1450.65	1208.87	967.10	725.32	483.55	241.77
Closing balance	2175.97	1934.19	1692.42	1450.65	1208.87	967.10	725.32	483.55	241.77	0.00

Total interest on Loan	295	264	233	202	171	140	109	78	47	16

Interest on working Capital

O & M cost	53.75	Lakhs/yr
Escalation in O&M	5.72%	Percent
Maintenance & Spares	15.00%	of O&M
Interest on working capital	12%	percent

Year		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Tariff rate		20.24	10.89	10.63	10.37	10.10	9.83	9.56	9.28	9.00	8.72	7.28	7.41	7.54	7.68	7.83	7.99	8.15	8.33	8.51	8.70	8.91	9.12	9.35	9.59	9.84
Units generated	after Dearation	83.2	82.4	81.6	80.7	79.9	79.1	78.3	77.6	76.8	76.0	75.3	74.5	73.8	73.0	72.3	71.6	70.9	70.1	69.4	68.8	68.1	67.4	66.7	66.0	65.4
	Auxiliary Consump	41.5	82.2	81.4	80.5	79.7	78.9	78.2	77.4	76.6	75.8	75.1	74.3	73.6	72.8	72.1	71.4	70.7	70.0	69.3	68.6	67.9	67.2	66.5	65.9	65.2
Total revenue generated		840.1	894.6	864.7	834.9	805.4	776.1	747.0	718.2	689.7	661.5	546.3	550.4	554.8	559.6	564.8	570.3	576.3	582.7	589.6	596.9	604.8	613.2	622.2	631.8	642.1
Two months receivable		140.0	149.1	144.1	139.2	134.2	129.3	124.5	119.7	114.9	110.2	91.0	91.7	92.5	93.3	94.1	95.1	96.0	97.1	98.3	99.5	100.8	102.2	103.7	105.3	107.0
O&M Expense		53.8	56.8	60.1	63.5	67.1	71.0	75.0	79.3	83.9	88.7	93.7	99.1	104.8	110.8	117.1	123.8	130.9	138.4	146.3	154.7	163.5	172.9	182.7	193.2	204.2
Monthly O&M Expense		4.5	4.7	5.0	5.3	5.6	5.9	6.3	6.6	7.0	7.4	7.8	8.3	8.7	9.2	9.8	10.3	10.9	11.5	12.2	12.9	13.6	14.4	15.2	16.1	17.0
Maintenance & Spares		8.1	8.5	9.0	9.5	10.1	10.6	11.3	11.9	12.6	13.3	14.1	14.9	15.7	16.6	17.6	18.6	19.6	20.8	21.9	23.2	24.5	25.9	27.4	29.0	30.6
Total Working Capital		152.6	162.4	158.1	154.0	149.9	145.9	142.0	138.2	134.5	130.9	112.9	114.9	116.9	119.1	121.5	123.9	126.6	129.4	132.4	135.6	139.0	142.5	146.3	150.4	154.7
Interest on working capital		18.3	19.5	19.0	18.5	18.0	17.5	17.0	16.6	16.1	15.7	13.6	13.8	14.0	14.3	14.6	14.9	15.2	15.5	15.9	16.3	16.7	17.1	17.6	18.0	18.6
Change in working capital		152.6	9.8	-4.2	-4.2	-4.1	-4.0	-3.9	-3.8	-3.7	-3.6	-18.0	1.9	2.1	2.2	2.3	2.5	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.3

Levelised Tariff

Discount Rate	10.13%
Annuity factor	8.99

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Units generated after auxiliar	41.51	82.18	81.36	80.55	79.74	78.94	78.15	77.37	76.60	75.83	75.07	74.32	73.58	72.84	72.12	71.40	70.68	69.97	69.27	68.58	67.90	67.22	66.54	65.88	65.22

Fixed cost Components

Interest on Loan	296.44	265.37	234.30	203.24	172.17	141.10	110.03	78.96	47.90	16.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Interest on working Capital	18.31	19.48	18.98	18.48	17.99	17.51	17.04	16.59	16.14	15.71	13.55	13.78	14.03	14.29	14.57	14.87	15.19	15.53	15.89	16.27	16.67	17.10	17.56	18.05	18.56
O&M Expenses	53.75	56.82	60.07	63.51	67.14	70.98	75.04	79.34	83.88	88.67	93.75	99.11	104.78	110.77	117.11	123.80	130.89	138.37	146.29	154.66	163.50	172.85	182.74	193.19	204.24
Depreciation	207.24	207.24	207.24	207.24	207.24	207.24	207.24	207.24	207.24	207.24	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08
ROE	181.35	181.35	181.35	181.35	181.35	181.35	181.35	181.35	181.35	181.35	219.76	219.76	219.76	219.76	219.76	219.76	219.76	219.76	219.76	219.76	219.76	219.76	219.76	219.76	219.76
Incentive cost	83.01	164.36	162.72	161.09	159.48	157.89	156.31	154.75	153.20	151.67	150.15	148.65	147.16	145.69	144.23	142.79	141.36	139.95	138.55	137.16	135.79	134.43	133.09	131.76	130.44
Total Fixed Components	840.09	894.63	864.66	834.90	805.37	776.07	747.01	718.22	689.70	661.46	546.29	550.38	554.81	559.59	564.75	570.31	576.28	582.69	589.56	596.93	604.81	613.23	622.23	631.84	642.09

Total project cost	840.09	894.63	864.66	834.90	805.37	776.07	747.01	718.22	689.70	661.46	546.29	550.38	554.81	559.59	564.75	570.31	576.28	582.69	589.56	596.93	604.81	613.23	622.23	631.84	642.09
Cost of generation	20.24	10.89	10.63	10.37	10.10	9.83	9.56	9.28	9.00	8.72	7.28	7.41	7.54	7.68	7.83	7.99	8.15	8.33	8.51	8.70	8.91	9.12	9.35	9.59	9.84

Levelised cost of tariff	₹ 10.42

Profit & Loss

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Net Units Generated	41.5	82.2	81.4	80.5	79.7	78.9	78.2	77.4	76.6	75.8	75.1	74.3	73.6	72.8	72.1	71.4	70.7	70.0	69.3	68.6	67.9	67.2	66.5	65.9	65.2
Levelised tariff	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4
Total Revenue	432.6	856.6	848.0	839.5	831.1	822.8	814.6	806.4	798.4	790.4	782.5	774.7	766.9	759.3	751.7	744.1	736.7	729.3	722.0	714.8	707.7	700.6	693.6	686.7	679.8
O&M Expense	53.75	56.82	60.07	63.51	67.14	70.98	75.04	79.34	83.88	88.67	93.75	99.11	104.78	110.77	117.11	123.80	130.89	138.37	146.29	154.66	163.50	172.85	182.74	193.19	204.24
EBDITA	378.86	799.75	787.93	776.02	763.99	751.84	739.55	727.11	714.51	701.73	688.75	675.56	662.15	648.49	634.56	620.34	605.82	590.96	575.76	560.17	544.17	527.74	510.85	493.46	475.55
Depreciation	207.24	207.24	207.24	207.24	207.24	207.24	207.24	207.24	207.24	207.24	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08	69.08
Total interest	314.75	284.86	253.28	221.71	190.16	158.61	127.07	95.55	64.04	32.54	13.55	13.78	14.03	14.29	14.57	14.87	15.19	15.53	15.89	16.27	16.67	17.10	17.56	18.05	18.56
EBT	-143.12	307.66	327.42	347.07	366.60	385.99	405.24	424.33	443.23	461.95	606.12	592.70	579.04	565.11	550.90	536.39	521.55	506.36	490.79	474.82	458.42	441.56	424.21	406.34	387.91

Taxation

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
EBT	-143.1	307.7	327.4	347.1	366.6	386.0	405.2	424.3	443.2	462.0	606.1	592.7	579.0	565.1	550.9	536.4	521.5	506.4	490.8	474.8	458.4	441.6	424.2	406.3	387.9
Gross Income	64.1	514.9	534.7	554.3	573.8	593.2	612.5	631.6	650.5	669.2	675.2	661.8	648.1	634.2	620.0	605.5	590.6	575.4	559.9	543.9	527.5	510.6	493.3	475.4	457.0
Tax paid	-28.6	61.6	65.5	69.4	73.3	77.2	81.1	84.9	88.7	92.4	206.0	201.5	196.8	192.1	187.3	182.3	177.3	172.1	166.8	161.4	155.8	150.1	144.2	138.1	131.8
PAT	-114.5	246.1	261.9	277.6	293.2	308.8	324.2	339.4	354.6	369.5	400.1	391.2	382.2	373.0	363.7	354.1	344.3	334.2	324.0	313.4	302.6	291.5	280.0	268.2	256.1
Cumulative PAT	-114.5	131.6	393.5	671.2	964.4	1273.2	1597.3	1936.8	2291.3	2660.8	3060.9	3452.2	3834.4	4207.4	4571.1	4925.2	5269.4	5603.7	5927.6	6241.1	6543.7	6835.2	7115.2	7383.4	7639.5
Post tax ROE	-11.05%	23.75%	25.28%	26.79%	28.30%	29.80%	31.28%	32.76%	34.22%	35.66%	38.61%	37.76%	36.89%	36.00%	35.10%	34.17%	33.23%	32.26%	31.27%	30.25%	29.20%	28.13%	27.02%	25.89%	24.71%

Payback Period	13	years

Project & Equity IRR

Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
PAT	-114.5	246.1	261.91	277.63	293.25	308.76355	324.16	339.43	354.55	369.52	400.1	391.243	382.22	373.03	363.65	354.07	344.27	334.25	323.97	313.43	302.6	291.47	280.02	268.22	256.06
Depreciation	207.24	207.24	207.24	207.24	207.24	207.23518	207.24	207.24	207.24	207.24	69.078	69.08	69.078	69.078	69.078	69.078	69.078	69.078	69.078	69.078	69.078	69.078	69.078	69.078	69.078
Int On Loan	296.44	265.37	234.3	203.24	172.17	141.10053	110.03	78.965	47.897	16.829															
Interest on Working capital	18.307	19.484	18.975	18.476	17.987	17.508873	17.041	16.586	16.142	15.712	13.551	13.7826	14.03	14.293	14.574	14.873	15.19	15.528	15.887	16.269	16.674	17.105	17.561	18.046	18.561
Change in Working Capital	152.56	9.8065	-4.237	-4.158	-4.075	-3.987296	-3.895	-3.797	-3.695	-3.586	-18.01	1.93331	2.0611	2.1959	2.3384	2.4888	2.6476	2.8154	2.9926	3.1797	3.3775	3.5863	3.807	4.0401	4.2864

Cash flow available	outflow	Inflows																							
	-3453.92	254.94	728.39	726.66	710.73	694.72	678.60	662.36	646.01	629.52	612.89	500.74	472.17	463.27	454.21	444.97	435.53	425.90	416.04	405.94	395.60	384.98	374.07	362.85	351.31	339.41

Project IRR	16.37%

PAT	-114.48	246.10	261.91	277.63	293.25	308.76	324.16	339.43	354.55	369.52	400.10	391.24	382.22	373.03	363.65	354.07	344.27	334.25	323.97	313.43	302.60	291.47	280.02	268.22	256.06
Depreciation	207.24	207.24	207.24	207.24	207.24	207.23518	207.24	207.24	207.24	207.24	69.078	69.1	69.078	69.078	69.078	69.078	69.078	69.078	69.078	69.078	69.078	69.078	69.078	69.078	353.08
Interest on loan	241.77	241.77	241.77	241.77	241.77	241.77437	241.77	241.77	241.77	241.77															

Cash flow Available	Outflow	Inflows																							
	-1036.18	-149.02	211.56	227.37	243.09	258.71	274.22	289.62	304.89	320.01	334.98	469.18	460.32	451.30	442.11	432.73	423.15	413.35	403.33	393.05	382.51	371.68	360.55	349.10	337.30	609.14

Equity IRR	20.37%

Balance Sheet

Assets	Year	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Gross Fixed Assets		3453.9	3246.7	3039.4	2832.2	2625.0	2417.7	2210.5	2003.3	1796.0	1588.8	1381.6	1312.5	1243.4	1174.3	1105.3	1036.2	967.1	898.0	828.9	759.9	690.8	621.7	552.6	483.5	414.5
Book Depriciation		207.2	207.2	207.2	207.2	207.2	207.2	207.2	207.2	207.2	207.2	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1	69.1
Net Fixed Assets		3246.7	3039.4	2832.2	2625.0	2417.7	2210.5	2003.3	1796.0	1588.8	1381.6	1312.5	1243.4	1174.3	1105.3	1036.2	967.1	898.0	828.9	759.9	690.8	621.7	552.6	483.5	414.5	345.4
Cash Flow from Operations		92.8	453.3	469.1	484.9	500.5	516.0	531.4	546.7	561.8	576.8	469.2	460.3	451.3	442.1	432.7	423.1	413.4	403.3	393.0	382.5	371.7	360.6	349.1	337.3	325.1
Principal Payment		241.8	241.8	241.8	241.8	241.8	241.8	241.8	241.8	241.8	241.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cash and Equivalent		-149.0	62.5	289.9	533.0	791.7	1065.9	1355.6	1660.4	1980.5	2315.4	2784.6	3244.9	3696.2	4138.3	4571.1	4994.2	5407.6	5810.9	6204.0	6586.5	6958.1	7318.7	7667.8	8005.1	8330.2
Total ASSETS		3097.7	3102.0	3122.1	3158.0	3209.5	3276.4	3358.8	3456.5	3569.3	3697.0	4097.1	4488.3	4870.6	5243.6	5607.3	5961.3	6305.6	6639.8	6963.8	7277.2	7579.9	7871.3	8151.3	8419.6	8675.6

Liabilities	Initial																									
Equity Share Capital		1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2	1036.2
PAT For the Year		-114.5	246.1	261.9	277.6	293.2	308.8	324.2	339.4	354.6	369.5	400.1	391.2	382.2	373.0	363.7	354.1	344.3	334.2	324.0	313.4	302.6	291.5	280.0	268.2	256.1
Reserves And Surplus		-114.5	131.6	393.5	671.2	964.4	1273.2	1597.3	1936.8	2291.3	2660.8	3060.9	3452.2	3834.4	4207.4	4571.1	4925.2	5269.4	5603.7	5927.6	6241.1	6543.7	6835.2	7115.2	7383.4	7639.5
Networth		921.7	1167.8	1429.7	1707.3	2000.6	2309.3	2633.5	2972.9	3327.5	3697.0	4097.1	4488.3	4870.6	5243.6	5607.3	5961.3	6305.6	6639.8	6963.8	7277.2	7579.9	7871.3	8151.3	8419.6	8675.6
Rupee Debt	2417.74	2176.0	1934.2	1692.4	1450.6	1208.9	967.1	725.3	483.5	241.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Liabilities		3097.7	3102.0	3122.1	3158.0	3209.5	3276.4	3358.8	3456.5	3569.3	3697.0	4097.1	4488.3	4870.6	5243.6	5607.3	5961.3	6305.6	6639.8	6963.8	7277.2	7579.9	7871.3	8151.3	8419.6	8675.6
	check	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00	₹0.00

Debt Service Coverage ratio

Years	1	2	3	4	5	6	7	8	9	10
Principal Payment	241.77	241.77	241.77	241.77	241.77	241.77	241.77	241.77	241.77	241.77
Interest Payment	296.44	265.37	234.30	203.24	172.17	141.10	110.03	78.96	47.90	16.83
Total Debt Service	538.21	507.15	476.08	445.01	413.94	382.87	351.81	320.74	289.67	258.60
Cumulative Debt Service	538.21	1045.36	1521.44	1966.45	2380.39	2763.27	3115.08	3435.82	3725.49	3984.09
Post-tax Cashflow before Debt Service	254.94	728.39	726.66	710.73	694.72	678.60	662.36	646.01	629.52	612.89
Cumulative Cashflow Available for Debt Service	254.94	983.33	1709.99	2420.72	3115.44	3794.03	4456.40	5102.41	5731.93	6344.81

DSCR	0.47	0.94	1.12	1.23	1.31	1.37	1.43	1.49	1.54	1.59

Average DSCR	1.25