FORUM OF REGULATORS

Evolving Net-metering Model Regulation for rooftop based solar PV projects

FORUM OF REGULATORS WORKING GROUP REPORT

Energy Accounting, Commercial and Technical Arrangements

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1 Introduction

There are two different types of metering arrangements that can be used for development of rooftop solar PV projects: gross and net metering. Globally, both net-metering and gross metering concepts have been implemented.

- In a gross metering arrangement, the entire energy generated by rooftop solar PV system is fed directly into the electrical grid and the system owner is benefited by feed-in-tariff based on sale of power to the utility.
- In a net-metering arrangement, the focus is primarily on self-consumption of electricity generation by the consumer. The excess/surplus is either sold to or banked with the local utility. Net metering arrangements, thus, combine elements of captive consumption and exchange of power with the utility.

A brief comparison of the gross metering and net metering arrangements is provided in Annexure 1. There are several incentive arrangements which have been implemented for the promotion of these metering arrangements. While Feed in Tariff (FiT) mechanism is linked to gross metering, fiscal incentives such as capital subsidy, tax credits etc. are generally linked to net metering.

Germany is the most well-known example of a successful propagation of the gross metering concept, in which the rooftop solar projects sell electricity directly to the local grid at a declared FiT. Japan and several states in the United States, on the other hand, have implemented net-metering concept where the energy is self-consumed before the surplus is sold to the grid. The recent trend in Japan has been to progressively move towards a gross metering model with FiT mechanism.

Table 1 provides an overview of the metering arrangements, ownership pattern and incentive structure for the rooftop solar PV projects which is being followed by various geographies across the world.

Table 1 : Global Rooftop Solar PV Models

Country	Solar Rooftop PV Model	Type	Incentives
Germany	Gross Metering	Self-Owned and Third Party Owned	• Feed-in-Tariff
Japan	Net Metering and Gross Metering	Self-Owned and Third Party Owned	• Capital Subsidy
Colorado, USA	Net Metering	Self-owned or third party owned	• Capital Subsidy (Rebates) • Sales Tax exemption available to owners • Income Tax Credit • Production Tax Credits
California, USA	Net Metering	Self-owned or third party owned	• Property Tax exemption • California Solar Initiative – fully/partially subsidized PV systems for low income households • Performance Based Incentives to builders
New Jersey, USA	Net Metering	Self-owned or third party owned	• Sales Tax exemptions – Purchaser fills out a form instead to paying the tax • Property Tax Incentive

Source: European PV Industrial Association, Deloitte Research

International experience in evolution of rooftop solar segment shows that there is very high reliance on the policy and regulatory framework which can support the development and propagation of business models. Gross and Net metering models require distinct and customized policy support from the Government for various benefits, incentives and subsidy mechanisms. Similarly, the ownership patterns, intermediaries and financing mechanisms get shaped to a large extent by the regulatory mechanism in place across various countries.

1.1 Rooftop Solar PV experience in India

The National Action Plan for Climate Change (NAPCC) released in June 2008 outlines a national strategy that aims to enable the country to adapt to climate change and enhance the ecological sustainability of India's development path. As a part of NAPCC, the Government of India launched the Jawaharlal Nehru National Solar Mission ("JNNSM" or "National Solar Mission") which inter alia targets 20 GW of grid connected solar capacity by year 2022.

The JNNSM Phase I (2010-13) implementation has witnessed appreciable scaling up of solar capacities in India in a short time span of three years. In addition, several state governments have declared their own state level solar policies to promote solar generation. As a result, the installed capacity of solar energy has increased from mere 2 MW in 2008-09 to more than 1,686 MW by March 2013[1]. The aggressive participation from the private sector in the grid-connected segment under Phase I of JNNSM has already resulted in lowering of solar tariffs for both the solar thermal and solar PV projects.

Apart from promoting the ground mounted solar PV projects, the JNNSM also has a mandate to encourage the rooftop solar segment. Under Phase I of JNNSM, a separate scheme called 'Rooftop PV and Small Scale Solar Generation Program (RPSSGP)' was implemented for developing solar PV projects with maximum capacity of 2 MW as rooftop or small scale ground mounted solar projects. A total of 100 MW capacities of projects under this program were to be installed and connected at a level below 33 KV and same GBI linked tariff was provided for both the categories of project. While more than 90 MW of projects have been installed under this scheme, it is observed that this scheme garnered enthusiastic responses primarily in the ground-mounted segment, while it received almost negligible responses in the rooftop segment. Similarly, the focus under most state solar policies/ programs has been on the ground mounted grid-connected solar PV projects.

Although the JNNSM and state solar policies have been successful in kick-starting the development of utility scale solar power projects in India, the small scale rooftop solar segment remains in a nascent stage of development in India.

The inherent benefits of the rooftop solar projects have been well recognized by the policy makers and the initial push for the development of these projects has started in India. The rooftop based solar projects installations have several advantages over the ground mounted projects from the following perspectives.

- Rooftop solar PV is connected to the distribution system and ingestion of power is into a load center thereby avoiding transmission and distribution (T&D) losses incurred in the case of centralized, larger plants. This is a strong rationale for rooftop solar projects in India, where the national average of T&D losses hover at close to 30%[2].
- The ease of connectivity with the consumer premises, particularly in net-metered arrangement, also provides an opportunity for utilizing the rooftop solar for captive

[1] Ministry of New and Renewable Energy (MNRE) website
[2] Power Finance Corporation Report on "Performance of State Power Utilities for the Years 2007-08 to 1009-10"

consumption even when the grid is not available. This is thus relevant in abating the consumption of diesel / liquid fossil fuel, which dominates as the choice for back-up power across most parts of India.

- Rooftop solar projects also have the potential to create economic value for unutilized rooftops & are not faced with the issues of land availability, applicable for ground-mounted projects. The self-replication potential is thus very high for rooftop projects.

Several initiatives have been taken recently by the central and state governments for promoting rooftop solar projects. The key consideration behind these projects is to develop a commercial framework for the self-replication of rooftop solar projects. The key features of the key policies are tabulated below:

Table 2 : Select state rooftop solar policies/schemes

Parameter	Central Government	Gujarat	Karnataka	Tamil Nadu	Andhra Pradesh
Type	Grid connected	Grid connected	Grid connected	Grid connected	Grid connected
Capacity Target	10 MWp	5 MW in Gandhinagar[3]	1.3 MWp	350 MWp	-
Off Taker	-	Utility	Utility	Consumer	Consumer
Incentives for Rooftop owner	-	Green Incentive	Lease Rental	-	-
Metering	Gross/Net	Gross	Gross	Net	Net

Source: Respective state solar policies, Deloitte Research

Solar PV technology is at the stage of commercial maturity in India with several installations having demonstrated the techno-commercial feasibility of such projects over the past few years. Unfortunately, most of these installations operate on a captive basis. Widespread propagation has lagged primarily on account of a lack of clarity in policy and regulatory framework for rooftop solar PV projects. The key barriers to large-scale adoption of this segment remain in the country include the following.

- Non availability of clearly defined technical standards and guidelines for grid connectivity, metering, safety and security, etc
- Lack of energy accounting and commercial settlement guidelines for grid connected solar rooftop projects
- Lack of clarity on applicability of charges relating to wheeling, open access, cross-subsidy, etc.

1.2 Context of developing net metering regulations in India

The regulatory framework in India for the gross-metering based renewable projects (including solar) has been evolving over the years. The development of regulatory framework for the solar

[3] Additional 25 MW is proposed to be developed under the replication project covering 5 cities

sector has progressed in line with the implementation of applicable policies, viz, the JNNSM at the national level and specific state solar policies in some states. This has resulted in enhanced capacity addition from the large capacity solar power projects, which have been implemented under gross-metering arrangement.

Rooftop solar projects have, thus, far been implemented in India under either gross metering arrangements or on captive consumption arrangements. States like Gujarat have initiated the implementation of small capacity rooftop solar projects under the gross-metering arrangement, with defined commercial arrangement and interconnection requirements. Technical and commercial requirements for net-metering arrangement have however not been addressed adequately and thus constrains the propagation of this segment of rooftop projects.

A grid connected net-metering arrangement requires a well-defined regulatory and commercial framework to address issues related to third party owned systems, provisions under the open access regulations, provision related to banking of energy, etc.

Recognizing the need for a model net metering based regulations for rooftop solar PV projects, this report identifies the various issues that need to be addressed in the regulatory domain for implementation of grid connected net-metering based rooftop solar projects. The report is organized as follows:

- identification of key business models, and
- identification of key parameters important from the perspective of developing draft model net-metering based rooftop solar regulation.

2 Net-metering business models

The net metering based rooftop solar projects facilitates the self-consumption of electricity generated by the rooftop project and allows for feeding the surplus into the network of the distribution licensee. The type of ownership structure for installation of such net metering based rooftop solar systems becomes an important parameter for defining the different rooftop solar models. In the international context, the rooftop solar projects have two distinct ownership arrangements

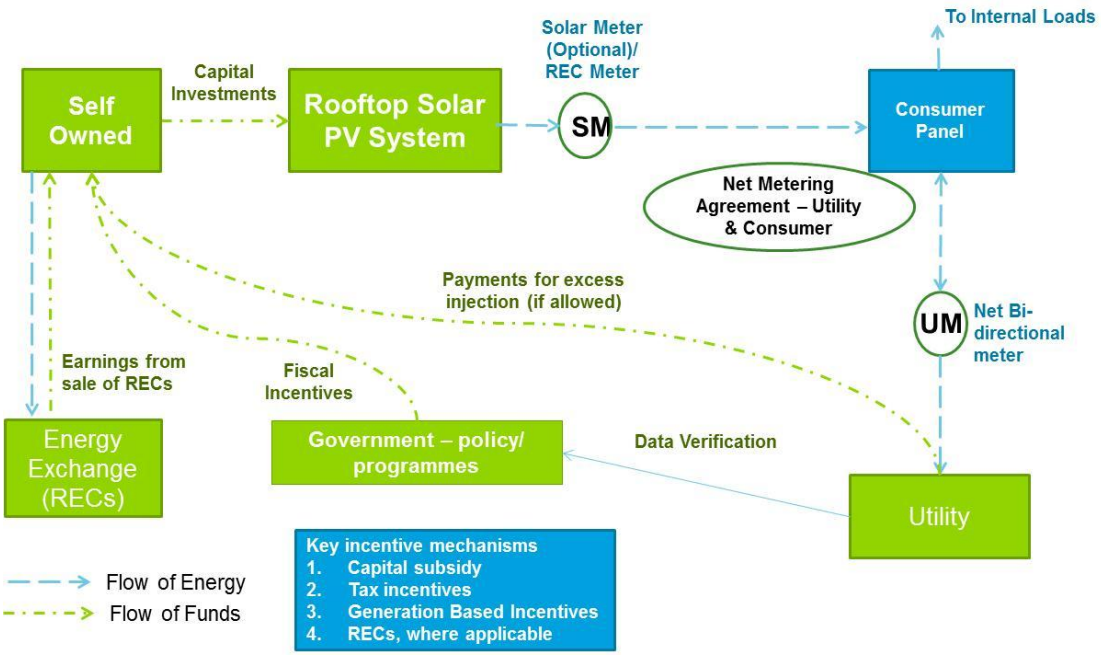
- Self-owned arrangement wherein rooftop owner also owns the PV system and
- Third party ownership in which a developer owns the PV system and also enters into a lease/commercial arrangement with the rooftop owner.

Both these models are relevant in the Indian context and have been discussed in the section below.

2.1.1 Self-owned, net-metering based rooftop PV

In a self-owned, net-metering based rooftop PV model, the rooftop owner who is also the electricity consumer for the utility installs the rooftop solar system, either on its own or with the help of a system supplier and installer. The electricity generated by the system is first used to service consumer's captive load within the rooftop owner's premises. The solar power generated in excess of the owner's electricity consumption is fed into the grid through a net-meter, which is a bi-directional energy meter capable of registering both import and export of electricity. This net generation is then credited to the owner's account and adjusted subsequently against imports from the grid. Figure 1 provides a broad level structure of a self-owned net metering model.

Figure 1 : Self owned net-metering model



Source: Deloitte Research

For this model to work and to interconnect with the distribution utility, necessary provisions permitting net-metering through rooftop solar systems have to be adopted. The prevailing scenario of declining trends in solar tariff and increasing retail tariffs across most consumer categories like residential, commercial and industrial consumers in India, makes net metered projects financially viable over the medium term.

In the interim, there are several policy instruments like Generation Based Incentive (GBI) or capital subsidy which can be adopted to bridge the difference between the higher cost of solar generation and applicable retail tariff for the consumer categories. There are several instances globally of this model having been implemented. For example, in Japan, the relatively higher retail tariffs combined with capital subsidy make such systems attractive for rooftop owners while in the case of the United States, tax rebates are the primary tool for incentives.

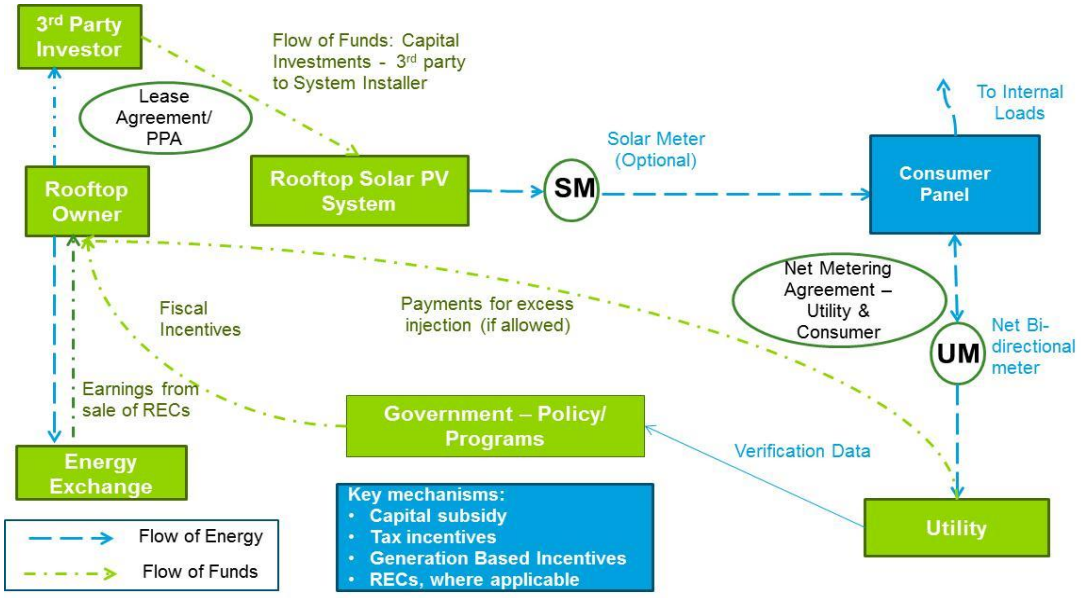
2.1.2 Third party owned Rooftop PV net metering model

In the third party owned rooftop PV net metering model, the developers or intermediaries lease out solar PV systems to interested rooftop owners. This is a popular model for residential home owners in the United States, where turnkey installers lease rooftop systems to individual households who in turn pay them a monthly lease rental. The owner of the house provides the rooftop and commissions a turnkey installer to design and install the system. Alternatively, the installers can also offer an integrated service of leasing, commissioning and maintaining the systems to homeowners and guaranteeing standards of performance. The electricity generated from such a system is used to meet the rooftop owner's internal electricity needs while the excess generation is fed into the grid on net metering basis. This model has the following benefits.

- Benefits to rooftop owner: The household owner avoids large upfront investment for the solar equipment and on occasion avoids assuming technology or performance risk of solar systems. Net-metering allows the rooftop owner to save on power consumed from the grid to the extent of solar generation. A part of savings in power consumption is shared with the developer by way of a lease rental.
- Benefits to developer: The leasing company generates revenues by way of lease rental from the rooftop owner under a contract. As it continues to be owner of the equipment, it also qualifies for claiming depreciation on the capital cost of the PV systems, with associated direct tax benefits.

Figure 2 provides a broad level structure of a third party owned net metering model:

Figure 2 : Third party owned net metering model



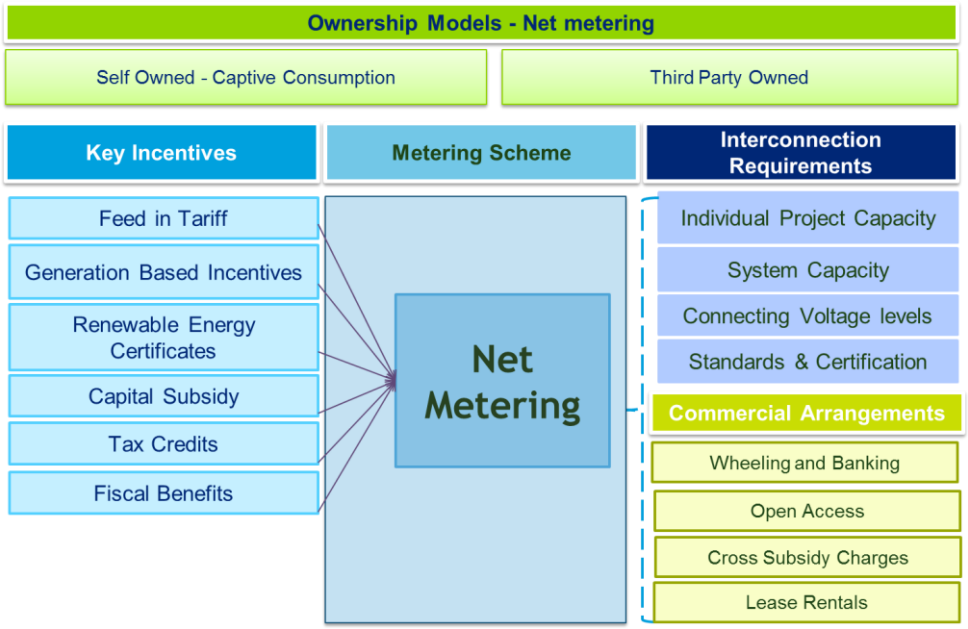
Source: Deloitte Research

In order to make this model operational, electricity regulations need to be designed to remove specific barriers to participation of developers and intermediaries, who play an important role in the propagation of such systems. Under prevailing regulations in the Indian context, a third party owned system, unless specifically addressed, may result in an open access transaction, with implications of wheeling charges and surcharge relating to cross-subsidy.

2.2 Supporting framework

The implementation of net-metering based rooftop solar system needs to address critical factors relating to nature of incentives being made available to the net metered schemes, metering arrangements to be finalized, interconnection requirements for net metered projects and the commercial framework. Figure 3 summarizes the various factors which a model regulation will need to consider and address.

Figure 3 : Supporting Framework - Net metering



Source: Deloitte Research

2.2.1 Key incentives

Fiscal benefits like capital subsidy, tax credits, and generation based incentives can be the options that can be provided to net-metering projects with an objective to bridge the gap between the cost of energy generated from rooftop solar system and retail tariff applicable on distribution utility consumer. The selection of incentive should address factors like impact on project viability & financing, ease of disbursement & robust monitoring framework to assess operational success. These benefits need to be addressed through an appropriate policy level framework.

Regulatory instruments like feed-in tariff and renewable energy certificates have been used in India primarily for projects under gross metering arrangement, which either sell electricity to a utility or operate on captive generation mode.

Net-metering based arrangement is primarily aimed at encouraging self-consumption by the consumer, with only the surplus being exchanged with the grid. The choice of incentive is thus dependent on the extent to which surplus energy is permitted to be exchanged with the grid and the price at which surplus over a settlement period is to be exchanged. Net-metering arrangement for a consumer primarily offsets power consumption from the grid and therefore compensates the owner of the rooftop system for solar energy consumption at the applicable retail tariff for the consumer category. Where tariffs in a consumer category are lower than tariffs

typically expected by rooftop solar system developers, some form of incentive, either as upfront capital subsidy or a generation-based incentive will need to be provisioned to propagate such systems. The provision of such incentives is in the policy domain and hence not addressed in detail in these regulations. It is however pointed out that such incentives for net metered based arrangements will need to vary across consumer categories and from state to state, as retail tariffs are different across categories and across states.

Issuance of Renewable Energy Certificate (REC) is related to the generation of electricity and India has a well-defined regulatory framework for the same. The net-metering arrangement, which will have both generation & consumption within the consumer premises, needs to be analyzed for applicability of REC.

2.2.2 Interconnection arrangements

Interconnection framework for net-metering based rooftop solar projects need to address parameters including connecting voltage level, any minimum technical standards for interconnection and capacity of the system that can be connected to the grid. The cumulative capacity to be allowed by a distribution utility under the net-metering arrangement also needs to be specified. Such arrangements must consider the impact of overall as well as local level (feeder/DTR level) penetration of net-metering based rooftop solar PV power in the grid.

2.2.3 Commercial arrangements

Commercial arrangements and charges applicable on the net-metering rooftop solar projects will have an impact on the overall viability as well as ownership patterns to be promoted. Implementation of net metering based rooftop solar system will require clarity on the energy accounting & commercial settlement for electricity consumed from rooftop solar system as well as excess injected into the grid. Given the fact that such systems could also be third party owned, regulatory clarity will be required on implication of various charges like wheeling, open access, cross subsidy etc. Also the settlement for consumers under Time of Day (TOD) tariff regime may need a differentiated approach.

In the subsequent sections, the above parameters related to key regulatory instruments, interconnection arrangement and commercial arrangement for net-metering based rooftop solar projects have been discussed to form the background for the model regulations framed for net metering based rooftop solar PV systems.

3 Net metering model regulations for rooftop solar projects

A comparative review of the implementation of net metered models in other countries like the United States, Japan and Germany and the current level of regulations existing in various states in India indicate that there are certain critical issues pertaining to the energy accounting and commercial settlement process, requirements of the interconnection arrangements, applicability of the current regulatory instruments like RECs on the net metered projects and metering schemes options need to be addressed to implement net-metered based systems in India. These issues are now being addressed through the accompanying net metering regulations so that implementation can be streamlined across various states. In addition, applicable metering code and standards also need to be defined for the net metered connections.

The following parameters have been identified for coverage in the model regulations on which the options and possible recommendations have been discussed in subsequent sections.

1 Energy Accounting and Commercial arrangements

- Definition of eligible net metered consumer: Should net-metered consumer definition allow for both self-owned and/or third party owned facilities to qualify for net-metering?
- Defining the electricity generation limits & energy accounting options: how to account for the excess generation from the net metered solar projects and what could be the possible energy accounting options for the same?
- Time of Day (TOD) settlement: How to align the energy settlement under net metering with the existing framework under TOD regime?

2 Interconnection arrangements

- Interconnection Voltage: What are the maximum permissible generation system sizes in MW permitted for interconnection at different voltage levels of the distribution network?
- Defining the permitting capacity limits for Individual Projects: Whether to define an individual project capacity limit at consumer level?
- Level of overall/ local grid penetration: What could be the maximum capacity eligible for net-metering in a particular state/ distribution area? Should there be a limit on additions based on the level of connection voltage, type of feeder, etc?

3 Regulatory Instruments

- Whether the solar energy generated by net metered consumers who are not defined as obligated entities, be considered for meeting the RPO targets for the utilities?
- Are there any issues in the issuance of RECs to the net-metering consumers? Is there a requirement to change the REC framework in case the net metered projects are to become REC compliant?

4 Metering schemes

- What type of metering arrangement would be best suited for the net metered project?
- What would be the role of utility for net metering based systems?

In the following sections, each of the above identified issues have been discussed in detail with respect to the importance of the issue, international/national experience in this regard and possible options that can be adopted for developing the draft model regulation for net metering based rooftop solar projects.

3.1 Definition of Eligible Consumer

The definition of eligible consumer for the net metered project is important from the perspective of permitting third party ownership of rooftop solar systems.

Globally, net-metering system is permitted for both self-owned and third party ownership and accordingly regulatory frameworks have been developed to address the same. Table 3 shows select examples of third party ownership being facilitated through legislative or regulatory measures.

Table 3 : International experience - Third part ownership under net metering

State/Country	Key Observations
California, The United States	California addressed third party ownership via a legislative decision – they exempted energy corporations using non-conventional energy sources (meaning all renewables) from the need for a supply license to supply a maximum of two consumers located on the same property from any open access or other charges applicable.
Colorado, The United States	Colorado allowed non-conventional systems sited on consumer premises that did not generate more than 120 percent of the annual consumption of the consumer's annual demand to be owned by third party owner without applicability of any charges.
Oregon, The United States	Third-party investors are allowed to participate in net metering. A third-party investor's sale of electricity to a utility customer does not subject the investor to electricity service supplier provision under Commission rules.

Source: Database of State Incentive for Renewable & Efficiency (DSIRE)

In India, the third party owned power projects supplying electricity to consumers would amount to third party sale of electricity unless addressed otherwise. These consumers would subsequently be liable to pay wheeling charges, cross-subsidy surcharge and additional surcharge (if applicable). Rooftop solar projects under net-metering are expected to be of small size and will act as on-site generation cum consumption for the consumer. The connectivity with the grid will act as support facility to consumer to bank the electricity in the grid for a defined period. There is a merit in allowing both self-owned as well as third party owned systems under the net metering arrangements where the primary purpose is to meet the internal electricity consumption requirement of the consumer.

It is proposed that consumer's eligibility for net-metering be defined in such a way that it allows, both self-owned as well as third party owned systems, to be installed for meeting consumer's self-consumption. The regulations could then exempt only such eligible consumers from wheeling, banking and cross subsidy related charges.

The eligible consumer and net-metering as concept can be defined as follows.

- *'eligible consumer'* means a consumer of electricity in the area of supply of the distribution licensee, who uses a rooftop solar system installed in the consumer premises, to offset part or all of the consumer's own electrical requirements, given that such systems can be self-owned or third party owned;
- *"net metering"* means an arrangement under which rooftop solar system the system installed at eligible consumer premises delivers surplus electricity, if any, to the Distribution Licensee after off-setting the electricity supplied by distribution licensee during the applicable billing period;

3.2 Capacity Limits & Interconnection Voltage

The capacity of an individual rooftop PV systems under net metering concept is subject to various parameters such as available capacity of the service line connection of the consumer, the connected load of the consumer and the cost implications of utility system augmentation (if required). The installation of net metered rooftop solar systems on consumer premises will utilize the same service line for excess power injection into the grid, which is currently being used by consumer for drawl of power from utility network. Thus, the capacity limits for installation of net-metering based rooftop solar systems has to address the following two requirements:

a) the individual capacity limit for system that can be installed on a particular consumer premises
b) the maximum (higher limit) capacity allowed to be installed under a net-metering arrangement.

In addition, the issue concerning the implication of cost for infrastructure up-gradation at distribution level, if required on account of installation of higher capacity system than that permitted by the existing service line needs to be addressed.

International case studies on the capacity limits prescribed by the utilities shows a wide variation depending on technology, the customer type and application. In the United States, the net-metering concept in a number of provinces like California, Colorado, Florida, New Jersey etc includes other technologies (solar thermal electric, wind, biomass, hydroelectric, geothermal electric) apart from rooftop solar PV. Hence some of these provinces have higher limits allowed for net-metering going upto 10 MW. The capacity limits also depend internationally on the type of customer. For example,

- In Colorado, the capacity limits for net-metering is 25 kW for non-residential and 10 kW for residential.
- In California, 5 MW is the limit for systems operating under the bill credit transfer program authorized by Public Utilities Code 2830. System must be owned by, operated by, or on property under the control of, a local government or university. For other systems the capacity limit is 1 MW.

In India, the supply of electricity to the consumers by the distribution utilities is generally given at a defined voltage level on the basis of contracted load of the consumer. The contracted load is generally defined as maximum demand in kW, kVA or BHP, agreed to be supplied by the licensee and indicated in the agreement executed between the licensee and the consumer. The connecting voltage at low and medium tension voltages are defined such as 1 Phase 230 V, 3 Phase 415 V, 3 Phase 11 kV and 3 phase 33 kV, etc.

Since the system of supply (maximum demand for each voltage level, etc.) is already defined under the Supply or Distribution Code in each State, it can apply similarly for the net-metering based rooftop capacity. In other words, permitted maximum rated capacity of the rooftop solar PV system for any consumer shall be as per the Supply/Distribution Code applicable in the State read as if the rooftop PV solar system is equivalent to a Connected Load for the purpose of deciding the system of supply/interconnection, including the voltage level and the need for service line enhancements, etc. needed to connect to a higher voltage profile, is so desired by the eligible consumer.

A review of the recent tariff orders by the state electricity regulatory commissions and solar policies of state governments indicates that select states have defined the capacity limits for small capacity rooftop solar projects in terms of capacity to be connected and the connecting voltage levels, as shown in Table 4. These were also noticed to be in line with the applicable distribution/supply code of the state.

Table 4 : Connecting Voltage for various capacity ranges – Rooftop Solar

State	Capacity Range	Connecting Voltage
Gujarat (GERC Solar Tariff order 2012)	Up to 6 KW	Single Phase
	6 KW to 100 KW	415 V
	100 KW to 1 MW	11 KV
Tamil Nadu (Tamil Nadu Solar Policy 2012)	Up to 10 KW	240 V
	10 KW to 15 KW	240/415 V
	15 KW to 100 KW	415 V
	> 100 KW	11 KV
Kerala (KSERC Discussion Paper 2012)	Up to 5 KW	1 Phase 230 V
	5 KW to 100 KW	3 Phase 415 V
	100 KW to 1 MW	3 Phase 11 KV

Source: State orders/policies, Deloitte Research

The following provisions can be considered for developing the regulatory framework for net-metering based rooftop PV systems:

- The maximum rated capacity for a rooftop project for interconnection with the grid at a specific grid voltage level shall be as per the provisions of the respective state supply/distribution code, read for the purpose of deciding the interconnection voltage by replacing the contracted demand with maximum rated capacity of the solar rooftop system.
- The maximum capacity of rooftop solar system defined for grid connection in several states is 1 MW. The maximum permissible capacity under RPSSGP is 2 MW, where most projects have been ground-mounted small-scale projects. Considering the above, the maximum capacity limit for rooftop solar system can be capped at 1 MW for a single metering point to qualify under net-metering.
- In the long term, the interconnection of the rooftop solar power generation systems with the network of the distribution licensee would need to adhere to the technical standards for connectivity of distributed generated resources regulations, as and when notified by Central Electricity Authority (CEA).
- The cost of up-gradation of the service line and related infrastructure can be as per the provisions of state supply code. As a general practice, the cost implication is borne by the consumer.

3.3 Permitting limits on individual projects & commercial settlement mechanism

Net-metering measures over a defined settlement period the net drawl of an electricity consumer from the grid after offsetting the electricity generated from rooftop solar. The bi-directional meter measures the “net” of the generated electricity and consumption of electricity from the grid. While the key objective of proliferation of net-metering based rooftop solar system could be to encourage the self-consumption by the consumer, the commercial settlement mechanism needs to recognize the possible scenarios and address the implications concerning energy accounting, contracting arrangements and pricing framework. An important issue in the energy settlement mechanism is whether to recognize the excess injection into the grid as sale of electricity to utility & if so then what should be the settlement period and the price of energy transaction?

Energy Accounting

Internationally, several utilities have imposed a restriction on the overall generation from rooftop solar systems as a percentage of electricity consumption by the consumer over a settlement period. This has been done to encourage self-consumption by the consumer for electricity generated from net-metered rooftop system. The electricity generation limits vary and are either equal to the total electricity consumption by consumer or a specific percentage (both positive and negative) of the electricity consumption within a defined settlement period. Table 5 details the energy accounting approach adopted by select utilities:

Table 5 : International experience - Excess injection limits

S No	Utility	Provision for accounting of Excess Generation
1	New Jersey, US	Energy production should be limited to customer's annual on-site energy consumption
2	Colorado, US	Generation up to 120% of the customers average annual consumption
3	Virginia, US	Excess energy production allowed - Credit to be carried forward to subsequent net metering period cannot exceed amount of energy purchased during the previous annual period
4	Italy	Excess energy injection allowed – but no commercial settlement & only energy settlement in next period
5	Victoria, Australia	Excess energy generation allowed with commercial settlement but there is limit on individual system capacity (5 KW for household)

Source: DSIRE, Deloitte Research

In India, the state of West Bengal had come out with the net-metering related regulatory framework for select consumers in 2008. The regulations had imposed a cap on the maximum generation from rooftop solar system at 90 percent of the consumption by the eligible consumer from the licensee's supply within a financial year. Similarly, the Energy Department's recent order on the net metering in Andhra Pradesh also does not allow any commercial settlement of excess generation.

The merits of net-metering are based significantly on promotion of self-consumption to the highest extent possible. From the perspective of the distribution utilities, net-metering leads to reduction in consumption by existing consumers, which is seen as a negative. It will not be received well, if they are required further to procure electricity in excess of what a consumer was otherwise consuming from the grid.

Accordingly, it is recommended that electricity generated from a solar rooftop system be capped commercially at 90 percent of the electricity consumption by the eligible consumer at the end of a settlement period (i.e. financial year).

Settlement period & Commercial Settlement

The issue of injection of electricity which is in excess of the consumer's internal consumption needs to be analyzed over two periods

- The carry forward to be allowed in a particular billing period, which is usually a month for consumer-end energy accounting and billing.
- The carry forward to be allowed beyond the settlement period (which is generally a financial year).

The settlement period for undertaking the final settlement of the net-metered energy is generally 12-month period which has been adopted by most utilities globally to remove the effect of

seasonality in generation. The commercial settlements involve either settlement only in terms of energy or settlement of the net excess energy at avoided-cost rate/retail rate etc. In the international context, select utilities also allow for the carry forward of any excess energy at the end of settlement period to the next settlement period. Table 6 highlights the key provisions for settlement across select geographies:

Table 6 : International experience - Commercial settlement

Geography	Key Provisions
Italy	• Mechanism does not result in direct payments and is based on the balance of the energy fed in and consumed - Credit is unlimited in terms of time.
Virginia, the United States	• Settlement period: At the end of 12-month period, customer has the option of carrying forward eligible excess to the next net metering 12-month period or Selling to utility. • Credit to be carried forward to subsequent net metering period cannot exceed amount of energy purchased during the previous annual period.
Arizona, the United States	• Non- residential: Credited to customer's next bill at retail rate; excess reconciled annually at avoided-cost rate • Residential: Credited to customer's next bill at retail rate; excess reconciled annually in April at average annual market price minus price adjustment
California, the United States	• Credited to customer's next bill at retail rate (option of roll over credit indefinitely or settlement @ 12-month average spot market price)
Hawaii, the United States	• Credited to customer's next bill at retail rate; granted to utility at end of 12-month billing cycle

Source: DSIRE, Deloitte Research

The carry forward of excess injection to next billing cycle is well accepted settlement mechanism as it allows benefit to consumer to utilize any surplus generation in one billing cycle to be consumed in the subsequent billing cycle, which can also be due to variability of electricity generation across different months in a particular financial year or variability in consumption patterns on the part of a consumer.

For the purpose of the model regulations, it is proposed that the carry forward of energy from one billing cycle to the next billing cycle be permitted but within the same settlement period and the utility can reflect the credit (in energy terms) to consumer for any excess injection.

In case the energy credit is carried forward beyond the settlement period, there are several issues which would need to be considered. For instance, the retail tariff across settlement periods could change leading to complexities in energy accounting, billing and settlement. Drawing on the international experiences and to avoid complications in the energy accounting, billing and settlement mechanisms, while encouraging higher self-consumption, it is proposed that no carry forward of energy be allowed to the next settlement period.

To summarize, it is proposed to avoid the any form of commercial settlement for excess energy generated at the end of settlement period. This will encourage installation of rooftop systems for meeting primarily the internal electricity requirements of the consumer under the net-metering arrangement and also avoid any form of commercial complexities for utilities. The electricity generated from rooftop solar systems by eligible consumers shall not be more than 90 percent of the electricity consumption by the eligible consumer at the end of the settlement period (i.e. financial year). Any excess generation (above 90 percent) at the end of financial year would be considered as free energy and not offset against the consumer’s consumption. There shall be no carry forward of energy allowed to next financial year

3.4 Restrictions on level of overall or local grid penetration

Net-metering based rooftop solar systems are small capacity systems and can be expected to proliferate fast when the policy and regulations are conducive. The pace and level of proliferation of net-metering based rooftop would have an impact on the local grid which has to address technical, safety and grid security issues arising out of possible reverse flow of electricity in the local grids.

Internationally, the regulators have put an overall cap on the level of penetration for the rooftop solar capacities to be allowed. These limits vary and range from local level limits to state wide limits. In the United States, where the proliferation of rooftop solar projects on net metered arrangement has been the most, various states have defined capacity caps linked to utilities' load as shown below:

- Hawaii – Overall 15% per circuit distribution threshold for distributed generation penetration (Local level)
- California – A capacity cap of 5% of aggregate customer peak demand
- New Jersey – Utilities are allowed to stop offering net metering connections if statewide enrolled capacity exceeds 2.5% of peak electric demand
- Michigan - 0.75% of utility's peak load during previous year

In India, most state governments have fixed specific targets for the promotion of different renewable energy technologies through the state policies. The SERCs have issued RPO regulations fixing RPO targets for different renewable energy technologies. The State may cap the overall penetration linked to availability of subsidies or incentives for rooftop solar projects, Solar RPO accounting and the cost of up-gradation of the system for net metered arrangements. The local level targets are more from the technical stand point since the current distribution system is not geared to accommodate reverse power flows in the distribution network. The diversity of loads at the feeder or DTR level can assist in accommodating some generation from rooftop projects without causing safety issues but the same needs to be assessed for each utility to define the capacity cap. The current information and studies are inadequate to define the local level (feeder/DTR level) grid penetration limits with any accuracy for connectivity of distributed renewable energy generation including rooftop solar systems. Further, the implementation of HVDS by certain states would require separate considerations for defining the caps.

While the overall state target can be in the form of a percentage of aggregate customer peak demand or a defined capacity in MW terms, the local level caps can be implemented in a phased manner so that the state utilities have sufficient time to undertake technical studies and establish the norms based on the system characteristics. It is proposed to cap the capacity at the distribution transformer level to a conservative 15 percent of the peak capacity to avoid any technical issues in the initial phase. Accordingly, the following provisions have been proposed under the net-metering rooftop solar regulatory framework;

- *The distribution licensee shall provide net metering arrangement to eligible consumers as long as the total capacity (in MW) does not exceed the target capacity determined by Commission;*

  Provided a maximum cumulative capacity of…….MW[4] *shall be allowed to eligible consumers under net metering, on yearly basis, in the area of supply of the distribution licensee;*

[4] The maximum cumulative capacity for development of solar rooftop in a state shall be decided by the respective SERCs in keeping with overall solar energy and RPO targets for the State.

Provided also that the cumulative capacity to be allowed at a particular distribution transformer shall not exceed 15% of the peak capacity of the distribution transformer;

The cap of 15 percent can be reviewed based on technical studies conducted by the utility or based on standards subsequently defined by CEA. In the long term, the distribution utilities would need to identify appropriate enhancements to network architecture/infrastructure upgrades to increase penetration levels.

3.5 Renewable Purchase Obligation

Renewable Purchase Obligation (RPO) targets for the obligated entities (distribution utility/captive consumer/open access consumer) are defined by the state regulatory commissions. Net-metering based rooftop solar system represents a scenario where generation and consumption of electricity shall happen within the consumer premises. Hence, the key issue is to evaluate the applicability of RPO framework for such systems and analyse the requirements for the energy accounting from such systems. As per the current RPO framework, the captive consumers can be categorized into:

- Captive consumers defined as Obligated Entity under State RPO Regulation (Type 1) – generally for captive capacity of 1 MW and above (this limit can vary from state to state). These consumer categories having RPO targets would like to claim the benefits of self-consumption from net-metered based rooftop solar project for meeting their own RPO compliance.
- Captive consumers not defined under the definition of Obligated Entity under State RPO Regulation (Type 2) – generally for captive capacity less than 1 MW and other consumers. The generation and consumption of renewable power from these consumers is therefore not accounted for in the overall RPO framework.

The distribution utility to which the latter category of consumers (Type 2) are connected can be given the benefit of deemed RPO for self-consumption of electricity by consumers, who are not defined as obligated entities under the RPO framework. This will encourage utilities to facilitate implementation of small capacity net-metering based rooftop solar projects.

It is proposed that the quantum of electricity consumed by an eligible consumer, who is not defined as an obligated entity, from the rooftop solar system under net-metering arrangement shall qualify as deemed Renewable Purchase Obligation (RPO) for the distribution licensee.

3.6 Applicability of Renewable Energy Certificates

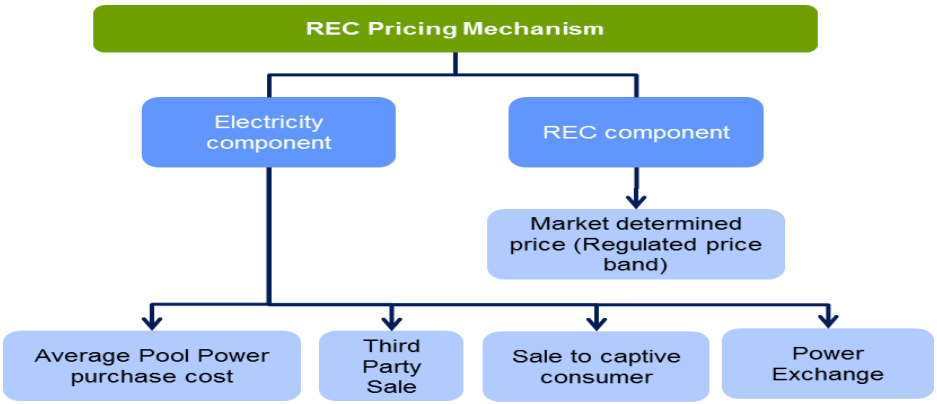
Renewable Energy Certificate (REC) mechanism is a market based instrument to promote renewable energy and facilitate compliance of renewable purchase obligations (RPO). While considering applicability of RECs for net-metered systems, the following issues need to be considered.

- Settlement of solar energy for net-metered based rooftop solar PV projects is deemed to happen at retail tariff rates applicable for the eligible customer.
- Net-metering based projects will enjoy other concessional benefits such as capital subsidy / generation based incentive or exemption of open access related charges, banking charges and wheeling charges, etc.

In most states across the United States, the ownership of RECs for the net metered projects is with consumers / customers. For example, in states like Connecticut, Michigan, New Jersey, Arizona, the ownership of REC is with the customer while in California, the customer owns the RECs except for the credited excess generation. In Virginia, customer signs the PPA with utility for net excess generation with one time option to sell RECs to the utility.

In India, the issuance of renewable energy certificates (RECs) is against the generation of electricity and only the obligated agencies and renewable energy generators can participate in market. Figure 4 illustrates the framework governing the REC mechanism in India:

Figure 4 : Framework for RECs



Source: REC Regulations, Deloitte Research

As per current regulatory framework, a Captive Power Producer (CPP) based on renewable energy sources shall be eligible for the entire energy generated from such plant including self-consumption for participating in the REC scheme subject to the condition that such CPP has not availed or does not propose to avail any benefit in the form of concessional/promotional transmission or wheeling charges, banking facility benefit.

In the above context, net-metering based rooftop solar PV projects enjoying exemptions from charges related to open access, wheeling and banking and receiving subsidy or generation-based incentive support from the Government may not qualify for REC.

3.7 Metering and Commercial Settlement

3.7.1 Time of Day Tariff Regime

Time of Day (ToD) tariffs have been introduced in several states as a demand side management instrument which serves to incentivize consumers to balance their peak and off peak consumptions. These are generally applicable to industrial and commercial consumers, with each state having its own ToD tariffs and time slots as shown below.

Table 7 : ToD framework across select States

State	Designation	Time Slot	Target consumer
Maharashtra	Off Peak	2200 - 0600	Mandatory for HT industrial consumers
	Normal	0600 - 0900	
	Morning Peak	0900 - 1200	
	Normal	1200 - 1800	
	Evening Peak	1800 - 2200	
Gujarat	Morning Peak	0700 - 1100	HT industrial consumers
	Evening Peak	1800 - 2200	
TN	Morning Peak	0600 - 0900	HT industrial consumers
	Evening Peak	1800 - 2100	
	Off Peak	2200 - 0500	
Chhattisgarh	Normal Period	0500 – 1800	HT and EHT consumers

State	Designation	Time Slot	Target consumer
	Peak Load	1800 – 2300	
	Off Peak	2300 – 0500	

Source: Deloitte Research

The net metering regulatory framework for rooftop solar projects needs to address the energy accounting and commercial settlement mechanism across the ToD periods for banked energy. It is proposed that the energy accounting & commercial settlements be mapped as per the respective state regulatory framework on time slots for ToD tariffs. Any cumulated excess generation over consumption over a time slot shall only be settled at the lowest applicable tariff across all time slots, provided the overall electricity generation from rooftop solar systems is not more than 90 percent of the cumulative electricity consumption of the eligible consumer over the settlement period (i.e. financial year).

This will safeguard the commercial interests of the utility and will ensure that the regulations are in line with the existing regulatory framework.

3.7.2 Applicability of other charges

Third party owned systems installed within consumer premises may fall under the ambit of sale of electricity on open access, thus inviting charges related to wheeling and surcharge related to cross-subsidy. Also net-metering based systems owing to their connectivity to grid & banking of electricity can also come under the purview of banking and wheeling charges etc. In order to promote the third party owned systems and avoid complexities around evaluation and monitoring of wheeling/banking/open access charges, it is proposed that net metering rooftop solar arrangements are specifically exempted from these charges.

3.7.3 Metering

The net meter arrangement may have a single, double or a three meter system. In case of 2 or 3 meter systems, the utility has to recognize all the installed meters for commercial settlements. For the model regulations, a 2 meter system is recommended for net-metering in order to clearly account for solar generation and electricity consumption by the consumer. Annexure 2 provides the basic recommended meter configuration options. Existing consumers availing rooftop solar net-metering arrangement will be required to have new/additional net-meter(s) and the cost of new/additional meter (s) will be borne by the consumer and installed by the distribution licensee. This is in line with the existing regulatory framework adopted by different states w.r.t responsibility of bearing cost of consumer meter.

Process of meter reading is important from the perspective that net-metering systems utility will be required to complete the commercial settlement at the end of the settlement period.

Given the fact that the commercial settlement for net-metering based consumers need to be done at the end of financial year, this may require utility to adopt meter reading instrument (MRI) or wireless equipment for recording meter readings as it will facilitate faster compilation of relevant consumer metering details to complete the final year end settlement. Hence, net-meters are proposed to be MRI compliant or wireless enabled for remote reading. In case the consumer wishes to have a record of the reading taken, he shall be allowed so by the licensee. The position of the solar meter should be accessible to the utility and be preferably alongside where the consumer meter is mandated under the Supply Code.

The Electricity Act has mandated Central Electricity Authority (CEA) to specify the metering Standards. Accordingly, CEA issued the CEA (Installation and Operation of meters) Regulations. The standards for net-meter can be same as specified for Consumer Meters in Central Electricity

Authority (Installation and Operation of Meters) Regulations, 2006 and Electricity Authority (Installation and Operation of Meters) Amendment Regulations, 2010 as amended time to time. State regulatory frameworks for Consumer Meter have adopted the CEA regulations for the consumer meter standards & relevant provisions. As the net-meter will act as a consumer meter for commercial settlement with the utility, it is proposed that the existing metering specifications, standards can be adopted for net meters also.

Given the fact that the rooftop solar projects would be of small capacity of kW scale, requirement of check meters can be avoided for the very small capacity projects. For example, under the Gandhinagar rooftop solar programme, the requirement of check meters has only been for the rooftop solar capacity above 20 kW. It is proposed that similar provision be adopted to avoid requirement of check meters for very small capacity net metered projects. The requirement of check meters can be kept provisional for capacity less than and equal to 20 kW and consumer can bear cost for these check meters. The main generation meter (solar meter) can be of 0.2s class accuracy and with facility for recording meter readings using Meter Reading Instrument (MRI).

The following provisions are proposed for facilitating net-metering based rooftop solar projects;

- Position & sealing of net meter will be guided by the same provisions as applicable to consumer meter in Supply Code
- Net meters shall bi-directional & be accepted for commercial settlements. These net meters should be MRI compliant or wireless equipment for recording meters so that in case the bills are prepared on the basis of remote meter reading or MRI downloads and the consumer wishes to have a record of the reading taken, he shall be allowed to do so by the licensee.
- The main Solar Meters shall be of 0.2s class accuracy and with facility for recording meter readings using Meter Reading Instrument (MRI). The solar check meters shall be mandatory for rooftop solar installations having capacity more than 20 kW. For installations size of less than and equal to 20 kW, the solar check meters would be optional.
- The cost of new/additional meter (s) shall be borne by the eligible consumer and installed by the distribution licensee.
- The meters installed shall be jointly inspected and sealed on behalf of both the parties and shall be interfered/tested or checked only in the presence of the representatives of the consumer and distribution licensee
- In case the eligible consumer is under the ambit of time of day tariff, meters will be compliant for recording the time of day consumption and generation.
- The meter reading taken by the distribution licensee shall form the basis of commercial settlement.

3.8 Connection Agreement

- The draft connection agreement (Refer **Error! Reference source not found.**) has been developed based on the analysis of key issues discussed in this report.

Annexure 1: Gross Metering and Net Metering Concept

The following table highlights the key features of the gross metering and net metering arrangements.

Table 8 : Gross and Net metering mechanisms for rooftop solar PV

Parameter	Gross Metering	Net Metering
Objective	Electricity sale to utility	Self-consumption of electricity
Contractual Arrangement	Power Purchase Agreement (PPA) with the utility Price determined by Regulator or based on Competitive Bidding	Arrangement between utility and consumer in case the excess electricity sale is allowed
Metering Requirement	Compliance with the specifications of generation meter	Metering arrangement to measure generation as well as respective consumption
Energy Accounting	Accounting for the solar generation	Accounting for the net power consumption by the consumer as well as solar generation (in case it is linked to any benefits/ incentives)
Beneficiary	Enables the utility to meet its Solar RPO compliance	Enables the consumer in reducing the electricity consumption form the grid
Utility's Concern	Not keen on signing PPA with small rooftop projects	Loss of revenue for utility
Developer's Concern	Grid unavailability to impact revenue	Low level of incentive may impact viability of project for certain consumer segments

Source: Deloitte Research

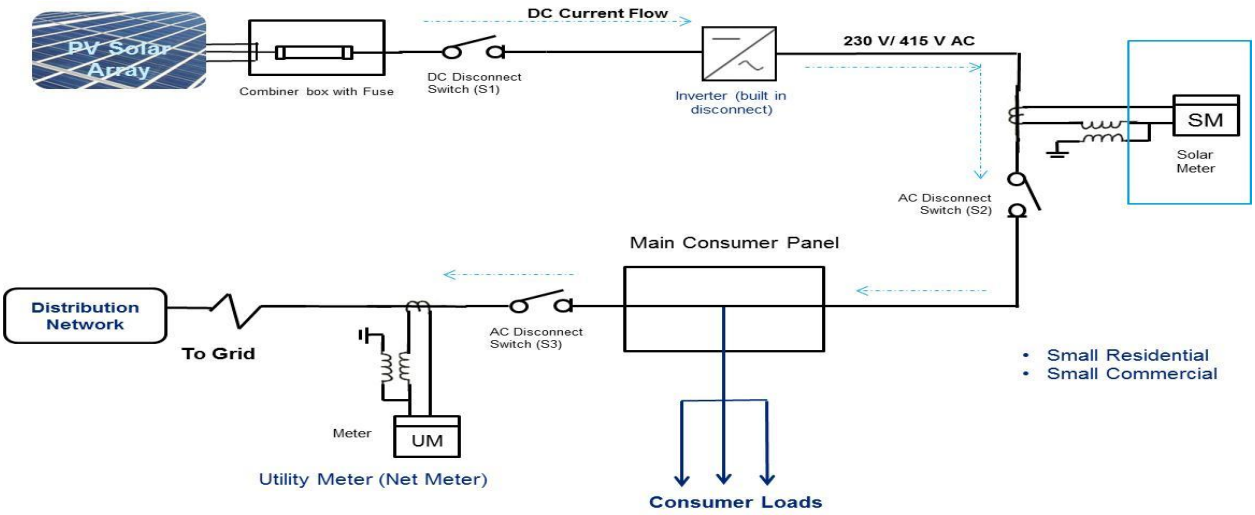
Annexure 2: Net Metering – Meter Configuration options

The metering system for rooftop solar system, under net-metering arrangement, shall be as elaborated below which should be applicable till such time the Central Electricity Authority notifies the standards in this matter.

a) Two Meter Configuration without Storage

The metering protocol for 'Grid connected rooftop solar PV system without storage' and location of solar meter and consumer meter shall be in accordance with the schematic below

Figure 5 : Two Meter Configuration without Storage



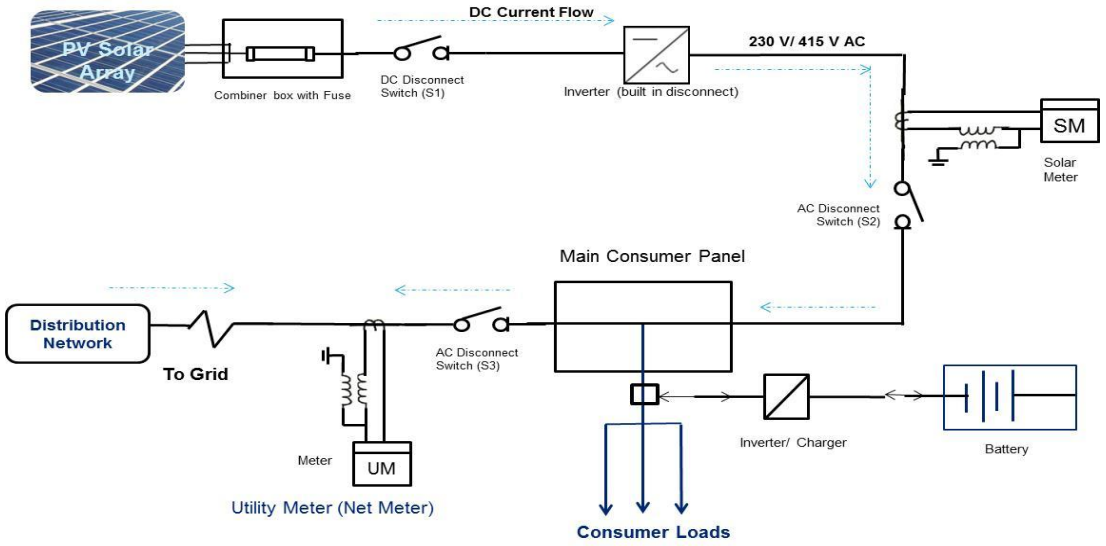
Source: Deloitte Research

The utility meter (Net-meter) has to be bi-directional meter to register both import grid electricity amount as well as export solar electricity amount.

b) Two meter configuration with storage

The metering protocol for 'Grid connected rooftop solar PV system with storage' and location of Solar Meter (SM) and Utility Meter (UM) shall be in accordance with the schematic below,

Figure 6 : Two meter configuration with storage



Source: Deloitte Research

The utility meter (Net-meter) has to be bi-directional meter to register both import grid electricity amount as well as export solar electricity amount.

Annexure 3: Net Metering – Connection Agreement

Every state in India has a distribution code that covers the consumer connection related technical parameters and requirements. Unfortunately, not much has been covered in context of connecting small and distributed system into the grid. Thus, most of distributed systems in India have been connected to the grid adhering only to international equipment standards of the International Electrochemical Commission (IEC).

Central Electricity Authority (CEA) had come out with a draft technical regulation on connecting small and distributed solar/renewable generating systems with grid in 2012 but the final regulation is still awaited. Central Power Research Institute (CPRI), Bangalore has developed few technical requirements and testing facilities for small rooftop PV systems with maximum capacity of 3 KW. Thus, comprehensive and exhaustive technical requirements are needed to be laid to facilitate smooth deployment of net metering systems in country.

A net-metering arrangement with no excess generation allowed for commercial settlement wouldn't require any power purchase agreement between the consumer and the distribution licensee. However, there must be a net-metering connection agreement between the two parties that can cover the technical requirements for interconnection of a net metering system with the grid.

The net connection agreement also serves as an agreement that clarifies the roles, responsibilities and liabilities of the two parties during the period of net-metered system will be connected to the grid. It must cover aspects related to the safety of the grid and PV system, connection cost, termination clauses etc.

The connection agreement has been framed with reference to various standards and regulations relevant to connection of small and distributed system to the grid.

Important clauses related to the technical and interconnection requirements are provided below.

Table 9: Technical and interconnection requirements

Parameter	Reference	Net Metering Connection Agreement
Overall Conditions of Service	State Distribution Code	Reference to State Distribution Code
Overall Grid Standards	Central Electricity Authority (Grid Standard) Regulations 2010	Reference to regulations
Equipment	IEEE/ IEC/BIS	Reference to standards
Safety and Supply	Indian Electricity rules, 1956 and Central Electricity Authority (Measures of Safety and Electricity Supply) Regulations, 2010	Reference to regulations
Interconnection Requirements		
Harmonic Current	IEEE 519 CEA Draft Regulation on Interconnection of Small and Distributed System (2012)	Harmonic current injections from a generating station shall not exceed the limits specified in IEEE 519
Synchronization	CEA Draft Regulation on Interconnection of Small and Distributed System (2012) CPRI Testing Requirements	Photovoltaic system must be equipped with a grid frequency synchronization device
Voltage	CEA Draft Regulation on Interconnection of Small and Distributed System (2012) CPRI Testing Requirements	The voltage-operating window should minimise nuisance tripping and should be under operating range of 80% to 110% of the nominal connected

Parameter	Reference	Net Metering Connection Agreement
		voltage. Beyond a clearing time of 2 seconds, the Photovoltaic system must isolate itself from the grid
Flicker	CEA Draft Regulation on Interconnection of Small and Distributed System (2012) CPRI Testing Requirements IEC Standards	Operation of Photovoltaic system shouldn't cause voltage flicker in excess of the limits stated in the relevant sections of IEC standards or other equivalent Indian standards, if any.
Frequency	CEA Draft Regulation on Interconnection of Small and Distributed System (2012) CPRI Testing Requirements	When the Distribution system frequency deviates outside the specified conditions (50.5 Hz on upper side and 47.5 Hz on lower side), the Photovoltaic system shouldn't energize the grid and should shift to island mode
DC Injection	CEA Draft Regulation on Interconnection of Small and Distributed System (2012) CPRI Testing Requirements	Photovoltaic system should not inject DC power more than 0.5% of full rated output at the interconnection point or 1% of rated inverter output current into distribution system under any operating conditions
Power Factor	CEA Draft Regulation on Interconnection of Small and Distributed System (2012) CPRI Testing Requirements	While the output of the inverter is greater than 50%, a lagging power factor of greater than 0.9 should operate
Islanding and Disconnection	CEA Draft Regulation on Interconnection of Small and Distributed System (2012) CPRI Testing Requirements IEC Standards	The Photovoltaic system in the event of voltage or frequency variations must island/disconnect itself within IEC standard on stipulated period
Overload and Overheat	CEA Draft Regulation on Interconnection of Small and Distributed System (2012)	The inverter should have the facility to automatically switch off in case of overload or overheating and should restart when normal conditions are restored
Paralleling Device	CEA Draft Regulation on Interconnection of Small and Distributed System (2012)	Paralleling device of Photovoltaic system shall be capable of withstanding 220% of the nominal voltage at the interconnection point

Source: CERC/SERC Regulations, CEA Regulations, Deloitte Research

It is to be noted that the technical requirements under the connection agreement are the recommendations only and serves as an interim arrangement until the CEA finalizes the technical guidelines and regulations for connection of small and distributed generation system with the grid.

Net Metering Connection Agreement

This Agreement is made and entered into at (location) _____ on this (date)___ day of (month) _____between

The Eligible Consumer, _____ residing at _____(address)_____ as first party

AND

_____ Distribution Licensee (herein after called as Discom) and having its registered office at ____(address)_____ as second party of the agreement.

Whereas, the eligible consumer has taken the responsibility to set up or facilitate the requisite Photovoltaic system and injection system into the Discom's grid

And whereas, the Discom agrees to benefit the eligible consumer for the electricity generated and as per conditions of this agreement and net-metering regulations.

Both the party hereby agrees to as follows:

1. Eligibility

1.1 Eligible consumer is required to be aware, in advance, of the standards and conditions his system has to meet for being integrated into grid/distribution system.

1.2 Eligible consumer agrees that connection of Photovoltaic system to Discom's distribution system shall be bound by requirements of state Distribution Code and/or Discom's conditions of service. The grid shall continue to perform with specified reliability, security and quality as per the Central Electricity Authority (Grid Standard) Regulations 2010 as amended from time to time.

2. Technical and Interconnection Requirements

2.1 Eligible consumer agrees that he has installed or will install, prior to connection of Photovoltaic system to Discom's distribution system, an isolation device (both automatic and inbuilt within inverter and external manual relays) and agrees for the Discom to have access to and operation of this, if required, for repair and maintenance of the distribution system.

2.2 Eligible consumer agrees that in case of a power outage on Discom's system, photovoltaic system will shut down, unless special transfer and isolating capabilities have been installed on photovoltaic system.

2.3 All the equipment connected to distribution system must be complaint with relevant international (IEEE/IEC) or Indian standards (BIS) and installations of electrical equipment must comply with Indian Electricity rules, 1956 and Central Electricity Authority (Measures of Safety and Electricity Supply) Regulations, 2010.

2.4 Eligible consumer agrees that Discom will specify the interface/inter-connection point and metering point.

2.5 Eligible consumer agrees to adhere to following power quality measures as per International or Indian standards and/or other such measures provided by Commission/Discom.

a. **Harmonic current**: Harmonic current injections from a generating station shall not exceed the limits specified in IEEE 519.
b. **Synchronization**: Photovoltaic system must be equipped with a grid frequency synchronization device.

c. **Voltage**: The voltage-operating window should minimise nuisance tripping and should be under operating range of 80% to 110% of the nominal connected voltage. Beyond a clearing time of 2 seconds, the Photovoltaic system must isolate itself from the grid.
d. **Flicker**: Operation of Photovoltaic system shouldn't cause voltage flicker in excess of the limits stated in the relevant sections of IEC standards or other equivalent Indian standards, if any.
e. **Frequency**: When the Distribution system frequency deviates outside the specified conditions (50.5 Hz on upper side and 47.5 Hz on lower side), the Photovoltaic system shouldn't energize the grid and should shift to island mode.
f. **DC Injection**: Photovoltaic system should not inject DC power more than 0.5% of full rated output at the interconnection point or 1% of rated inverter output current into distribution system under any operating conditions.
g. **Power Factor**: While the output of the inverter is greater than 50%, a lagging power factor of greater than 0.9 should operate.
h. **Islanding and Disconnection**: The Photovoltaic system in the event of voltage or frequency variations must island/disconnect itself within IEC standard on stipulated period.
i. **Overload and Overheat**: The inverter should have the facility to automatically switch off in case of overload or overheating and should restart when normal conditions are restored.
j. **Paralleling device:** Paralleling device of Photovoltaic system shall be capable of withstanding 220% of the nominal voltage at the interconnection point

2.6 Eligible consumer agrees to furnish all the data such as voltage, frequency, and breaker, isolator position in his system, as and when required by the Discom. He may also try to provide facilities for online transfer of the real time operational data.

3. Safety

3.1 Eligible consumer shall comply with the Central Electricity Authority (Measures Relating to Safety and Electricity Supply) Regulations 2010.

3.2 Eligible consumer agrees that the design, installation, maintenance and operation of the photovoltaic system are performed in a manner conducive to the safety of the photovoltaic system as well as the Discom's distribution system.

3.3 Due to Discom's obligation to maintain a safe and reliable distribution system, eligible consumer agrees that if it is determined by Discom that eligible consumer's photovoltaic system either causes damage to and/or produces adverse effects affecting other distribution systems' consumers or Discom's assets, eligible consumer will have to disconnect photovoltaic system immediately from the distribution system upon direction from the Discom and correct the problem at his own expense prior to a reconnection.

4. Clearances and Approvals

4.1 The eligible consumer agrees to attain all the necessary approvals and clearances (environmental and grid connected related) before connecting the photovoltaic system to the distribution system.

5. Access and Disconnection

5.1 Discom shall have access to metering equipment and disconnecting means of photovoltaic system, both automatic and manual, at all times.

5.2 In emergency or outage situation, where there is no access to a disconnecting means, both automatic and manual, such as a switch or breaker, Discom may disconnect service to the premise.

6. Liabilities

6.1 Eligible consumer and Discom will indemnify each other for damages or adverse effects from either party's negligence or intentional misconduct in the connection and operation of photovoltaic system or Discom's distribution system.

6.2 Discom and eligible consumer will not be liable to each other for any loss of profits or revenues, business interruption losses, loss of contract or loss of goodwill, or for indirect, consequential, incidental or special damages, including, but not limited to, punitive or exemplary damages, whether any of the said liability, loss or damages arise in contract, or otherwise.

6.3 Discom shall not be liable for delivery or realization by eligible consumer for any fiscal or other incentive provided by the central government.

7. Commercial Settlement

7.1 All the commercial settlement under this agreement shall follow the Net metering regulations of _ Electricity Regulatory Commission.

8. Connection Costs

8.1 The eligible consumer shall bare all costs related to setting up of photovoltaic system including metering and interconnection costs. The eligible consumer agrees to pay the actual cost of modifications and upgrades to the distribution facilities required to connect photovoltaic system in case it is required.

8.2 Cost for interconnection equipment including the isolators, meters etc. are also to be borne by the eligible consumer.

9. Termination

9.1 The eligible consumer can terminate agreement at any time by providing Discom with 90 days prior notice.

9.2 Discom has the right to terminate Agreement on 30 days prior written notice, If eligible consumer breaches a term of this Agreement and does not remedy the breach within 30 days of receiving written notice from Discom of the breach.

9.3 Eligible consumer agrees that upon termination of this Agreement, he must disconnect the photovoltaic system from Discom's distribution system in a timely manner and to Discom's satisfaction.

In the witness, where of Mr. _____ for an on behalf of _____ (Eligible consumer) and Mr. _____ for and on behalf of _____ (Discom) agree to this agreement.

_____

_____