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Partnership to Advance Clean Energy - Deployment (PACE-D)
Technical Assistance Program

White Paper on Gross Metering for Solar Rooftops in Karnataka

March 2016

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Submitted to USAID in March, 2016

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ACRONYMS

Acronyms	Definition
APPCC	Average Power Purchase Cost
ARR	Average Revenue Requirements
COG	Cost of Generation
CUF	Capacity Utilization Factor
CM	Consumer Meter
DISCOM	Distribution Company
FIT	Feed-in-Tariff
FOR	Forum of Regulators
GERC	Gujarat Electricity Regulatory Commission
GW	Gigawatt
HT	High Tension
IPP	Independent Power Producer
KERC	Karnataka Electricity Regulatory Commission
KREDL	Karnataka Renewable Energy Development Ltd.
kW	Kilowatt
kWh	Kilowatt Hour
LCOE	Levellised Cost of Electricity
LT	Low Tension
MW	Megawatt
MNRE	Ministry of New and Renewable Energy
NM	Net Meter
NPV	Net Present Value
O&M	Operation and Maintenance
PPA	Power Purchase Agreement
RE	Renewable Energy
REC	Renewable Energy Certificates
RPO	Renewable Purchase Obligation
SERC	State Electricity Regulatory Commission
SM	Solar Meter
SBI	State Bank of India
WACC	Weighted Average Cost of Capital

EXECUTIVE SUMMARY

Solar has emerged as the fastest-growing energy generation technology globally over the past decade due to large-scale adoption of the technology by utilities and consumers on the back of rapid decline in the cost of solar energy, increased awareness on climate change and energy security, and enabling frameworks for adoption by policymakers. The development of solar has been led by the decentralised solar PV rooftop space with its ability to replicate rapidly when provided with an enabling policy and regulatory environment. By the end of 2013, almost 60 percent of the global solar PV capacity was from solar PV rooftops.

Solar PV rooftop deployment has depended heavily on the presence of a facilitating policy and regulatory environment for its replication. Globally two main instruments are driving the deployment of solar rooftop installations – Gross Metered Feed-in-Tariffs (FITs) and Net Metering. While both promote accelerated investments, they differ from each other in a number of subtle ways and thus differ in ways in which the solar PV rooftop market develops.

Most states in India use the Net Metering framework to promote solar PV rooftops. The same has been the case in the state of Karnataka, which used Net Metering to promote solar PV rooftop installations. The basic drivers for Net Metering include the lower pay-outs from utilities to solar PV rooftop developers vis-à-vis Gross Metered FITs and higher attraction for investment in case of high paying industrial and commercial consumers. While the Net Metering framework for solar PV rooftop offers these two critical advantages, it also suffers from a number of key disadvantages: a) Net Metering makes solar PV rooftop economically attractive only for commercial and industrial consumers who pay a high utility tariff - higher than solar Levellised Cost of Energy Generation (LCOE) - leaving out a large number of consumers with high potential for rooftop installations like schools, hospitals, and storage facilities; b) increased risks for third party investors as they have to depend on consumers for their payments; and c) loss of business for the utility, especially of high paying cross subsidizing consumers.

The state of Karnataka has made a creditable start to its solar PV rooftop program through a robust solar policy and an enabling regulation with an excellent provision of INR 9.56/ kilowatt hour (kWh) export tariff for excess solar generation that is fed into the grid. However, a number of challenges have also come to light during the implementation of this solar PV rooftop program. These include:

- A large number of consumers (mostly domestic and agriculture) are not in a position to make use of the Net Metering regulations due to the low cost of power and no other incentives to promote Net Metering.
- Focus only on commercial and industrial consumers or with consumers with large rooftops and low loads who can leverage the export tariff for solar PV rooftops.
- Contract sanctity has been identified as a major risk for third-party investors under the Net Metering mechanism, especially in cases where the consumer has appreciable load and consumption vis-à-vis the size of the solar PV rooftop system.

Given the challenges and unintended consequences of the Net Metering mechanism, there is a need for the development and deployment of an alternative parallel regulatory mechanism, to operate in conjunction with the Net Metering, which not only addresses these challenges and also provides an alternative investment narrative for solar rooftop projects and project developers. One such solution is Gross Metered FIT.

The Gross Metered FIT is the simplest, most widely adopted mechanism to promote solar rooftop projects. It is also easily to implement as state regulators and distribution utilities have been working with Gross Metered MIT for more than a decade. The biggest advantage of the Gross Metered FIT is that the tariff paid under this mechanism is related only to the cost of solar rooftop generation and not to the tariff paid by a consumer. Therefore this mechanism provides regulators the flexibility to modify the quantum paid for solar rooftop power based on the prevailing market rates of solar rooftop plants rather than linking them with escalating consumer tariffs for twenty five years. Table 1 provides a broad comparison of a Gross Metered FIT approach with Net Metered approach.

Table 1: Comparison of Gross Metering vs. Net Metering

S. No	Parameters	Gross Metering		Net Metering	
		Short Term (0-10 Years)	Long Term (11-25 Years)	Short Term (0-10 Years)	Long Term (11-25 Years)
1	Impact on Utility				
	Sales	No impact		Fall in sales due to self-procurement from rooftops	
	Utility Cash flow	Fall in cash flow due to incremental cost of procurement	Rise in cash flow as the FIT will be lower than Average Power Purchase Cost (APPC) in long run	Reduction in cash flow due to reduction in sales volume	Falling cash flow due to increase in procurement from rooftops
	Impact on Utility – APPC	Increase in APPC due to FIT (~ INR 1.5/kWh)	Negative impact on APPC due to reduction in FIT (~ INR 1.75 /kWh)	Marginal increase in APPC with increase in price of conventional power but lesser procurement	
2	Impact on Consumers				
	Impact on Consumer Tariff	Increase in consumer tariff due to increase in APPC	Impact on consumer tariff would be negative due to lower procurement cost	Impact on consumer tariff would increase with time due to reduction in high paying consumers and increasing burden of cross subsidy	
	Access to Finance	Easily available			
3	Impact on Third Party Transaction				
	Investment – Participation by Third Party	Higher participation by third party due to surety of return under Gross Metering and larger project size		Lower participation by third party due to lack of surety of returns from rooftop owner	
	Project Size Optimization	Higher capacity target is also possible with an attractive FIT		Size optimization could not be achieved as system designing would primarily be for self-consumption	
	Access to Financing	Easily available		Low due to lower contract sanctity	

	Contract Sanctity – Ease of enforcement (Third Party)	Single contract--power purchase agreement (PPA)--with utility makes it more attractive	Tripartite agreement between third party, consumer and distribution companies (DISCOMs) would be required to execute Net Metering to facilitate payment from DISCOM to developer

One of the greatest benefits of Gross Metering is that it is linked with FIT (for the entire project life), which makes it more attractive and bankable for end consumers, financiers and utilities. Gross Metering also allows regulators to assess the market dynamics and determine/modify FIT accordingly to suit market needs and also bring efficiency to the market. Gross Metered FITs are easy to design and administer, they link the returns to the cost of generation from solar and allow any consumer to become an independent power producer (IPP) and earn a rate of return on the investment made. However, the biggest driver for Gross Metered FITs is their limited impact on utility finances while offering a creditable alternative to consumers and developers.

This White Paper undertook a detailed quantitative analysis of the impact of the adoption of Gross Metered FIT framework on power purchase costs for utilities, stresses utility cash overall increase in retail supply tariffs, etc. To arrive at some conclusion, the following three scenarios were developed and simulated:

1. The impact of solar rooftop capacity addition through Net and Gross Metered FIT mechanisms on the utility for solar rooftop projects commissioned in the current financial year for the same capacity developed under both the mechanisms.
2. The impact of solar rooftop capacity addition through Net and Gross Metered FIT mechanisms on the utility for solar rooftop projects commissioned between FY 2016 and FY 2022 and their impact on the utility in future years (up to 2040) for the same capacity developed under both the mechanisms.
3. The total cost to the utility to implement rooftop projects under Net Metering and Gross Metering FIT (between FY 2016 and FY 2022).

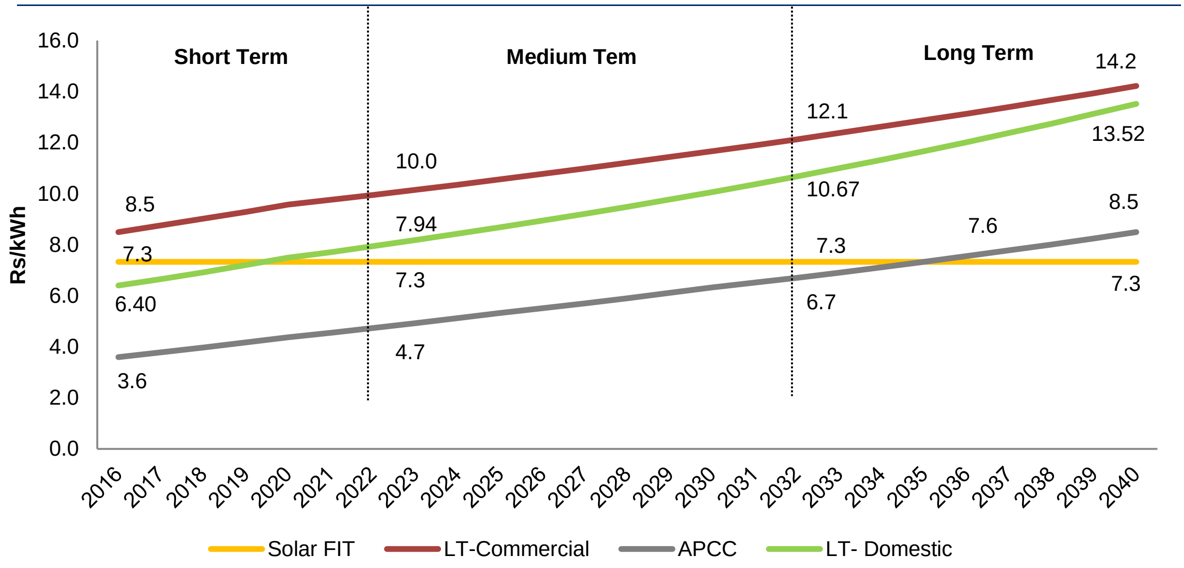
These scenarios[1] were developed and simulated based on prevailing retail supply tariffs, average power purchase costs of the utility vis-à-vis cost of procurement from solar rooftop (Solar FIT) between FY 2016 and FY 2022 and then projected onwards to FY 2040.

Scenario 1

The first scenario was developed and simulated to plot the relative impact of one unit of power procured through Net Metering and Gross Metering based FIT from the time the solar rooftop project has been commissioned in 2015-16 till 2040 (which is the life of the solar PV rooftop project). The change in the consumer tariffs (both commercial and residential) was plotted against average power procurement costs and the levelised cost of generation per unit for solar PV rooftop systems and the impact of these plotted over the life of the project.

[1] Data was used from BESCOM's Regulatory Filings

Figure 1: Comparison of Solar FIT with Retail Tariff for Project Commissioned in FY16



The key inferences arrived at from the above analysis are:

a. As depicted in Figure 1, for every unit of energy for the commercial consumer met through Net Metering, the utility would lose INR 8.5/kWh in FY 2016, which would increase year on year to touch INR 14.2/kWh by FY 2040[2]. However, the utility will also save from lower power procurement costs during this period, starting from INR 3.6/ kWh in FY 2016 and going up to INR 8.5/kWh by FY 2040. Therefore the benefit from rise in commercial tariffs would be lost to the utility (the difference between the commercial tariff and the APPC).

b. If the utility, instead of implementing Net Metering, would have procured the solar power through a Gross Metering FIT, then the cost of solar procurement would be met by the utility. Under this mechanism, the utility would have saved on power procurement costs during this period, starting from INR 3.6/kWh in FY 2016 and going up to INR 8.5/kWh by FY 2040 but paid for the solar PV rooftop procurement. In case of the Gross Metered FIT, the utility pay out initially would be more, but with time the differential between the Gross Metered FIT and the power procurement cost would come down, resulting in savings over the medium to the long term.

Inferences drawn from the above hypothesis

a. The implementation of Net Metering would reduce utility sales and impact revenue, which will lead to increase in retail tariff across consumer categories in the short, medium and long term.
b. Impact of increase in retail tariff would be more on low paying consumers due to migration of high paying consumers from the utility to Net Metering.

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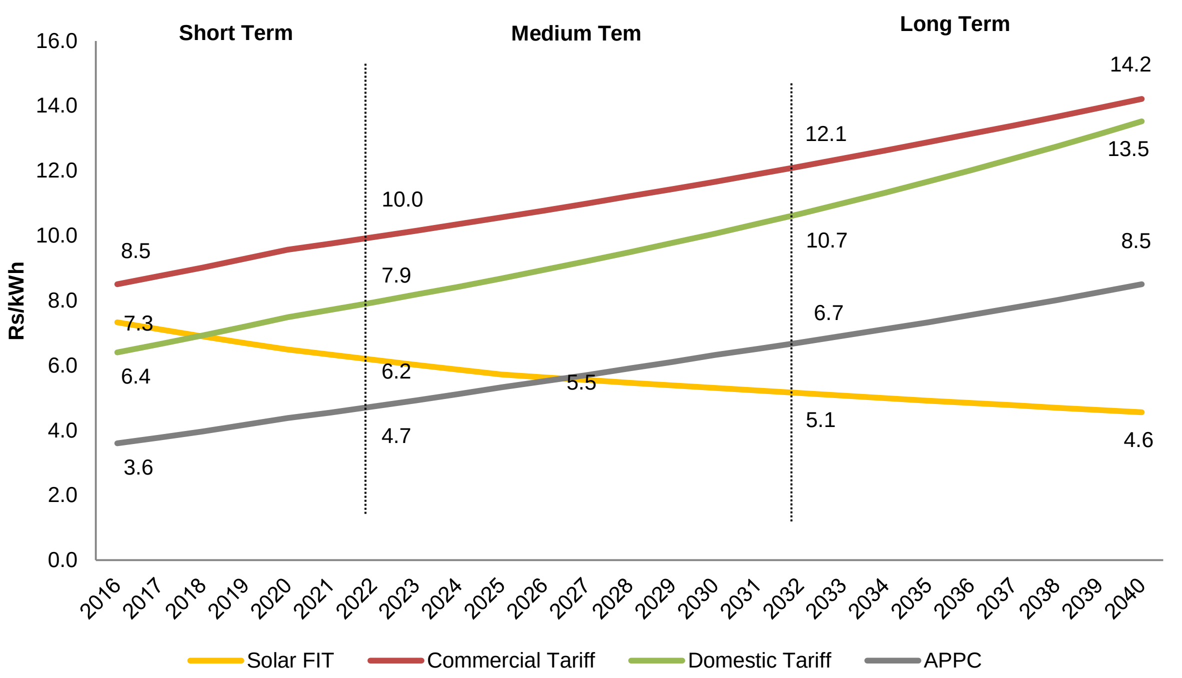
[2] Considering the growth rate lower than the historical growth rate of supply tariff due to the mandate of reduction in cross-subsidy.

c. Adoption of Gross Metering FIT would not impact utility sales. However the procurement cost of utility would tend to increase for short term but would fall in the medium to long term.
d. In the long term, procurement from rooftops would help utilities to save revenue through procurement at lower rate than APPC.
e. The Net Present Value (NPV) of Gross Metering FIT procurement is 40 percent lower than that from Net Metering procurement.

Scenario 2

In the second scenario, it was assumed that the price of solar PV rooftop projects and the consequent LCOE generation has come down with time. This reduction in price has been mapped in this scenario and the impact of that price reduction over the next 25 years computed. Subsequently the impact of adoption of Gross Metered FIT was analysed by undertaking the comparison of solar PV rooftop Gross Metered FIT for future projects vis-à-vis the change in retail tariffs and APPC for the same time frame (Figure 2).

Figure 2: Comparison of Solar FIT with Retail Tariff for Future Projects



Analysis and Inferences

1. As can be seen from Figure 2, the utility will continue to lose high paying consumers and utility sales revenue due to replacement of utility power with solar power in the case of Net Metering. This difference in the savings for the consumer will increase with time as LCOE of solar PV rooftop power will keep coming down with decrease in the capital costs of solar rooftop projects commissioned in each subsequent year as shown in Figure 2. These higher savings will prompt more and more commercial and industrial consumers to move to Net Metering.

2. On the other hand, if the similar capacity of rooftop were to be implemented by utilities through the FIT-Gross Metering route, they would still face relatively higher procurement costs in the short term but with a decreasing trend as shown in Figure 2. However most of this higher cost of procurement would be passed on to the consumers as a part of the Average Revenue Requirements (ARR), all the while ensuring that revenues from high paying consumers are not lost. Further, in the long run the steadily reducing Gross Metered FIT would make solar rooftops more competitive (once it falls below the APPC) for the utilities and allow them to reduce costs.
3. In this case, the NPV of procurement of solar power from Gross Metered FIT vis-à-vis Net Metering, there is a significant savings from Gross Metered FIT projects.

Scenario 3

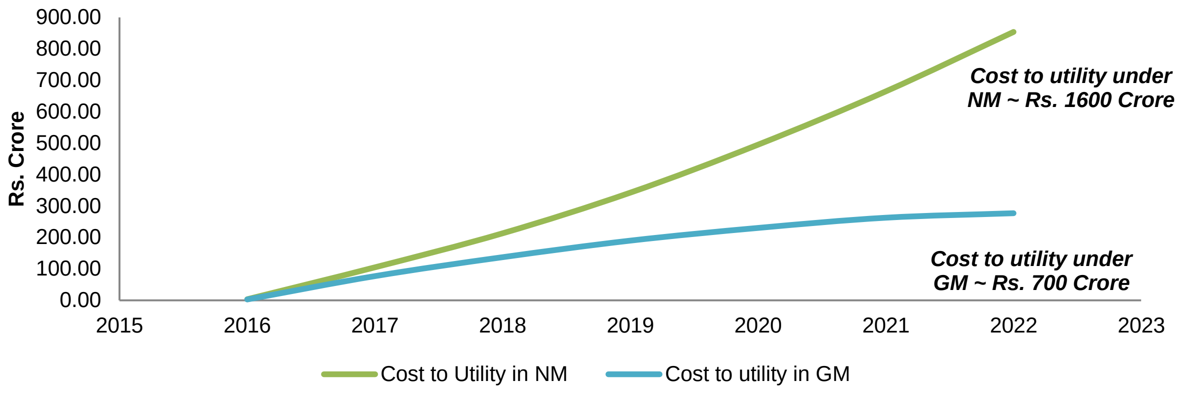
Scenario 3 explores the overall impact of the procurement of solar rooftop-based power using both of these two procurement methods—Net Metering and Gross Metered FIT. For the purpose of hypothesis, it has been assumed that the state of Karnataka would meet its target of 2,300 MW, designated by the Ministry of New and Renewable Energy (MNRE), for solar PV rooftop by 2022 through a 50:50 split between Net Metering and Gross Metering as outlined in Table 2.

Table 2: Capacity Addition Targets for Solar Rooftop for Karnataka

Capacity addition target for Karnataka under JNNSM (MW) by 2022								
Particular	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**	**FY22**	**Total**
Target Capacity	10	275	290	344	403	460	518	**2300**
Capacity under NM	5	137	145	172	201	230	259	**1150**
Capacity under GM	5	137	145	172	201	230	259	**1150**

The impact on the utility from the adoption of solar rooftops using the Net Metering framework was computed in terms of the reduction in revenues due to reduced sales resulting while in case of Gross Metered FIT, the impact on the utility has been computed based on the higher cost of procurement for the amount of energy procured from gross metered rooftops at the solar FIT. The result of the scenario has been outlined in Figure 3.

Figure 3: Cost to Utility to adopt Net Metering vis-à-vis Gross Metering



In the specific case of Bangalore Electric Supply Company Limited (BESCOM), if it procured all the 2,300 MW, the utility would have to bear a cost of INR 700 crore between FY 2016 and FY 2022 for procurement undertaken through Gross Metered FIT route while the utility will stand to lose revenues of INR 1,600 crore over the course of the same period if these projects are developed using the Net Metering route.

1 INTRODUCTION

1.1 WHY SOLAR ROOFTOP

Solar has emerged as the fastest-growing energy generation technology globally over the past decade on the back of large-scale adoption of the technology by utilities and consumers. Such has been the rate of growth of this technology that close to one fourth of the total global capacity addition happened in 2014 and the years between 2012 and 2014 have seen the installation of close to 60 percent of all solar PV capacity in operation worldwide[3].

A number of drivers have been pushing the development of solar energy generation across the globe. These range from increasing awareness of climate change hazards, energy security considerations, design and deployment of a number of facilitating policy and regulatory frameworks, rapid decline in solar energy generation costs (with scale and technology advancements), emergence of new and innovative business models and greater reliability in the technology itself. A number of countries around the world have taken the lead in structuring enabling policies and incentives to increase the penetration of solar power applications using either large utility scale route or the decentralized consumer based route or a combination of both.

While large utility-driven installations have their advantages, globally, the decentralized, customer-driven route using solar PV rooftop installations (referred to from now on as the solar rooftop market) have led the development of the solar PV sector. The key factor behind this has been the ability of the solar rooftop market to replicate rapidly when provided with an enabling policy and regulatory environment. Up to the end of 2013, the solar PV rooftop market had added close to 85 GW of capacity vis-à-vis around 55 GW of large utility-driven installations with Germany, Japan, Italy and the U.S. leading the way in rooftop installations.

This difference in global capacity addition between large utility-driven installations and rooftop installations is all the more surprising when one considers that utility-scale projects are 10 to 20 percent cheaper than similar solar rooftop installations. However, when the economic advantages of solar rooftop installations are taken into account (listed below), then it becomes easy to see why the solar rooftop sector has been at the forefront of global solar deployment.

1. **Enhances the investment potential of the sector**: The solar rooftop sector allows a wide variety of investors, including retail and institutional investors, energy developers and end users, to enter the market as investors, raising the investment potential and capacity of the sector.

2. **Reduces transmission and distribution losses vis-à-vis centralized generation and distribution:** Solar rooftop systems have the advantage of supplying energy close to load centres and benefit distribution utilities as they significantly reduce network losses.

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[3] Global Status Report 2015 – REN 21

3. **Accelerates permitting and deployment process**: Large solar plants/farms have significant land and infrastructure requirements which do not exist for solar rooftop installations. On the other hand, due to their small size, lack of any land acquisition and interconnection with an established grid, solar rooftop systems can be permitted and installed faster than most ground-mounted systems.

4. **Enhances energy security**: Solar rooftops have the ability to ensure greater user level energy security through fixed and LCOE generation with no fuel costs and minimal operation and maintenance (O&M) requirements.

1.2 ROLE OF POLICY AND REGULATION IN SOLAR ROOFTOP DEVELOPMENT

Solar PV, due to high upfront costs, has some of the highest cost of energy delivery amongst energy sources available today. Solar PV has intermittent generation with variations across days and seasons. However these technologies offer a huge potential for long term energy security and the ability to address climate change issues along with a host of other benefits. Due to these challenges, the promotion of solar PV has been and is heavily dependent on encouragement from policy makers and regulators at the national, state, and municipal levels. These actors have supported the rapid take-up of solar PV-based rooftop solutions through the introduction and roll-out of policies and regulations conducive to solar deployment.

This affirmative action has led to the development and deployment of FITs in 108 jurisdictions across the globe and of Net Metering policies across 48 countries[4]. As a result of this enabling policy and regulatory environment, the solar PV rooftop market has been able to ramp up significantly, especially over the past decade. Germany, the global leader in solar deployment, has witnessed a bulk of its deployment (70 percent) come through small-scale users who install solar PV rooftop systems. Similarly Australia, Japan, Italy, and the U.S. are other countries have achieved a significant share of rooftop installations in the overall solar mix. Most of this growth has come on the back of policies and regulations which supported early market deployment.

Policy makers and regulators have used two main instruments for the promotion of solar rooftop installations—FITs and Net Metering.

- **Gross Metered FITs**: Under this framework, all the energy generated from solar rooftop systems is exported to the grid with no internal consumption at the rooftop owner’s facility. The FIT denotes the price paid by the utility for the solar power from the rooftop.

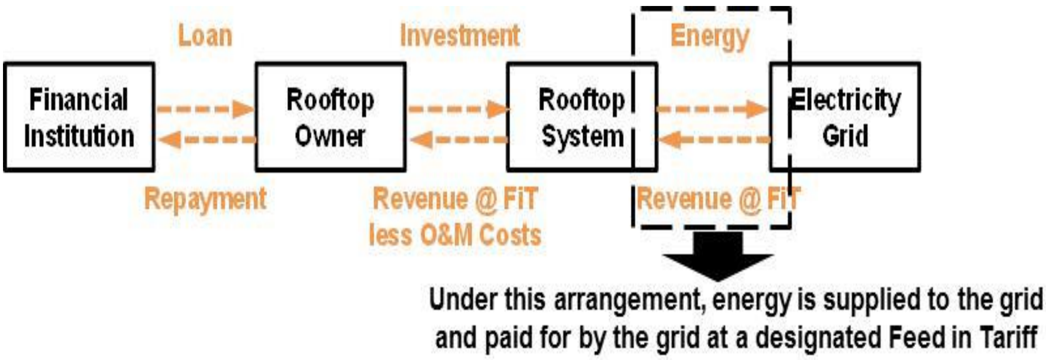
- **Net Metering:** Under this framework, the energy generated from the rooftop system is first used internally (by the rooftop owner’s facility to meet internal loads) and the excess is exported to the grid only to be netted out against energy imports at other times.

[4] Global Status Report 2015 – REN 21

1.3 GROSS METERED FEED IN TARIFF

Under the Gross Metered regime, the rooftop systems deployed on any rooftop (home, commercial building, industrial park or government office) becomes a stand-alone IPP, which generates solar power and supplies all the power to the grid at pre-defined rates called FITs. FITs are defined by the regulator using a cost plus approach which allows the investor in solar rooftop systems to earn a profit over the cost of generation from rooftop systems. The most successful example of this can be seen in the case of Germany and the FIT offered by the state. The German Renewable Energy Act of 2000 provided priority access for renewable energy (RE) sources like solar rooftop installations to the grid and obligated the grid operators to purchase electricity produced from solar rooftop systems and other RE sources as well. The business model, based on the Gross Metered FIT arrangements, has been depicted in Figure 1.

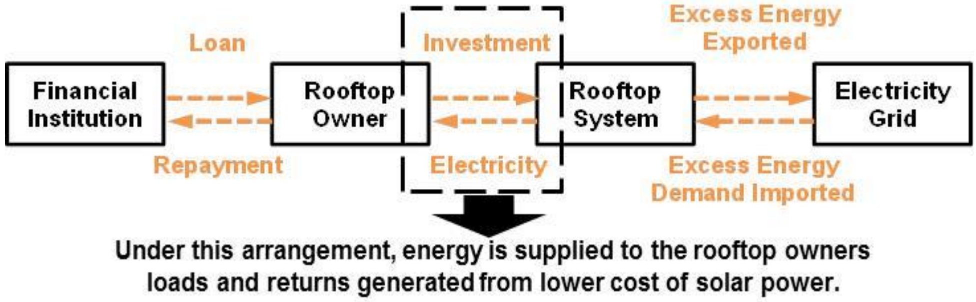
Figure 4: Schematic of a Gross Metered Rooftop System



1.4 NET METERING

Under the Net Metering arrangement, the power generated from the solar PV rooftop system is first consumed by the captive loads of the consumer (who also owns the rooftop) and the excess generation is exported to the grid. This excess generation (which is exported) is settled against the import by the consumer at other times of the day/week/month from the distribution utility grid. The most successful example of Net Metering can be seen in the U.S. The success of the Net Metering framework depends on the cost of electricity paid by the consumer. If the cost of electricity is higher than the cost of generation of solar-based energy, then an economic and financial rationale exists for investments in solar PV rooftop systems using the Net Metering framework. In case the cost of solar PV rooftop-based power is higher than that of the power from the grid, then there will be a need for providing consumers with certain fiscal incentives to bridge the gap between the cost of solar power and grid based power. These incentives may be in the form of subsidies and/or tax credits and are required to ensure that investors get a minimum rate of return on their investments. The business model based on Net Metering arrangement with inter-relationships between stakeholders is outlined in Figure 2.

Figure 5: Schematic of a Net Metered Rooftop System



The key difference between the two mechanisms is 'accounting and settlement' of energy from the rooftop facility which has a direct impact on the overall revenue generation potential of solar rooftop projects.

Both Gross Metered FITs and Net Metering are mechanisms designed to accelerate investments in clean energy technologies (specifically solar rooftops) by providing a framework for energy producers or rooftop owners to earn a return on investment for generating energy and feeding it either to their local loads or into the grid. However they both differ from each other in some very subtle yet important ways that influence how the market develops and their impact on the key stakeholders:

- **Design Philosophy**: The basic design philosophy of Net Metering programs is to incentivize investment in solar rooftop installations and solar generation for meeting the rooftop owners' own energy needs. In the case of Net Metering, the return on investment comes from replacing lower higher cost utility power with lower cost solar power. On the other hand, the design philosophy for Gross Metered FITs considers every investor, be it a rooftop owner, as an IPP who installs a rooftop system, generates solar power and sells the same to the distribution utility with the aim of making a return on the investment.

  In the case of Net Metering, the utility has no commercial role except providing interconnection and Net Metering arrangements. In case of Gross Metered FITs, the utility not only interconnects but also receives all the energy from the solar rooftop system and compensates the rooftop developer for the power.

- **Pricing of Power:** In both the Net Metering and Gross Metering systems, the cost of generation of solar power remains the same. However the consumer pays the cost of generation for solar in the case of Net Metering, while the utility pays the cost of generation in the case of Gross Metering. In the case of Gross Metering, the cost of power remains the same as that supplied by the grid, while in the case of Net Metering, the utility pays no cost for the solar energy exported to the grid.

- **Contractual Requirements:** Net Metering requires very simple contractual agreements between the utility and the consumer as most of the time no payment is made by one party to the other except provision of Net Metering and Interconnection. These requirements are usually addressed through the use of a Net Metering

Agreement. On the other hand, Gross Metered arrangements are more complex and require that both the utility and the developer enter into a long term PPA, which usually have tenures of up to 20-25 years.

- **Energy Security:** As the price of solar energy generated and consumed under the Net Metering regime directly replaces electricity supplied at the retail price, Net Metering acts as a perfect hedge against rising electricity retail prices (which is the common trend seen in India) for the consumer. Therefore Net Metering provides long term energy security to the consumer/rooftop owner. On the other hand, the Gross Metered systems supply solar power at flat FITs, and in turn provide long term energy security to the distribution utility and indirectly to all consumers.

- **Sizing of Rooftop Systems:** One of the key challenges for consumers and solar rooftop system owners in the case of Net Metering is that they either get almost no returns for the excess power generated by the rooftop systems and exported to the grid. Thus sizing the system beyond a point, regardless of the capacity of the rooftop to accommodate larger systems becomes counter-productive. This in turn constrains the sizing of the system and may not lead to optimization in the use of the rooftop for solar installation at a consumer’s premises. This issue does not arise in the case of Gross Metering as the electricity generated is not linked to the consumer’s ability to consume the same but the availability of the rooftop area.

- **Impact on Utility Economics:** In case of Net Metering, the solar power generated from rooftop installations negatively impacts the consumption of electricity from the grid and in turn the receivables to the utility from the consumers. However, solar rooftop systems under Net Metering do not add to the cost of power procurement for the distribution utility as no pay-out is made to the consumer as is the case for Gross Metering where the utility pays for solar power at a pre-determined FIT. However, in the case of Net Metering, the utility losses a consumer’s business. As high tariff consumers usually opt for solar rooftop under Net Metering, especially in cases where the cost of solar power is lower than the retail tariffs being paid by them, the utility sees an erosion of its profitability.

On the surface of it, both Net Metering and Gross Metered FIT have been able to add significant capacity through solar PV rooftop programs. However it is necessary to understand and acknowledge that in most cases Net Metering aims to replace cheaper utility power with more expensive solar power for consumers who are also either the investors or the customers of the investors. In cases where the cost of solar is higher than the retail tariff paid to the utility (for some consumer classes like residential), this approach would require an enabling set of incentives, over and above the mechanism of Net Metering, which would make the returns from the investments commensurate with the norms of the market and investor expectations. A number of jurisdictions in the U.S. have made the Net Metering program work. Examples include New Jersey, California to name a few. These jurisdictions were able to make Net Metering work because they were able to combine the Net Metering program with other appropriate incentives (tax benefits and subsidies, high retail tariff, etc.) which stimulated demand and led to capacity addition.

However, when the focus is on a developing market which is still talking its first steps, Net Metering might not be the only appropriate mechanism to promote solar PV rooftop installations. Gross Metered FIT has been used across the globe to promote solar PV rooftop installations. Some of the leading solar rooftop markets rely on Gross Metered FITs (e.g. Germany, Japan, Italy, France, Spain, etc.) The main objective behind the adoption of FIT by these countries has been to encourage a wide range of investors and consumers to install solar PV rooftop systems while also guaranteeing long term assured returns for investors irrespective of their consumer class. The provision of a stable FIT allowed the industry to develop by providing investor certainty through the use of fixed price signals. Coupled with the stable FIT, the policymakers also defined an annual reduction in FIT which the industry was expected to achieve. This annual mandated reduction in FITs allowed policymakers to define a trajectory for long term cost reduction in the procurement of solar PV rooftop-based energy.

2 EVOLUTION OF SOLAR ROOFTOPS IN INDIA

The development of the solar rooftop sector in India started in June 2010, with the announcement of "Rooftop PV & Small Solar Power Generation Programme" scheme by MNRE. This scheme was designed primarily as a state-driven scheme to encourage states to outline their solar policy for grid-connected projects focusing on the distribution networks. Under the scheme, a target of 100 MW was set for rooftop and small ground-mounted solar plants connected at the LT/11 KV grid. This scheme was based on the Gross Metered FIT framework, wherein the state utilities signed long term PPA with solar rooftop developers on solar FITs approved by the respective State Electricity Regulatory Commissions (SERCs).

Although the scheme was well received and 78 projects were selected from 12 states, of which, 71 projects with a cumulative capacity 90.80 MW have been commissioned, it did not succeed as far as solar rooftop was concerned as close to zero capacity came on solar rooftops.

At around the same time, the Government of Gujarat launched the Gandhinagar (Solar) Photovoltaic Rooftop Programme (October 2010). This program envisaged the installation of solar rooftop systems with a combined capacity of 5 MW in Gandhinagar, the capital of Gujarat. The aim of the program was to showcase development of solar rooftop systems on public as well as private (residential) buildings. This program also used the Gross Metered FIT framework. Two bidders (Azure and SunEdision) were shortlisted and long term PPAs were signed with them.

With the success of the initial pilot programs, the inherent benefits of rooftop solar projects became widely recognized by policy makers and regulators and consequently the initial push for the development of solar rooftop projects got underway in India.

The Forum of Regulators (FOR) met in August 2013 and released a detailed study on Net Metering policies adopted across the world. It defined a set of parameters required to develop Net Metering regulations. On the basis of research findings and the results of this study, FOR presented 'Model Regulations for Net Metering-based Rooftops in India'. The FOR chose Net Metering with the objective of not putting the load of solar rooftop power purchase onto the distribution utilities, who already suffered from high losses and weak revenue bases.

Following this development, more than 20 SERCs released their own regulatory provisions and 16 states announced their own solar policy to develop solar rooftop projects.

2.1 EVOLUTION OF THE SOLAR ROOFTOP PROGRAM IN KARNATAKA

The development of solar rooftops in Karnataka started in 2009 with the announcement of the Karnataka RE Policy 2009-14. The policy set a target of deploying 25,000 solar rooftop installations with a capacity between 5 and 10 kWp using the Net Metering facility under the 'Solar Karnataka Program'. The policy covered solar rooftop systems installed on individual homes and commercial establishments and provided a tariff of INR 3.40/kWh for export of power over and above the internal consumption under the Net Metering facility. However, the program was not as successful as envisaged due to the low export price provided under the Net Metering scheme as well as the higher cost of solar generation when compared to the cost of power from the distribution utility.

In order to encourage more individual households to install solar rooftops, the Karnataka Energy Regulatory Commission (KERC), through its solar tariff order dated October 10, 2013 set the solar export tariff at INR 9.56/kWh under the Net Metering arrangement. Under the tariff order, KERC exempted additional charges such as wheeling, banking, and cross subsidy surcharge in order to allow third party investments in the solar rooftop market. The Order also allowed consumers to install projects up to 1 MW and export surplus power to the grid.

To implement this scheme, BESCOM, one of the state distribution utilities launched its Solar Rooftop PV Program in October 2014. The program was well received by all stakeholders and within the first six months of the program, BESCOM received interest from over 300 applicants with a proposed capacity of more than 17 MW. However, the actual achievement under the program remained much lower than anticipated. By September 2015, only 2.5 MW of solar rooftop capacity was connected to the grid. Despite the attractive export tariff of INR 9.56/kWh and exemption of additional charges for investors, the program has not been able to scale up its deployment effectively or swiftly.

An analysis of the key technical and operational challenges of developing and deploying these systems in Karnataka was undertaken and a number of programmatic roadblocks have been identified that have impeded the program's progress:

- Difficulties in encouraging and engaging consumers with lower retail tariff structures
- Low participation of solar rooftop marketing companies due to the high transaction cost of acquiring consumers Low participation by third party investors due to contracting and payment security issues

3 THE CASE FOR GROSS METERING FIT IN KARNATAKA

The state of Karnataka has been able to add only ~2.5 MW of solar PV rooftop capacity despite having a robust solar policy and an enabling regulation with an excellent provision of INR 9.56/ kWh export tariff for excess solar generation that is fed into the grid. While Karnataka has made a creditable start, the state has a huge potential for solar rooftop deployment which can be realised if the right set of incentives are made available to the market.

As things stand, a number of challenges face the state in terms of solar PV rooftop capacity addition:

1. **A large quantity of consumers are not in a position to make use of the Net Metering regulations due to the low cost of power and no other incentives to promote Net Metering.** Karnataka's five DISCOMs have a total of around 20 million retail customers, of which 86 percent of all consumers come under the agriculture and domestic categories. At present, it is economically not attractive for them to go for Net Metering (exception is for low load and large rooftop installations which will benefit from the very high solar tariff) as they pay very low tariffs for grid-based electricity. In terms of energy sales, low paying categories like agriculture and domestic constitute 57 percent of the total units sold in Karnataka with an average retail tariff of INR 4.59/kWh.

2. **Focus only on commercial and industrial consumers or with consumers with large rooftops and low loads**. As pointed out earlier, Net Metering would make sense if the cost of the solar power was lower than the tariff being paid by the consumer to the utility. In the state of Karnataka, especially under the jurisdiction of BESCOM, the only consumers with tariffs higher than the cost of procuring solar power are commercial and industrial consumers. However these consumers often lack adequate awareness about these solutions, resources and knowledge required to set up their own plants or are unwilling to make the investment themselves while also not being very attractive for third party-based PPAs. Furthermore, they often consider this type of investment extremely risky. One potential way for this market to develop would be through investments from third parties. This focus on Net Metered consumers excludes a large number of potential solar consumers like schools, hospitals, and storage facilities, etc. which have a large rooftop space but cannot provide a financial justification to adopt net metered solar rooftop business models.

3. **Contract sanctity is a major risk for third party investors especially under the Net Metering mechanism:** Industrial and commercial consumers can still benefit from lower solar-based tariffs from rooftop installations if this is done through third party developers. However, one of the major challenges facing third party developers today is the contract sanctity with rooftop power off-takers. This means according due recognition to the contractual framework which embodies the understanding between parties with appropriate legislative and legal back up in order to ensure that the protection of rights of any of the parties and enforceability are not eroded or taken away.

4. **Optimal sizing and design of solar rooftop systems under the Net Metering mechanism:** Solar rooftop project development is not based on the optimal utilization of rooftop space but the load of the consumer and the available rooftop space available to commercial and industrial consumers.

3.1 NEED FOR INCENTIVE MECHANISMS WHICH MEET REQUIREMENTS OF THE MARKET

The FOR (which includes most state regulators) has chosen the Net Metering framework for the promotion of solar PV rooftop across states. The state of Karnataka has also used the same approach as most other states and adopted the Net Metering framework as this framework offers a number of advantages, most notably the reduced burden of power purchase on the state distribution utilities.

However, as seen above, the Net Metering framework for solar rooftop deployment also suffers from a number of challenges and has a number of unintended consequences, a few of which have been highlighted above. Besides the above mentioned challenges, the biggest unintended consequence of the Net Metering framework is the loss of revenue from non-subsidised consumer categories (commercial and industrial), who cross-subsidise domestic and agriculture consumers.

Given the challenges and unintended consequences of Net Metering mechanism, there is a need for the development and deployment of an alternative parallel regulatory mechanism, to operate in conjunction with the Net Metering (as the market is in its infancy and needs multiple channels for development), which addresses these challenges and unintended consequences and provides an alternative investment narrative for solar rooftop projects and project developers. Some of the alternate regulatory mechanisms, which address these challenges and can be used for the promotion of solar rooftop projects, can be:

a) Gross Metered FIT.
b) Cost-based tendering.
c) Generation-based Incentives.

Of the three proposed alternatives, the Gross Metered FIT is the simplest, most widely adopted mechanism to promote solar rooftop projects. It is easy to implement as state regulators and distribution utilities have been working with Gross Metered FIT for more than a decade. The biggest advantage of the Gross Metered FIT is that the tariff paid under this mechanism is related only to the cost of solar rooftop generation and not to the tariff paid by a consumer. Therefore this mechanism allows the regulators the flexibility to modify the quantum paid for solar rooftop power based on the prevailing market rates of solar rooftop plants rather than linking them with escalating consumer tariffs for twenty five years.

The adoption of Gross Metered FIT for solar rooftop installations also addresses a number of unintended consequences of Net Metering such as the need for economic incentives to ensure that all consumer categories are able to set up solar PV rooftop plants as well as a positive impact from procurement of relatively cheaper power over the medium to long term and consequent impact on utility finances. Table 1 provides a broad comparison of a Gross Metered FIT approach with Net Metered approach.

Table 3: Comparison of Gross Metering vs. Net Metering

S. No	Parameters	Gross Metering		Net Metering	
		Short Term (0-10 Years)	Long Term (11-25 Years)	Short Term (0-10 Years)	Long Term (11-25 Years)
1	Impact on Utility				
	Sales	No Impact		Fall in sales due to self-procurement from rooftops	
	Utility cash flow	Fall in cash flow due to incremental cost of procurement	Rise in cash flow as the FIT will be lower than APPC in long run	Reduction in cash flow due to reduction in sales volume	falling cash flow due to increase in procurement from rooftops
	Impact on utility – APPC	Increase in APPC due to FIT (~ INR 1.5 /kWh)	Negative impact on APPC due to reduction in FIT (~ INR 1.75 /kWh)	Marginal increase in APPC with increase in price of conventional power but lesser procurement	
2	Impact on Consumers				
	Impact on Consumer Tariff	Increase in consumer tariff due to increase in APPC	Impact on consumer tariff would be negative due to lower procurement cost	Impact on consumer tariff would increase with time due to reduction in high paying consumers and increasing burden of cross subsidy	
	Access to Finance	Easily available			
3	Impact on Third Party Transaction				
	Investment – Participation by Third Party	Higher participation by third party due to surety of return under Gross Metering and larger project size		Lower participation by third party due to lack of surety of returns from rooftop owner	
	Project Size Optimization	Higher capacity target is also possible with an attractive FIT		Size optimization could not be achieved as system designing would primarily be for self-consumption	
	Access to financing	Easily available		Low due to lower contract sanctity	
	Contract Sanctity – Ease of enforcement (Third Party)	Single contract (PPA) with utility makes it more attractive		Tripartite agreement between third party, consumer and DISCOMs would be required to execute Net Metering to facilitate payment from DISCOM to developer	

Gross Metered FITs are applicable for technologies, market segments and sectors entering commercialization stage where the supply base is building up and there is a need for a risk cushion. Gross Metered FIT has had considerable success in developing solar rooftop markets as can be seen from Table 4.

Table 4: Regulatory Mechanisms used by large Solar Rooftop Markets

Country	Quantity	Mechanism	Fiscal Measures
Germany	FIT-linked capacity cap (MW) - introduced recently	FIT	• Capital subsidy (way back) • Low interest loans
Italy	FIT-linked capacity cap (MW) - introduced recently	FIT	
France	FIT-linked capacity cap	FIT	• Tax abatement on equipment
Spain	Annual capacity cap (MW)	FIT	
U.S.	Energy purchase (RPS)	• Competitive bidding	• Tax abatement on equipment • Capital subsidy • Property tax rebates
Japan	Energy purchase (Renewable Purchase Obligation (RPO))	• Earlier Net Metering • Now moved to FIT	• Capital subsidy

From the discussions above, it is clear that there is space (along with Net Metering) for the introduction of a well-designed Gross Metered FIT scheme which can also contribute to accelerated deployment of solar rooftop projects. One of the greatest benefits of Gross Metering is that it is linked with FIT (for the entire project life), which makes it more attractive and bankable for end consumers, financiers and utilities. Gross Metering also allows regulators to assess the market dynamics and determine/modify FIT accordingly to suit market needs and also bring efficiency to the market. Gross Metered FITs are easy to design and administer, link the returns to the cost of generation from solar and allow any consumer to become an IPP, and earn a rate of return on the investment made.

3.2 BUSINESS CASE FOR UTILITIES – GROSS METERING VS NET METERING

As highlighted above, Gross Metered FIT offers a number of advantages over the Net Metered mechanism. This section specifically focuses on simulating the impact of the adoption of Gross Metered FIT by the distribution utilities vis-à-vis the impact of the adoption of Net Metering mechanism by the same utility. This section also aims to provide quantitative evidence on the question of whether the adoption of Gross Metered FIT framework increase power purchase costs for utilities (if yes, then for how long), stresses utility cash flows and leads to overall increase in retail supply tariffs. To arrive at some conclusion, three scenarios were developed and simulated:

1. The impact of solar rooftop capacity addition through Net and Gross Metered FIT mechanisms on the utility for solar rooftop projects commissioned in the current financial year for the same capacity developed under both the mechanisms.
2. The impact of solar rooftop capacity addition through Net and Gross Metered FIT mechanisms on the utility for solar rooftop projects commissioned between FY 2016 and FY 2022 and their impact on the utility in future years (up to 2040) for the same capacity developed under both the mechanisms.
3. The total cost to the utility to implement rooftop projects under Net Metering and Gross Metering FIT (between FY 2016 and FY 2022).

These scenarios[5] were developed and simulated based on prevailing retail supply tariffs, average power purchase costs of the utility vis-à-vis cost of procurement from solar rooftop (solar FIT) between FY 2016 and FY 2022 and then projected onwards to FY 2040.

3.3 ASSUMPTIONS FOR DEVELOPING BUSINESS CASE

In order to develop scenarios for computation of impact of Net and Gross Metering FIT-based approaches for solar rooftop development on the distribution utility, certain assumptions have been used. These assumptions have been summarized in Table 6.

a. Increase in commercial tariffs and residential tariffs (due to an increase in power procurement costs and cost of delivery by the utility).
b. Increase in APPC due to an escalation in fossil fuel costs.
c. Flat solar tariff for 25 years of plant life, which is in effect the LCOE for the life of the solar rooftop plant.
d. The costs and projections have been based on the costs prevailing in FY 2016.

Figure 6: Assumption for developing Business Case for Utilities

S. No	Parameters	Base for calculations	Annual Escalation
1.	Retail tariff – LT Domestic[6]	INR 6/kWh	4% annual escalation on base for first 5 years and 3% for next 20 years
2.	Retail tariff – LT Commercial	INR 8.5/kWh	3% annual escalation on base for first 5 years and 2% for next 20 years
3.	APPC	INR 3.6/kWh	Annual escalation on base • 5% for first 5 years • 4% from 6th -10th years • 3.5% from 11th-15th year • 3% from 16th-25th year
4.	Solar Gross Metered FIT	INR 7.3/kWh	Annual reduction in Solar FIT • 3% for first 5 years • 2.5% from 6th -10th years • 1.5% from 11th-25th year
5.	Capacity addition in solar rooftop by Karnataka	As per MNRE target of 2300 MW by FY 2022	Capacity addition target for solar rooftop for Karnataka as per MNRE • 10 MW by FY16 • 275 MW by FY17 • 290 MW by FY18 • 344 MW by FY19 • 403 MW by FY20 • 460 MW by FY21 • 518 MW by FY22
6.	Capacity addition target under Net and Gross Metering	Equal capacity to come up under Gross and Net Metering	Capacity addition target for solar rooftop under Net/Gross Metering • 5 MW by FY16 • 137 MW by FY17 • 145 MW by FY18 • 172 MW by FY19 • 201 MW by FY20 • 230 MW by FY21 • 259 MW by FY22

[5] Data was used from BESCOMs Regulatory Filings
[6] For analysis purpose, highest slab tariff of LT domestic is considered, as it would not be viable for lower paying consumers to install solar rooftops

3.4 IMPACT ON UTILITY DUE TO ROOFTOP PROJECT COMMISSIONED IN CURRENT FINANCIAL YEAR (FY 2016)

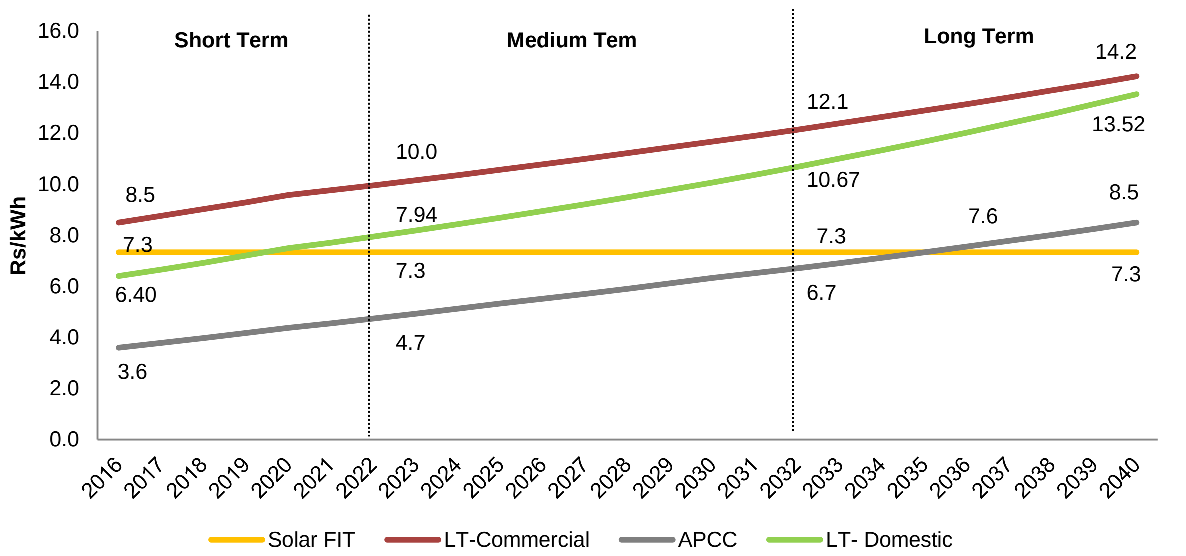
Based on the prevailing capital costs, the capacity utilization factor (CUF) and market interest rates, the LCOE from solar rooftop projects ranges between INR 7-8/kWh depending upon the size of the project. Keeping this figure in mind, any consumer paying a retail tariff of INR 8/ kWh and above, would find solar rooftop system deployment profitable and move to rooftop-based generation using the Net Metering mechanism. Only in a few cases, consumers with lower tariffs (lower than INR 8/ kWh), low power consumption and large rooftop area, will be able to leverage the high solar tariff offered for export of surplus power offered under the Net Metering scheme.

This scenario aims to evaluate the cost the utility pays for procuring solar rooftop power from both Gross Metering-based FIT and Net Metering. One assumption, over and above the ones taken above in Table 6, is that most of the Net Metering capacity would be developed on commercial and industrial consumers premises and is expected to result in contraction of utility power sales and sales revenues from these consumer. Adoption of Net Metering by high paying consumers will lead to the total quantum of cross subsidy being met through a lower number of units and a consequent increase in retail tariffs across the board.

Thus, the higher the number of high paying consumers installing solar rooftops (under the Net Metering mechanism), the higher will be the impact on the utility's revenues and sales. Thus, in order to recover the distribution cost, utilities will have to distribute the costs across a lower number of units and consumers, leading to an increase in the retail tariff for all consumer categories.

Based on the above assumptions, a scenario was developed and simulated which aims to plot the relative impact of one unit of power procured through Net Metering and Gross Metering-based FIT from the time the solar rooftop project has been commissioned in 2015-16 to 2040. The manner in which the hypothesis plays out has been highlighted in the graph (Figure 7).

Figure 7: Comparison of Solar FIT with Retail Tariff for Project Commissioned in FY16



1. Analysis

a. As can be seen from the graph, commercial consumers have a retail tariff of INR 8/kWh and above and would shift to Net Metering from utility procurement as the LCOE from solar rooftops is around INR 7.3-7.5/kWh (depending on the size of the units – however for all practical purposes the solar LCOE will be considered INR 8/kWh from now on). Over and above this, the retail tariff paid by commercial consumers is expected to follow an increasing trend, and the LCOE from solar rooftops will remain flat for the entire lifecycle of the project (25 years). The savings for the consumer for the lifecycle of the solar rooftop project will be the difference between prevailing retail tariff (for that year) and the LCOE from solar rooftops.

b. As high paying consumer categories consumer (industrial and commercial) cross subsidize agriculture and domestic consumers, when they start procuring energy from solar rooftop projects using Net Metering, the utility either has to spread the cross subsidy across a lower number of commercial and industrial consumers (leading to an increase in these tariff for these categories) or raise tariff across all consumer categories including agriculture and domestic.

c. As depicted in Figure 3, for every unit of commercial consumer met through Net Metering, the utility would lose INR 8.5/kWh in FY 2016, which would increase year on year to reach INR 14.2/kWh by FY 2040[7]. However, the utility will also save from lower power procurement costs during this period, starting from INR 3.6/ kWh in FY 2016 and going up to INR 8.5/ kWh by FY 2040. Therefore the benefit from rise in commercial tariffs would be lost to the utility (the difference between the commercial tariff and the APPC).

d. If the utility, instead of implementing Net Metering, would have procured the solar power through a Gross Metering FIT, then the cost of solar procurement would be met by the utility. In the same way as highlighted in point (g), the utility would have saved on power procurement costs during this period, starting from INR 3.6/ kWh in FY 2016 and going up to INR 8.5/ kWh by FY 2040. In this case (Gross Metered FIT), the utility would initially be paying more for the solar power (this cost would have been passed on as a part of the ARR but the differential between the Gross Metered FIT and the power procurement cost would come down with time resulting in savings over the medium to the long term.

2. Result of the above hypothesis

a. To understand the impact of solar rooftop procurement through Gross FIT and Net Metering, the NPV of the loss in revenue for the utility from Net Metering needs to be compared to the higher outflow (payments) from the Gross Metered FIT. As per the above hypothesis, the NPV for solar procurement from Gross Metered FIT comes out 40 percent lower than the NPV from loss of revenues from Net Metering.

[7] Considering the growth rate lower than the historical growth rate of supply tariff due to the mandate of reduction in cross-subsidy.

3. Inferences drawn from the above hypothesis

a. The implementation of Net Metering would reduce utility sales and impact revenue, which will lead to increase in retail tariff across consumer categories in the short, medium and long term.
b. Impact of increase in retail tariff would be more on low paying consumers due to migration of high paying consumers from the utility to Net Metering.
c. Adoption of Gross Metering FIT would not impact utility sales however the procurement cost of utility would tend to increase for short term but would fall in the medium to long term.
d. Over the long term procurement from rooftops would help utilities to save revenue through procurement at lower rate than APPC.
e. The NPV of Gross Metering FIT procurement is 40 percent lower than that from Net Metering procurement.

3.5 IMPACT ON UTILITY DUE TO ROOFTOP PROJECT COMMISSIONED IN FUTURE

The last scenario aimed to evaluate the cost the utility pays for procuring solar rooftop power, from either Gross Metering-based FIT and Net Metering, for one unit of power procured from solar rooftop projects commissioned in FY 2015-16. Using the same set of assumptions for commercial and residential tariffs, power purchase costs and the solar Gross Metered FIT for 2015-16, an analysis was undertaken to simulate the impact of a reducing solar Gross Metered FIT with time and the relative impact of the same on the utility.

The cost of solar PV systems and components has been falling quite consistently and it is expected that this fall will continue in the future as well, leading to a further reduction in the LCOE from solar PV projects. The price discovered under the recent biddings conducted in different states reveals a steep decline in solar tariffs. In recognition of this fact, KERC, under its Solar Tariff Order dated July 30, 2015, re-determined the tariff for large-scale solar projects to INR 6.51/kWh from INR 8.40/kWh (a reduction of 23 percent in tariff in two years).

On similar lines, the cost of solar rooftops has also come down significantly. With technology innovations and improvements in operational efficiency, the cost is expected to come down further in the future. As per the International Energy Agency’s Technology Roadmap for Solar PV, the cost of solar modules will drop to half the current cost within the next 20 years.

The analysis and the scenarios built under this analysis aims to evaluate the change in LCOE and its impact on Gross Metered FIT for solar rooftop projects to be commissioned in future, in order to compare the relative cost of adoption of Gross Metered FIT vis-à-vis Net Metering for a distribution utility.

An analysis of key parameters influencing the cost of solar projects was carried out to develop this hypothesis. Three outlooks were used (Optimistic, Base and Pessimistic) to arrive at the future anticipated solar Cost of Generation (COG), based on the following assumptions:

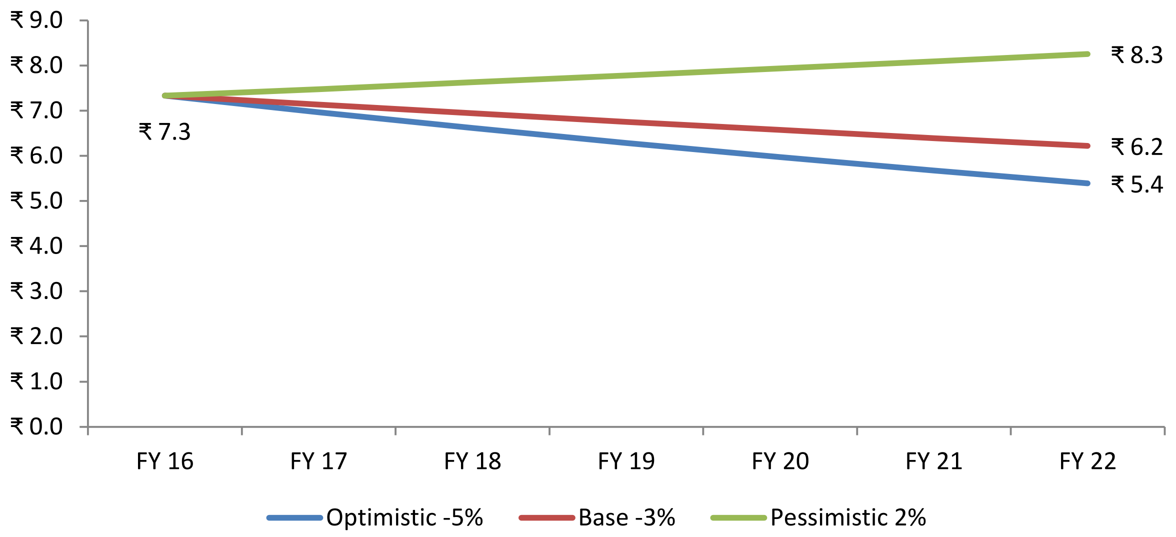
- **Optimistic case:** A five percent reduction in solar COG annually due to a fall in prices through technology innovation with a conducive policy and regulatory environment.

- **Base:** A three percent reduction in solar COG annually due to moderate environment for investors.

- **Pessimistic:** A two percent increase in solar COG annually due to increase in prices because of limited technology innovations and increase in inflation.

The year on year projection of COG over the period FY 2016 to FY 2022 was plotted and has been presented in Figure 8.

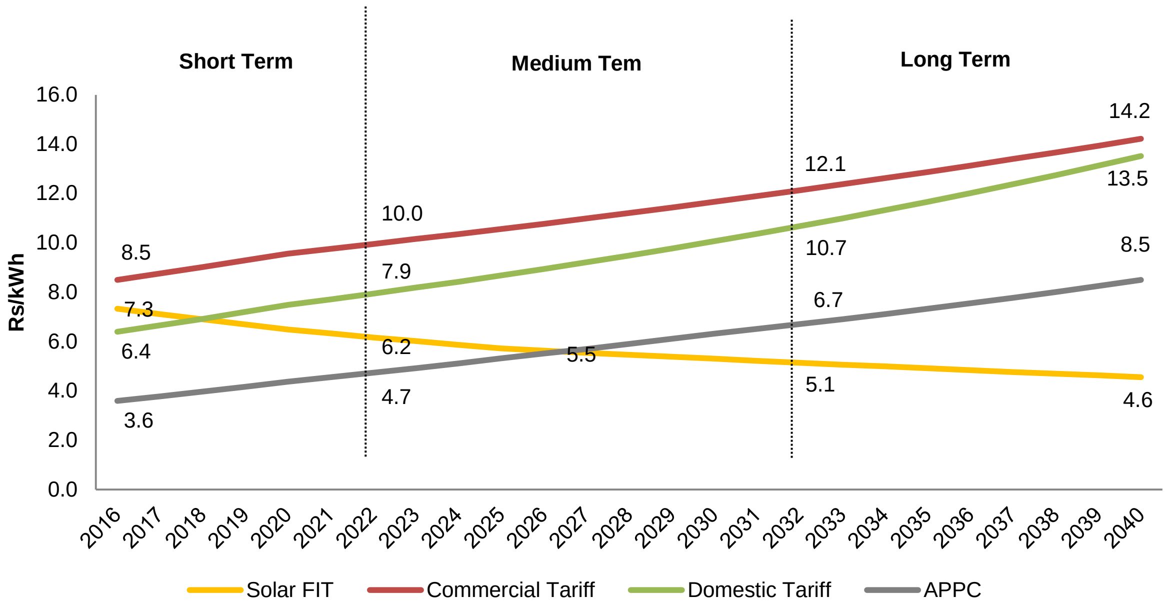
Figure 8: Projection of Solar Cost of Generation



A 'base case' has been used for further analysis, assuming average industry growth, demand of PV modules, and currency risk, etc. Taking this base case, the future value of solar Gross Metered FIT for upcoming projects due to be commissioned over the next 25 years were computed and plotted on a graph.

In order to evaluate the impact of adoption of Gross Metered FIT vs. Net Metering, the comparison of solar FIT for future projects vis-à-vis the change in retail tariffs and APPC for the same time frame was also carried out and plotted on a graph shown in Figure 9.

Figure 9: Comparison of Solar FIT with retail tariff for future projects



4. Analysis

a. As can be seen from Figure 9, the utility will continue to lose high paying consumers and utility sales revenue due to replacement of utility power with solar power in the case of Net Metering. This difference in the savings for the consumer will increase with time as LCOE of solar rooftop power will keep coming down with decrease in the capital costs of solar rooftop projects commissioned in each subsequent year as shown in Figure 9. These higher savings will prompt more and more commercial and industrial consumers to move to Net Metering.

b. On the other hand, if the similar capacity of rooftop were to be implemented by utilities through the FIT-Gross Metering route, they would still face relatively higher procurement costs in the short term but with a decreasing trend as shown in the Figure 9. However most of this higher cost of procurement would be passed on to the consumers as a part of the ARR (all the while ensuring that revenues from high paying consumers are not lost). Further, in the long run the steadily reducing Gross Metered FIT would make solar rooftops more competitive (once it falls below the APPC) for the utilities and allow them to reduce costs.

c. At the same time the utility will also be able to maintain and increase revenues with no loss of consumers/sales and an increase in commercial tariffs.

5. Result of hypothesis

a. In this case, the NPV of procurement of solar power from Gross Metered FIT vis-à-vis Net Metering, there is a significant savings from Gross Metered FIT projects.

6. Inferences drawn from the above hypothesis

Over and above the advantages offered by Gross Metered FIT over Net Metering (highlighted in scenario 1 – Section 3.4) like no reduction in utility sales and revenue impact, impact on cross subsidy and retail tariffs, the reducing nature of solar LCOE will make future projects more attractive for utility procurement using Gross Metered FIT vis-à-vis Net Metering.

3.6 COST TO UTILITIES IN ADOPTION OF NET METERING VIS-À-VIS GROSS METERING

The above two scenarios highlighted the impact of both Gross Metered FIT and Net Metered procurement on the utility power procurement costs based on unit power sales for projects commissioned in FY 2016 and subsequently up to FY 2040. The third scenario now explores the overall impact of the procurement of solar rooftop-based power using both of these two procurement methods—Net Metering and Gross Metered FIT. This analysis and scenario will assist policy makers and distribution utilities plan their targeted capacity addition.

1. Assumption for the hypothesis

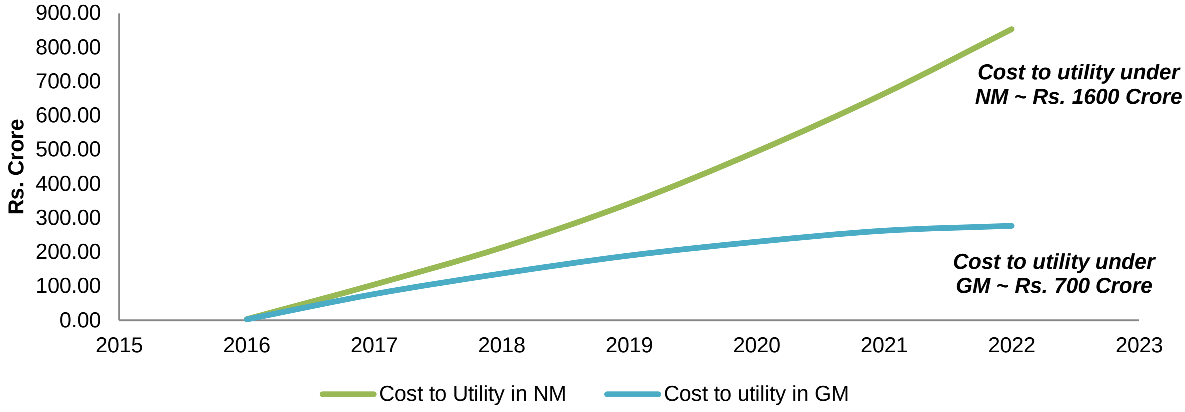
a. For the purpose of hypothesis, it has been assumed that the state would meet its target of 2,300 MW (designated by MNRE) for solar rooftop by 2022. One half of the target would be met through the Net Metering mechanism and the other half under the Gross Metered FIT mechanism as outlined in Table 5.

Table 5: Capacity Addition Targets for Solar Rooftop for Karnataka

Capacity addition target for Karnataka under JNNSM (MW) by 2022								
Particular	**FY16**	**FY17**	**FY18**	**FY19**	**FY20**	**FY21**	**FY22**	**Total**
Target Capacity	10	275	290	344	403	460	518	**2300**
Capacity under NM	5	137	145	172	201	230	259	**1150**
Capacity under GM	5	137	145	172	201	230	259	**1150**

b. The impact on the utility from the adoption of solar rooftops using the Net Metering framework has been computed in terms of the reduction in revenues due to reduced sales resulting. In the case of Gross Metered FIT, the impact on the utility has been computed based on the higher cost of procurement for the amount of energy procured from Gross Metered rooftops at the solar FIT. The result of the scenario has been outlined in Figure 10.

Figure 10: Cost to Utility to adopt Net Metering vis-à-vis Gross Metering



2. Result of the hypothesis

In the specific case of BESCOM, the impact of these two computations shows that the utility will have to bear a cost of INR 700 crore between FY 2016 and FY 2022 if the procurement of solar rooftop is undertaken under the Gross Metered FIT route, while the utility will stand to lose revenues of INR 1600 crore over the course of the same period if these projects are developed using the Net Metering route.

3. Inference drawn from the above hypothesis

As the energy generated through solar rooftops under Net Metering will replace utility power, the cost to the utility will keep on rising with the increase in capacity of solar rooftops under the Net Metering arrangement. However under Gross Metered FIT, the utility's solar power procurement costs will increase initially but this increase will continue to come down till the Gross Metered FIT equals the average cost of power procurement, post which the Gross Metered FIT-based projects will contribute to lowering of the average power procurement costs.

4 RECOMMENDATIONS FOR DETERMINATION OF FIT AND OTHER DESIGN PARAMETERS FOR GROSS METERING

The Gross Metered FIT mechanism is the most widely used mechanism for accelerating the growth of RE deployment across the globe. This approach aims to offer a specified price for every kWh of electricity produced for a certain period ranging from 15-20 years. There are several approaches for computation of FIT; one of the most common approaches is 'cost plus return' approach with the levellised COG. Levellised COG is commonly used in India by central and various state electricity regulators while computing the tariff for different RE technologies.

4.1 APPROACH FOR DETERMINATION OF FIT

There are four basic approaches used in the computation of FIT for different RE technologies:

1. Levellized cost of RE generation plus targeted returns
2. Value of the RE generation either to society or to the utility
3. Fixed price incentive
4. Auction

In India, levellised and auction-based mechanisms are adopted to determine the cost of power. The Central Electricity Regulatory Commission (CERC) and SERCs commonly adopt levellised generic tariff approach in the case of RE projects. The reason for adopting this levellised approach is to encourage investors to promote clean energy generation. Moreover, this approach guarantees stable, long-term returns, access to grid and payment levels based on the costs of RE generation.

A "levellised cost plus return" approach is the most appropriate way to encourage investment and to make it easy for utility consumers to install rooftop solar systems. This approach is also beneficial for utilities as it allows them to pass through the cost of procurement from RE projects in their annual budget and socialize it to all consumers appropriately.

4.2 COMPARISION SUMMARY OF FINANCIAL PARAMETERS

This section provides a comparative summary of different financial parameters used by different SERCs to determine the levellised tariff for solar PV projects and specifically for rooftop solar projects via-a-vis parameters/recommendations given by the PACE-D TA Program.

Table 6: Comparison of financial parameters

Parameters (Units)	GERC	HERC	RERC	KERC	PACE-D
Capital Cost/MW (INR/lakh)	800	680	596	900	**700**
Debt: Equity (Ratio)	70:30				
Debt Repayment Tenure (Years)	10	10	12	10	**10**
Interest on Debt (%)	12.70%	13.75%	13%	12.50%	**11.70%**
Capacity Utilization Factor	19%	19%	20%	19%	**19%**

Deration Factor	1%	0%	0.5%		**0.5%**
Return on Equity (Post tax) (%)	14%	16%			**20% (Pre Tax)**
Discount Factor (%)	10.64%	14.42%	10.89%	13.41%	**11.41%**
Auxiliary consumption (%)	0%				
O & M expenses (INR Lakhs/MW)	10	11	13	18	**10.5**
O & M Escalation p.a. (%)	5.72%				
Interest on Working Capital (%)	11.85%	14%	12.50%	13%	**12.70%**
Depreciation for first 10 years	6%	7%	5.83%	7%	**7%**
Depreciation for next 15 years	2%	1.33%	1.54%	1.33%	**1.33%**

4.3 SUGESTED FIT FOR SOLAR ROOFTOPS

Based on the financial parameters used to determine the COG under a 'levellised cost plus return' approach, the levellised tariff approved by different regulatory commissions is shown in Table 4:

Table 7: Comparison of Levellised tariff by difference Regulatory Commissions

Parameters	**Units**	**GERC**	**RERC**	**HERC**	**KERC**
Category of Project		Rooftop	Rooftop	Rooftop	Rooftop
Capital Cost	(INR/kWp)	80	59.6	68.0	90.0
Tariff	(INR/kWh)	**8.42**	**6.74**	**7.19**	**9.56**

All SERCs have approved a single tariff for solar PV rooftops, even though the capital costs of systems vary with size/capacity of the system, which in turn impact the FIT. Considering this point, the Gujarat Electricity Regulatory Commission (GERC) in its latest Tariff Order has determined different tariffs for different capacity systems (small kW-scale systems (1 kW to 100 kW) and large-scale (100 kW to 1 MW) rooftop projects). Following the same strategy, it is recommended that the FIT for solar PV rooftop projects should vary with the capacity of the rooftop project. Using this approach, the proposed tariffs for different system sizes are shown in Table 8.

Table 8: PACE-D Proposed FIT for Solar Rooftops

Parameters	**Units**	**Levellised Tariff for different Capacity**		
System Size	(kWp)	1-10	Above 10 to 100	Above 100 to 500 kW[8]
Capital Cost	(INR /kWp)	**75,000**	**70,000**	**65,000**
Feed-In-Tariff	(INR./kWh)	**7.85**	**7.32**	**6.80**

4.4 DESIGN PARAMETERS FOR GROSS METERING

The concept of Gross Metering is not new in India, though it has not been adopted as much as Net Metering across the country. Recent regulatory development by various SERCs, have brought about a clearer understanding of the various design parameters used to implement Net Metering-based solar rooftops programs. However, to implement Gross

[8] It is recommended that Rooftop projects above 500 kW should be treated as large scale solar projects and hence tariff determined for MW scale solar projects shall be applicable on rooftop projects above 500 kW

Metering, there are some key parameters that need to be redefined, bearing in mind the scope and applicability of a Gross Metering framework. This section will identify and highlight key design parameters, which need to be deliberated to implement a Gross Metering framework in Karnataka.

4.4.1 Eligible Consumer

Defining a set of eligible consumers is the first key step towards developing any program. Once the consumer category/categories eligible from Gross Metering are defined, then deciding other key parameters such as project capacity, FIT, additional charges, etc. becomes relatively easier. As Gross Metering framework unlike Net Metering is linked with generation of solar power from rooftops, it makes installing rooftops feasible for all consumer categories. However the solar FIT for rooftop projects determines the actual profitability for any individual consumer category. For a particular consumer category, if the FIT for rooftops is higher than the retail supply tariff then Gross Metering is beneficial, otherwise Net Metering is more beneficial for consumers under that particular consumer category.

Ideally, a Gross Metering mechanism should be adopted to encourage the subsidized consumer (agriculture, domestic, and government institutes, etc.) categories to install solar rooftops. However, it should also be available for all consumer sections so that consumers can make their choice between the two i.e. Gross Metering and Net Metering as per their energy consumption and retail supply tariff.

It is recommended that all (non-defaulting) consumers connected to the utility grid should be eligible to install solar rooftops under the Gross Metering mechanism.

4.4.2 Project Capacity

The capacity of an individual project under the Gross Metered solar rooftop systems is another critical parameter from the point of view of network safety and quality of power. It has always been a complex issue for implementers as the project capacity is directly linked to project level generation, which in turn is linked to feeding of solar power into the grid. To determine the project capacity, the following parameters need to be studied:

a. The voltage level of the existing incoming feeder
b. Incoming feeder capacity
c. Installed capacity of the distribution transformer
d. Existing protection circuits on the incoming feeder
e. Connected load of eligible consumer
f. Maximum permissible injection in a single phase
g. Maximum permissible injection (reverse flow) to distribution transformer, etc.

Upon studying these technical parameters, the project capacity should be defined. In order to maintain grid safety, the minimum capacity and the maximum capacity of the project under Gross Metering should be 1 kW to 1 MW respectively. The allotment of capacity shall be done on first come first serve basis till the cumulative capacity at any particular feeder reaches 30 percent of the available capacity of distribution transformer. The interconnection to LT grid for the purpose of Gross Metering arrangement shall be governed as per the Central Electricity Authority's Regulations for distributed generation from renewable sources.

- ***It is recommended that the minimum capacity and the maximum capacity of the project under Gross Metering should be 1 kW to 1 MW respectively.***
- ***The allotment of capacity shall be done on first come first serve basis till the cumulative capacity at any particular feeder reaches 30 percent of the available capacity of distribution transformer.***

4.4.3 Feed In Tariff

FIT for solar rooftops under the Gross Metering mechanism is the most crucial parameter for both investor and utility. In India, CERC and SERCs compute single part tariff as the bench-mark for commercial settlement of power from rooftops and large-scale solar projects. Uniform tariff approach is appropriate for large-scale solar projects but for small-scale solar projects, uniform tariff may not be an appropriate approach, as the size/capacity of the project has a great influence on the capital, performance and operating costs of the rooftop PV project.

As the cost of rooftop system varies with size, the levellised FIT for 25 years of project life should be determined based on system size/capacity of the project.

1. ***Cost of solar rooftop systems varies significantly with size of the system. Therefore it is suggested to determination FIT for a range of capacity of rooftop project in three capacity range (viz. up to 10 kW, 10 to 100 kW, and 100 to 500 kW).***
2. ***For projects above 500 kW, tariff determined for large MW-scale solar projects should be applied (As per KERC Solar Tariff Order, the tariff for MW-Scale solar projects is INR. 6.51/kWh).***
3. ***For computation of FIT for Gross Metering, it is recommended that KERC adopt a single part levellized tariff for the 25 year of project life.***

4.4.4 Applicability of RPO/REC

Energy generated from solar rooftops is eligible for fulfilment of RPO of obligated entities identified under the RPO regulation by KERC. Obligated entities can fulfil their RPOs by procuring power from solar rooftops. Solar power from rooftops is also eligible for generating environmental credits (Renewable Energy Certificates (RECs)), however, if the investor/roof owner is not an obligated entity then the benefit of generating clean energy can be passed on to the distribution licensee serving that consumer.

Due to the small size of rooftop system, claiming RECs on solar generation is not a viable option for investors (due to registration, accreditation charges). Therefore, it is difficult for small-scale solar rooftop projects to participate under the REC mechanism. The most favorable condition for rooftop solar power generator is to sell the solar power to distribution utility on FIT.

The PACE-D TA Program therefore recommends that solar rooftop projects under the Gross Metering mechanism should not be allowed to participate under the REC mechanism. The energy generated from solar rooftops should qualify for fulfilling the RPO obligation of rooftop owner.

It is recommended that (a) the Gross Metered solar rooftop projects should not be allowed to participate under the REC mechanism, and (b) the energy generated from solar rooftop projects should qualify for fulfilling the RPO of obligated entity/distribution licensee.

4.4.5 Applicability of Other Charges

Third party lease is an attractive and widely adopted business model used for installation of solar rooftops. In this model, roof owner leases its roof to a third party for generation of solar power through rooftop. Power generated through such rooftop projects can either be used for self-consumption by the third party at any other premise or can be sold to open access consumer using the distribution network of the licensee. In this case, third party is entitled to pay wheeling, banking and cross subsidy surcharges.

In order to encourage third party business model, most of the SERCs under their Net Metering regulations have exempted the applicability of open access charges. Hence, the Program recommends that solar rooftops installed under the Gross Metering arrangement will also be exempted from paying such additional charges.

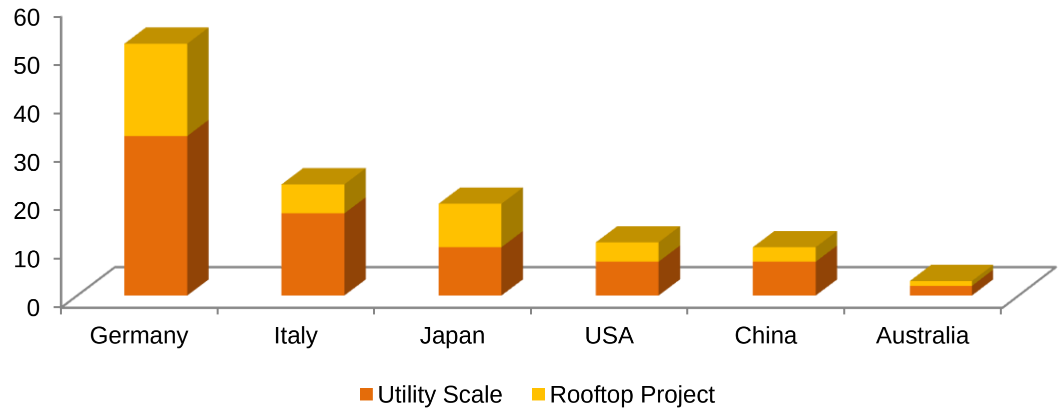
In order to promote solar rooftops and investment by third party, it is recommended that solar rooftops installed under the Gross Metering arrangement will be exempted from wheeling, banking and cross subsidy surcharge.

ANNEXES

ANNEXURE -1 (INTERNATIONAL EXPERIENCE)

Solar rooftops can evolve rapidly with the adoption of innovative business models and a supportive policy/regulatory framework. Countries at the forefront of solar PV installation have adopted both innovative business models and supporting policies to develop their solar rooftop capacities. Figure 11 depicts the capacity (in GW) of solar PV installed by leading countries across the globe.

Figure 11: Leading Countries in Solar Capacity (GW)



Even though a majority of the solar capacity was generated through large-scale solar projects, the associated benefits accrued were technology advancement and a greater understanding of the impact of policy and regulatory support in influencing the growth of the solar power sector. As a result, the cost of PV modules and other key equipment fell drastically, thereby improving the viability of small-scale solar projects for small and medium scale investors. In addition, supporting policies were also introduced aimed at reducing solar power tariffs.

Table 9 lists several promotional mechanisms adopted by leading countries to accelerate the growth of solar rooftops in their respective country.

Table 9: Schemes Adopted for Promotion of Solar Rooftops in Different Countries

Promotional Scheme	Australia	Germany	Italy	Japan	U.S.	India
Capital subsidy						
Renewable Purchase Obligation						
Tax Incentives/Tax credits						
Generation incentive						
Green electricity schemes						
PV specific green electricity scheme						
Mandatory green buildings						

Some of the most common instruments adopted worldwide to promote solar rooftops include: capital subsidy, RPO, and tax incentives. In addition to these, FITs have also been widely used to promote solar rooftops. Countries like Germany, Italy, Japan, France, Spain, etc. used the FIT instrument (Gross Metering) to promote their solar rooftops program.

FIT is the most widely used policy instrument used to accelerate the growth of RE deployment across the world, and in India. FIT accounts for a much larger share of RE development than either tax incentives or renewable portfolio standard (RPS) policies (REN21 2009). Moreover, the FIT instrument brings the flexibility of revision at later stages based on the market value of energy. In total, FITs are responsible for approximately 75 percent of global PV and 45 percent of global wind deployment (Deutsche Bank 2010).

Germany and Japan have been led the way in solar deployment. In 1999, Germany, after the success of a 1,000 solar rooftops program, launched another program which was ten times larger than the previous program i.e. a 100,000 rooftops program. The main attraction of this program included ten years concessional loans with attractive FIT. This provided a much needed push to individual households to take part in the program. This effort created the effective market pull required for the program, which enabled Germany to achieve the targets a year ahead of schedule, in 2003. After this Germany came out with a National Feed in Law (2000) and a New Feed in Law (2004) continuing with the FIT policy. This made PV cost competitive with other sources of energy and in 2011 when solar PV reached grid parity, FITs were modified to volume-based digression to encourage captive consumption. The Japanese rooftop market, on the other hand, is a perfect example of coordinated efforts from policy makers and market players. Research and development activities were undertaken on the supply side while, while on the demand side capital subsidies and self-owned Net Metering schemes encouraged households to adopt solar rooftop systems. The high cost of retail power also encouraged the installation of these systems. In 1994, Capital support through a subsidy program for residential PV systems was started, wherein subsidies were provided to individual roof owners and developers of housing complexes to install solar rooftop systems. The subsidy program was withdrawn in 2005.

In 2007, Japan introduced a new energy law to drive research and development for the next generation of PV systems. But in order to continue the pace of development, in 2009 Japan reintroduced its subsidy program once more. In July 2012, Japan implemented a new FIT system under the Act on Special Measures Concerning the Procurement of Renewable Energy by Operators of Electric Utilities. Under the terms of the FIT system, power utilities must purchase electricity at a fixed price for a given period from RE sources, including solar, wind, hydro, geothermal, biomass, and others, generated by certified power-generating facilities. This program contributed to the large-scale proliferation of solar rooftop in Japan.

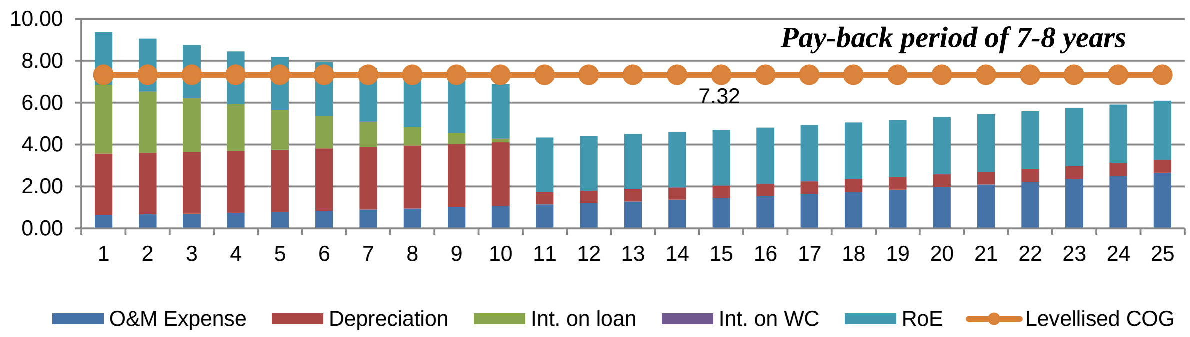
ANNEXURE -2 (BENEFIT FOR INVESOTERS)

1. Stable, long-term assured returns for Investors

The benefit of participating in Gross Metering scheme is long term assured returns for the investors. In order to quantify the returns for investors in rooftop system, the Program has undertaken the analysis of cash flow considering levellised COG over useful life for solar rooftop projects. The set of assumptions considered for developing COG model are summarized under Annexure 9.2.

As the capital cost of solar rooftop project varies according to the size of the project. The Program has done the analysis of rooftop project under three categories i.e. below 10kW, from 11 to 100 kW and more than 100 kW. On the basis of assumptions, LCOE for solar rooftop project has been derived and plotted on the graph.

Figure 12: COG of Solar Rooftop Project (for solar rooftop systems <10kWp)



The results show that the levellised COG for a typical solar rooftop system (of capacity above 10 kWp) is INR 7.35/kWh (for 25 years of plant life) and the payback period for investor is in the range of seven-eight years. This computation is done without any capital support from the state/central government. However, there is also a 30 percent capital subsidy available for rooftop projects from MNRE, which could further improve the profitability of investors in rooftop projects. Detailed analysis of COG of solar rooftops and other parameters used for determination of consumer benefits are covered in next chapter.

2. Ability to meet RPO targets

As per KERC (Procurement of Energy from Renewable Sources) Regulations, 2012, the obligated entities--distribution utilities, open access consumers, and captive consumers--under the RPO framework are required to meet a certain percentage of their consumption from RE sources. As per the existing regulations, distribution utilities are also required to procure 0.25 percent of their consumption though solar power, while open access and captive consumers are free to meet their RPO quota through purchase of five percent of their consumption from any RE source. All these obligated entities earmark significant portion of their revenue for fulfilment of their RPO targets. As the energy procured from solar rooftops is also eligible for RPO fulfilment, obligated entities can also meet their solar RPO targets through solar rooftops in addition to meeting their energy demand.

ANNEXURE- 3 (EVALUATION OF FINANCIAL PARAMETERS FOR DETERMINATION OF FIT)

To determination the FIT for a solar rooftop project, various financial parameters such as capital cost, return on equity, depreciation, etc. need to be evaluated. This section will discuss all these financial parameters for determining the FIT of solar rooftop project under the Gross Metering framework.

1. Capital cost

Capital cost is one of the most important parameter used for computation of tariff for any power project. Capital cost of a project largely varies in accordance with the scale of the project. As solar rooftop systems are largely small-scale projects, their cost is relatively higher than large-scale solar projects. Different states have adopted different approaches to determine the capital cost of solar rooftop projects. As there is no additional requirement of land, some SERCs such as Rajasthan ERC consider same capital cost for solar rooftops and large-scale solar projects, while Karnataka ERC allows additional capital cost for rooftop projects considering their small size. Further, HERC considers cost for solar rooftop projects lower than the MW-scale ground-mounted projects as there is no land cost involved in rooftop projects. To quickly analyze the cost approved by difference SERCs, a comparative analysis of capital cost for rooftop solar project is done and summarized in Table 3.

Table 10: Capital Cost Comparison of Different SERCs for Solar Rooftop Projects

Parameters	GERC	RERC	HERC	KERC
Issuance Date	17.08.15	19.06.15	13.08.14	10.10.13
Status	Final	Final	Final	Final
Capital Cost (INR Lakh/MW)				
PV Modules	350	326.76	396	491
Land Cost	00	7.30	0	0
Civil and General Works	100	50	284	409
Mounting Structures	114	50		
Power Conditioning Unit	136	45		
Cables and Transformers	50	55		
Preliminary and Pre-operative expenses IDC, etc.	50	47.74		
Connectivity Charges	00	15		
Total	800	596.80	680	900

The KERC Solar Tariff Order dated October 10, 2013 considers the capital cost of rooftop projects as INR 90/Wp. however, since then there has been significant reduction in the cost of PV modules and other key equipment. In pursuance to the same, KERC has issued a new Tariff Order dated July 30, 2015 for re-determined of capital cost for MW-scale solar projects. But to promote solar rooftops sector, KERC continued the capital cost of solar rooftop as per the previous tariff order i.e. INR 90/Wp.

In order to estimate the realistic cost of solar rooftop system, the best approach is market-based approach. Based on the discussion with various stakeholders including market experts, developers, and system installers, the PACE-D TA Program has estimated the benchmark capital cost of solar rooftop system. The recommended capital cost for different scale of the projects is shown in Table 8.

Table 11: Capital Cost of Solar Rooftops for Different Capacity (INR/kW)

Rooftop Capacity	Capital Cost (INR/kW)
1 - 10 kW	75,000
Above 10 to100 kWp	70,500
Above 100 kWp	65,000

2. Debt Equity Ratio

Solar rooftop projects are generally small-scale projects, which may not be stipulated to comply with the debt equity ratio. However, for third party and for large-scale installations, the investor is required to evaluating appropriate debt equity structure for its investment. **The Program recommends adopting the KERC approach of debt equity ratio of 70:30 while determining tariff for solar rooftop projects.**

3. Tenure of Debt

KERC, in its latest tariff order, has considered tenure of 12 years as the normative tenure for debt repayment. Consideration of a longer period for debt repayment will increase the interest burden on the investor resulting in higher FIT. Hence, **the Program recommends debt tenure of 10 years for rooftop project.**

4. Interest on Term Loan

CERC while determining the tariff for various RE technologies for FY 15-16, considered the State Bank of India (SBI) base rate and added 300 basis points on to it, considering higher risk factor involved in financing of solar projects. Similarly, KERC has also determined interest rate on prevailing SBI base rate plus 280 basis points for rooftop projects.

While understanding the need to promote solar rooftops and on the request of Ministry of Finance, many public sector banks considered loan for solar rooftops as a part of home loan/home improvement loan, which is currently in the range of ten percent. With this development, access to loan for solar rooftop installation (below 500 kW) will be easier for the consumers. **Hence, the Program recommends that the interest rate for solar rooftop projects should be 200 basis points higher than SBI base rate i.e. 11.70 percent.**

5. Operation & Maintenance Expense

The O&M cost for solar projects is usually considered as 1-1.5 percent of the capital cost. The cost of maintaining small-scale rooftop solar projects would be relatively higher than large-scale solar projects. Considering this, KERC has determined the O&M cost for solar rooftops as two percent of the capital cost, which is slightly higher as per market standards. **Thus, the Program recommends that O&M expense for solar rooftop projects to be 1.5 percent of the capital cost with an annual escalation of 5.72 percent.**

6. Working Capital

For the purpose of calculating working capital for solar projects, the CERC has consider O&M expenses of one month with 15 percent of O&M expense as maintenance of spares and receivables of two months from debtors. While KERC has only consider receivables of two months as working capital considering payment security mechanism in the form of Letter of Credit available with solar generator to recover his monthly claims of fixed and energy charges. **The working capital for solar rooftop projects should be equivalent to two months receivables from debtors.**

7. Interest on Working Capital

Interest on working capital is a key parameter used for determining tariff. For determination of interest on the working capital, CERC has adopted prevailing SBI base rate with additional 300 basis points considering the fact that financing of working capital requirements on a short term basis, would be at a marginally higher rate of interest from term loan. Hence, the Commission decided to allow 13.50 percent towards interest on working capital for different RE technologies. Similarly KERC has adopted the similar approach and approved 13 percent interest on working capital for solar projects. **The Program recommends that interest on working capital to be 300 basis points higher than the current base rate of SBI i.e. 12.70 percent.**

8. Return on Equity (ROE)

Return on equity is the fixed return that an investor would get on his equity investment. For the purpose of tariff calculation, CERC has considered pre-tax ROE of 20 percent per annum for first 10 years and 24 percent per annum for remaining period of plant life. While, KERC has considered flat ROE of 16 percent per annum for entire project life of 25 years and to allow actual tax as pass through. The PACE-D TA Program appreciate the state commissions' view but tax pass through for such small systems with huge volumes may not be an appropriate approach, thus **The Program recommends pre-tax ROE of 20 percent for rooftop projects for the entire 25 years of plant life.**

9. Depreciation

Central commission has considered 'Differential Depreciation Approach' per annum over loan period and beyond loan tenure over useful life of the project on 'Straight Line Method'. The depreciation rate for the first 12 years of the tariff period is 5.83 percent per annum and the remaining depreciation shall be spread over the remaining useful life of the project from 13th year onwards i.e. at 1.54 percent. KERC has also followed the same approach under the recent tariff order for solar projects. The differential depreciation approach is appropriate as it address the debt service requirement. Considering the loan tenure of 10 years, **the Program recommends that the depreciation rate for loan tenure should be seven percent and for the rest of the plant life it should be 1.33 percent p.a.**

10. Discount Factor

Discount factor is another key parameter used to calculate time value of money. For computing the discount rate, both CERC and KERC have adopted similar approach of "weighted average cost of capital (WACC).Hence, if a similar approach is adopted while computing discount factor with debt equity ratio of 70:30, interest on term loan as 11.70 percent and ROE of 20 percent for 25 years of plant life then the discount rate comes out to be 11.41 percent. Thus, **the Program recommends that the discount factor for computing levellised tariff for 25 years of solar rooftop should be 11.41 percent.**

11. Capacity Utilization Factor

Capacity utilization factor considered by different SERCs while computing tariff for rooftop projects varies in the range of 19-20 percent depending upon the available solar potential in different state. KERC while determining tariff for solar rooftops has considered 19 percent CUF same as of large-scale solar projects. Similar approach is adopted and **CUF of 19 percent has been considered while determining FIT for solar rooftop projects**

12. Auxiliary Consumption

In solar PV projects, there is no significant consumption in terms for meeting its auxiliary requirements hence both CERC and KERC has adopted zero auxiliary consumption for solar projects.

13. Deration Factor

As the solar panel gets old, its conversion efficiency reduces. Keeping this in consideration, many SERCs including KERC consider the deration factor. As per the latest Tariff Order of KERC, deration factor of 0.5 percent after forth year has been considered while computing tariff for large-scale solar projects. **The Program appreciates the Commission's view on it and recommends the same for solar rooftops as well i.e. 0.5 percent deration after four years.**

4.1 Comparison Summary of Financial Parameters

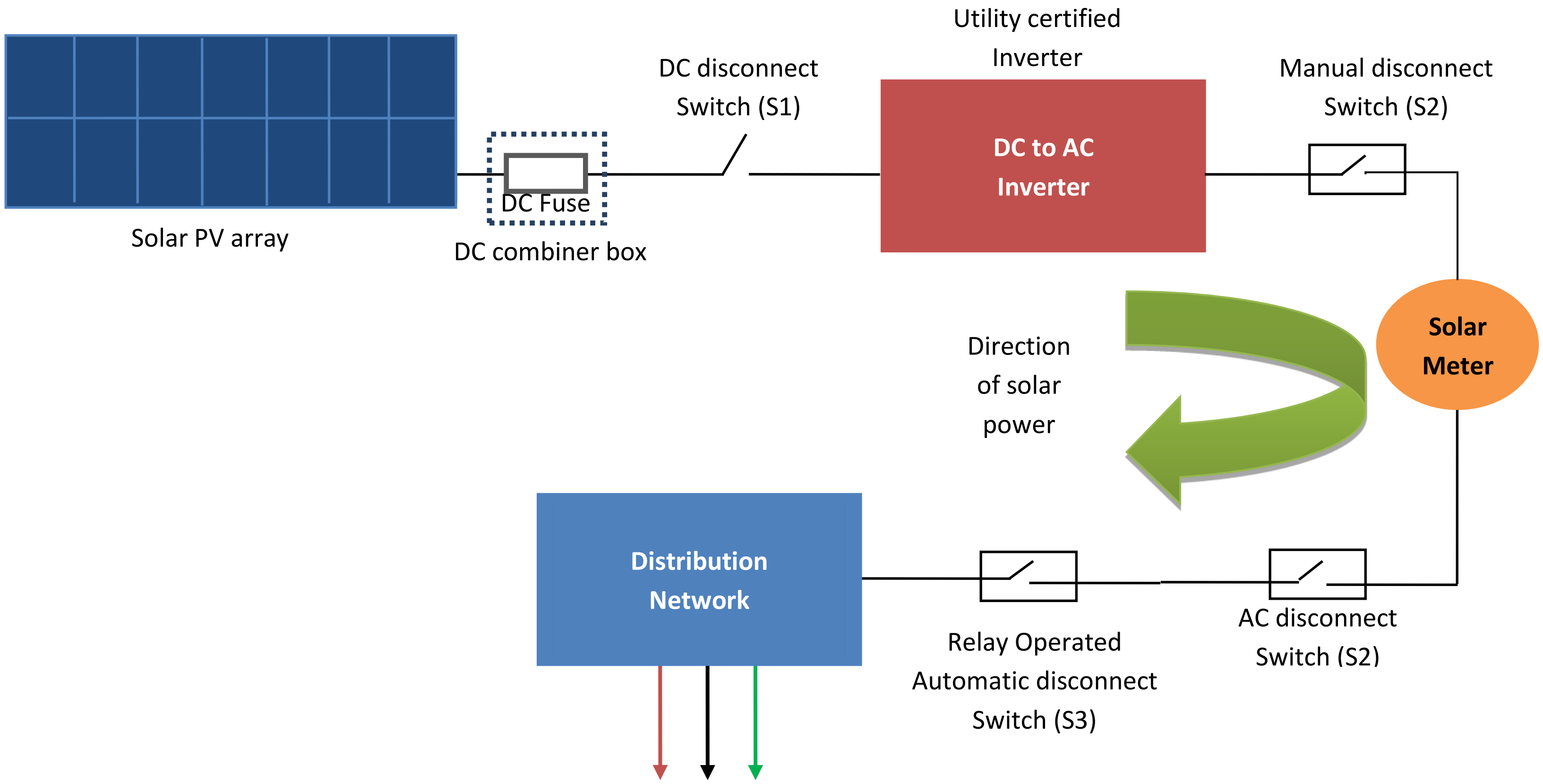
This section provides a comparative summary of different financial parameters used by different SERCs for determination of levellised tariff of solar PV projects and specifically for solar rooftop projects vis-à-vis parameters recommendations made by the PACE-D TA Program.

Table 12: Comparison of financial parameters

Parameters (Units)	GERC	HERC	RERC	KERC	PACE-D
Capital Cost/MW (INR/lakh)	800	680	596	900	**750**
Debt: Equity (Ratio)	70:30				
Debt Repayment Tenure (Years)	10	10	12	10	**10**
Interest on Debt (%)	12.70%	13.75%	13%	12.50%	**11.70%**
Capacity Utilization Factor	19%	19%	20%	19%	**19%**
Deration Factor	1%	0%	0.5%		**0.5%**
Return on Equity (Post tax) (%)	14%	16%			**20% (Pre Tax)**
Discount Factor (%)	10.64%	14.42%	10.89%	13.41%	**11.41%**

O & M expenses (INR Lakhs/MW)	10	11	13	18	**10.5**
O & M Escalation p.a. (%)	5.72%				
Interest on Working Capital (%)	11.85%	14%	12.50%	13%	**12.70%**
Depreciation for first 10 years	6%	7%	5.83%	7%	**7%**
Depreciation for next 15 years	2%	1.33%	1.54%	1.33%	**1.33%**

ANNEXURE -4 (SINGLE LINE DIAGRAM FOR GROSS METERED SOLAR ROOFTOPS)



ANNEXURE -5 (ASSUMPTIONS FOR COMPUTATION OF GROSS METERING BENEFITS)

In order to compute benefits of Gross Metering for utilities, the PACE-D TA Program has considered the following assumptions:

- For the purpose of analysis, that Karnataka will successfully achieve the targets allocated by MNRE, and capacity addition under the solar rooftop category will take place as per the targets shown below:
-

Target allocated to Karnataka under JNNSM								
Particular	FY16	FY17	FY18	FY19	FY20	FY21	FY22	Total
Capacity addition (MW)	**10**	**275**	**290**	**344**	**403**	**460**	**518**	**2300**

- During the period, There will be equal capacity addition through Net Metering and Gross Metering
- Capacity allocation under different consumer categories for Net Metering

Capacity addition under Net Metering		
Commercial Consumer	% of total Capacity under NM	90%
Domestic Consumer		10%
Export to grid	% of total Generation	10%

- Capacity addition under Gross Metering

Capacity addition under Gross Metering		
Commercial Consumer	% of total Capacity under GM	50%
Domestic Consumer		50%
Export to grid	% of total Generation	100%

- Solar FIT – INR 7.3/kWh for FY 2015-16 with decrease of 2 percent on YOY basis
- Escalation on retail tariff – Commercial (2 percent), Domestic (3 percent), APPC (3.5 percent)

ANNEXURE -6 (ASSUMPTIONS FOR DETERMINING SOLAR FEED-IN-TARIFF)

Sr. No	Head	Reference	Capacity below 10 kWp	Capacity above 10 to 100 kWp	Capacity above 100 kWp
1.	Capital Cost (Rs/kWh)	PACE-D research	75,000	70,000	65,000
2.	Debt: Equity Ratio	KERC	70:30		
3.	Debt Repayment	KERC	10 Years		
4.	Moratorium Period	KERC	0 Years		
5.	Interest Rate	PACE-D research	11.70%		
6.	Capacity Utilization Factor	KERC	19%		
7.	Auxiliary Consumption	PACE-D Research	0%		
8.	Deration Factor	KERC	0.50% (after 4th Year)		
9.	Return on Equity	PACE-D research	20% (pre-tax)		
10.	Discount Rate	WACC	11.70%		
11.	O & M expenses	PACE-D research	1.5% of Capital Cost		
12.	O & M Escalation	KERC	5.72%		
13.	Working Capital	KERC	2 Month receivables		
14.	Interest on Working Capital	PACE-D research	12.70%		
15.	Depreciation for first 10 years	PACE-D research	7%		
16.	Depreciation for next 15 years	PACE-D research	1.33%		

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