

Partnership to Advance Clean Energy - Deployment Technical Assistance Program

CASE STUDY ON VIRTUAL NET METERING



May 2018

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PARTNERSHIP TO ADVANCE CLEAN ENERGY
DEPLOYMENT (PACE-D)

Technical Assistance Program

Case Study on Virtual Net Metering

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LIST OF ACRONYMS

Acronyms	Definition
AT&C	Aggregate Technical and Commercial
BSVNM	Bulk Supply Virtual Net Metering
CPUC	California Public Utilities Commission
CVNM	Community Virtual Net Metering
GVNM	Group Virtual Net Metering
JNNSM	Jawaharlal Nehru National Solar Mission
kW	Kilowatt
MASH	Multi-Affordable Solar Housing
NREL	National Renewable Energy Laboratory
PV	Photovoltaics
RTSPV	Rooftop Solar Photovoltaic
TOD	Time of Day
UVNM	Utility Virtual Net Metering
VNM	Virtual Net Metering

1 BACKGROUND

1.1 NEED FOR THE STUDY

India, along with the rest of the world is undergoing an energy transition with an impetus on use of renewable energy technologies. Like other nations, India's Solar Photovoltaic (SPV) program was perceived in 1970s in response to the oil crisis. In 2010, the Jawaharlal Nehru National Solar Mission (JNNSM) was introduced as part of the National Action Plan on Climate Change 2008, and a target was set to install 20 gigawatt (GW) solar capacity by 2022. In 2014, the government increased this target to 100 GW, and set a sub-target of 40 GW of grid connected rooftop solar systems, or rooftop solar photovoltaic (RTSPV), which allow consumers to generate electrical energy at their premises using a net-metering mechanism.

1.1.1 Net Metering

Net metering is an energy accounting mechanism that helps consumers with grid connected rooftop solar systems reduce their energy bills. Globally, it has been a key instrument in promotion of rooftop PV deployment. Under a net metering arrangement, consumers who install solar rooftop system on their premises have their energy bill offset against the solar power generation. Net metering works with metering at two points—a bi-directional energy meter which records both import and export of energy and a generation meter that accounts the solar generation as shown in Figure 1.

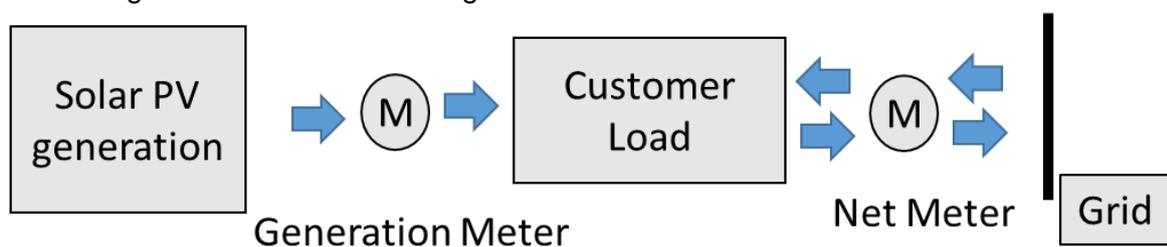


Figure 1: Schematic Representation of Net Metering Arrangement

1.1.2 Challenges of Net Metering

Despite the applicability of incentivized metering arrangements, India has only achieved about 1.1 GW of grid connected solar rooftop as on March 2018. This is due to a variety of reasons, ranging from poor implementation in some states, and reluctance or slow execution by discoms. From the point of view of the consumer, the challenge of net metering is that it only appeals to a small cross-section of consumers who have high-tariffs, adequate rooftop space and a sufficient load at a single location. Net-metering system presents challenges in promotion of rooftop solar among several classes of consumers. Some such classes are as follows.

- Consumers who are forced to install rooftop systems of lower capacity due to small connected loads, despite having large rooftop space and the financial capability, e.g., warehouses, domestic consumers in semi urban areas, etc. This leads to sub optimal usage of rooftop space and loss of benefit from potential 'economies of scale'.

- Consumers with a portfolio of buildings, e.g. large commercial establishments and institutions such as the Indian Railways. Such consumers with large rooftop space at several premises, may have significant loads at different locations. These customers are unable to avail net metering benefits under the current approach. The same is applicable for consumers who have sufficient aggregated load and adequate rooftop space at multiple locations.
- Urban residential consumers living in multi-story apartment without any roof rights are unable to invest in solar rooftop generation and derive benefits under conventional net metering schemes.
- Typical residential consumers in housing societies with adequate shared space within the premises have no incentive to adopt rooftop solar, as they cannot avail net metering benefits because net metering schemes map one consumer to one point of generation.

To facilitate such categories of consumers to set up rooftop solar, a new metering arrangement such as virtual net metering (VNM) is required. The concept and its applications are discussed in the following sections.

1.2 CONCEPT OF VIRTUAL NET METERING

Virtual Net Metering (VNM) is an innovative arrangement wherein billing software is used to allocate credits to linked accounts to help address the challenges associated of net metering discussed above. VNM allows customers with on-site generation to allocate their excess energy to other sites that they own. A schematic representation of the concept is shown in Figure 2.

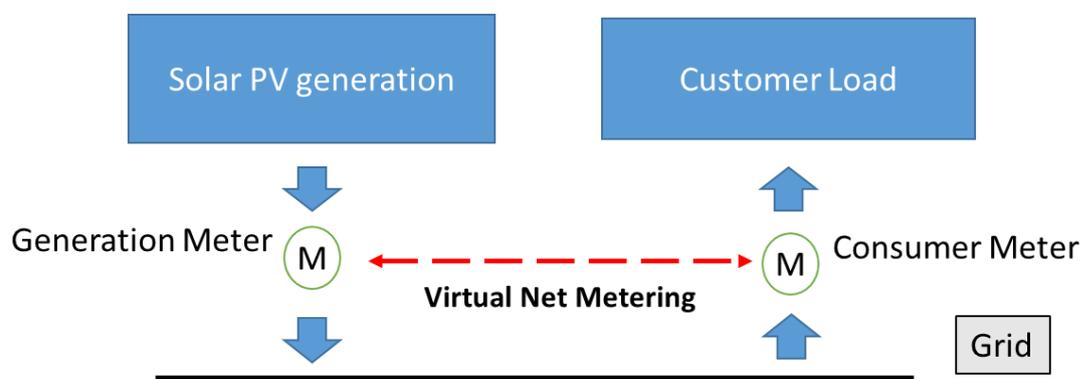


Figure 2: Schematic Representation of VNM System

This system also enables setting up of solar plants under joint ownership either on-site or off-site. Since a billing software is used for netting, single generation can be mapped to multiple consumers, which effectively allows sharing the net metering benefits among participating consumers on predetermined basis. VNM expands the scope of net metering benefits, by making it applicable to a larger set of consumers, as depicted in Table 1.

Table 1: Possibilities of VNM for Generation-Consumer Mapping

Model	Consumer	Generation	Location of Generation and Consumption	Example
Simple net metering	Single	Single	Same	Home or business customer installing a rooftop solar plant on a single location
One to one model	Single	Single	Different	A home owner installing a solar plant in another location owned by them
One to many model	Multiple	Single	Same	Residents of an apartment building installing solar plant on the common roof
	Multiple	Single	Different	Residents of an apartment building installing a solar plant on a different location
	Multiple	Multiple	Same	Residents of a housing society installing rooftop plants on society premises
	Multiple	Multiple	Different	Residents of a housing society installing one rooftop plants outside its premises

VNM can help allocate credits from a shared generation to multiple consumers and allow a single consumer to install a generation system with higher capacity equivalent to aggregated loads from multiple premises. VNM is a powerful tool for promoting adoption of rooftop solar by consumers, as it expands the type of customers who can avail its benefits, by providing greater flexibility in choosing locations of energy production and consumption. It offers financial benefits in terms of lower energy bills along with environmental benefits of using renewable energy.

Through VNM, a new class of Net Generator consumers can be created to export energy to the grid, which other Net Beneficiary consumers can use through the utility and provide infrastructure, thereby allowing its delivery. Developing new mechanisms like VNM to compensate utility for the use of infrastructure minimizes the revenue cost shifting problem.

Introduction of VNM to the Indian market will ensure that all the consumers, with or without adequate rooftop availability, have a facilitative framework in place to set up an rooftop solar system. However, to develop a resilient and robust framework, it is instructive to understand and learn from various schemes and provisions of the markets introducing metering arrangement as a concept to facilitate its consumers. Based upon these learnings, VNM framework may be tailored to suit the Indian scenario.

1.3 OBJECTIVES OF THE CASE STUDY

This document is a case study on VNM mechanisms which are currently practiced globally. The objective of the case study is to assimilate the best practices from international experiences that may aid in the development of VNM framework and identify possible implementation models for India.

1.4 SCOPE OF THE STUDY

This case study focusses on the VNM models adopted in the California and Massachusetts, as both states were fore-runners who paved the pathway for the rest of the world. The case study will also briefly examine different pathway VNM has toward distribution energy markets in Australia. While Massachusetts adopted a progressive approach without distinguishing between conventional and VNM; California, where VNM evolved has adopted a restrictive

policy stance on the use of power lines mandating generation close to load. Together, the three examples represent the spectrum of approaches which encompass of all the VNM programs.

2 RELEVANCE OF VIRTUAL NET METERING IN INDIA

India is blessed with an average 300 sunny days in a year and has selected solar photovoltaic (PV) energy as the prime driver for its ambitious renewable energy target of 175 GW by 2022. At the same time, this ambitious target presents challenges in deploying and integrating relatively expensive RE, while ensuring universal access for energy for Indian citizens. Large-scale deployment of utility solar, in an enabling policy environment with access to adequate capital has shown potential to achieve grid parity in the recent auctions. However, the rooftop segment remains a new area in India, and continues to lag in capacity addition, and necessitates innovation to reach the set goal of 40 GW. For rooftop solar to be successful, and in order to realize the full potential of the country's buildings sector, a robust net metering framework is critical. There are several reasons why VNM is an important aspect of such a framework, they are summarized below.

Adaptable platform: VNM provides a broad platform which can be used effectively to bring a wide spectrum of consumers with an inadequate rooftop space to access solar energy. This can be an enabling scenario for urban consumers who are driven by environmental and economic factors to adopt rooftop solar. VNM provides a sustainable solution for residential consumers in multi-tenant buildings and group housing societies to adopt solar energy. Benefits of VNM to various stakeholders are summarized in Figure 4.

Better economies of scale: VNM can help bridge the gap between large-scale utility scale deployment and the small-scale consumer driven deployment. VNM allows consumers to install larger sized installations, allowing them to take advantage of declining costs of solar energy. The ultimate benefit of VNM is that it casts a wider web for potential stakeholders who can participate in capacity addition, and increases the effective availability of sites suitable for deployment of rooftop solar across the country by removing policy barriers.

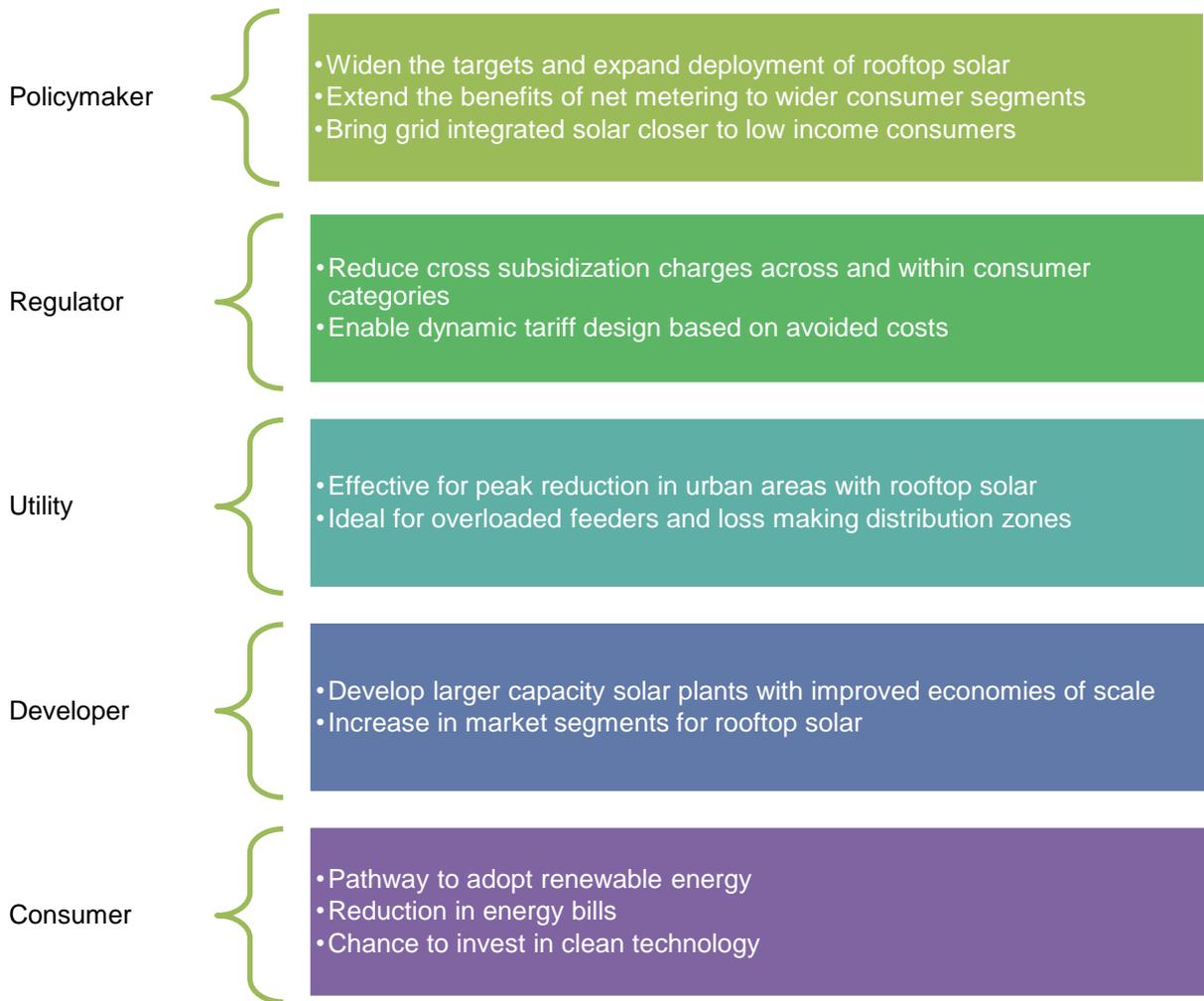


Figure 3: Benefits of VNM

3 INTERNATIONAL EXPERIENCE IN VNM

3.1 VNM IN THE UNITED STATES OF AMERICA

VNM for multiple entities developed in the United States (USA) as an enabling solution under the broader framework for shared renewables¹, allowing shared ownership in distributed generation. Shared renewable programs were designed to expand renewable access to customers who cannot install solar systems on their properties. The first public record available on VNM was when the state of Massachusetts² evolved a policy stance in their Neighborhood Net Metering³ program in 2008. Credit for the first successful experiment however goes to the Public Utilities Commission (CPUC) for California⁴ for their adoption of VNM under the Multi-Affordable Solar Housing (MASH) scheme for multi-story low income housing, in 2009.

With the marked success of VNM in the MASH scheme, CPUC extended the scheme to all multi-meter and multi-tenant properties in general market. In general, the framework of VNM has evolved over the years to fit varied consumer profiles. Currently, states of California, Colorado, Connecticut, Delaware, Hawaii, Maine, Maryland, Massachusetts, Minnesota, New Hampshire, New York, Oregon, Vermont, and Washington D.C have enabled VNM⁵. Most states in USA offer VNM for all renewable generation technologies including solar, wind, small hydro, and fuel cells.

3.2 VNM IN OTHER COUNTRIES

The success story of VNM has spread to other geographies, as depicted in Figure 3. Globally, regulators and utilities are adopting the innovative platform which offer consumers new pathways to participate in renewable electricity generation:

- Brazil's Energy Regulator, the National Electric Energy Agency has approved a revision of net metering regulations in 2015 to introduce VNM⁶.
- In Australia, VNM piloted in five areas including Byron Shire Council in 2015⁷ and is being evolved into Local Electricity Trading⁸ or peer-to-peer trading.
- VNM was introduced in Greece in 2016,⁹ which allows setting up of solar and wind installations away from the place of actual power consumption to consumer categories including schools, universities, and farmers.
- Canada has proposed an amendment¹⁰ to net metering regulation as part of its Long Term Energy Plan in 2017, to enable VNM demonstration projects.

¹ Model Rules for Shared Renewable Energy Programs, Interstate Renewable Energy Council, 2013.

² Department of Public Utilities (DPUC) Massachusetts Net Metering Regulations Available in Order No. 220 CMR 18.

³ Massachusetts Department of Public Utilities (DPU) Net Metering Resources Available at www.mass.gov/dpu/netmetering.

⁴ California Public Utilities Commission (CPUC) Decisions 08-10-036 and 11-07-03.

⁵ Database of State Incentives for Renewables and Efficiency Maintained by DSIRE USA Available at www.dsireusa.org/.

⁶ Article on Brazil's Net Metering Revision Available at www.pv-tech.org/news/brazil-approves-historic-net-metering-revision.

⁷ <http://reneweconomy.com.au/byron-shire-to-be-first-in-australia-to-pilot-virtual-net-metering-74516/>.

⁸ Rutovitz, J., Atherton, A., McIntosh, L., Langham, E. and Downes, J. (2016) Local Electricity Trading: Issues for Retailers. Institute for Sustainable Futures, University of Technology Sydney

⁹ Law No. 3428/2006 article 2.



Figure 4: Timeline Depicting Development of VNM Programs

3.3 INTERNATIONAL VNM MODELS

International experience in VNM shows that there are multiple approaches possible. Several forms are possible, as shown in Table 2. VNM can be designed as one-to-one model or one-to-many model including:

- Generation transfer to another meter/location owned by the same entity (i.e., customer has space for solar PV at one site, but the demand is at another facility).
- Generator-customers transfer or sell their exported generation to another customer or group of customers.
- Community-owned renewable energy generators transfer their generation to other shareholders such as local businesses.
- Third party generator sell energy to customers who do not have space to install rooftop solar plants.

The two major models of VNM practiced all over the World include:

- **Single Entity VNM:** Single entity with multiple meters can distribute credits from a generation sized to meet the load requirements of multiple properties located within the same load zone.
- **Multiple Entity VNM:** Multiple persons in a shared generation project receive credits from the electricity generated in proportion to the ownership share.

¹⁰ Proposed Amendment of Ontario Regulation 541/05: Net Metering, available at www.ebr.gov.on.ca

Table 2: Generic VNM Models From International Experience

Model	Type of VNM	Description	Owner of the Plant	Consumer	Example	Benefits	Example Regulations
Single Entity (One to One Model)	Single entity VNM	A consumer exports excess generation from a self-owned solar plant at one site and uses it to offset consumption at another site.	Consumer A	Customer A	An educational institution with more than one campus with excess rooftop space in one, installs a solar system to cater to both places.	<ul style="list-style-type: none"> - Solar can be installed where optimal generation exists. - Renewable energy supply to a building with limited solar resource potential. 	Metering aggregation programs in New York, California
Multiple Entity (One to Many Model)	Community VNM	A group of consumers can jointly own a solar plant within their premises and offset their consumption.	Consumer A, B, C etc.	Consumer A, B, C etc.	A housing society with adequate rooftop area in common for installing a solar system under shared ownership.	<ul style="list-style-type: none"> - Allows residential customers to benefit from economies of scale. - Shareholders receive higher return on investment as they can offset their own load. 	Neighborhood Net Metering Program in Massachusetts
	Joint ownership VNM	A group of consumers jointly own a solar plant which is located in the premises of one of the consumers and use the energy generated to offset their consumptions.	Consumer A, B, C etc.	Consumer A, B, C etc.	A group of residential consumers without rooftop space can co-own a solar plant with another consumer (e.g., Warehouse owner).	<ul style="list-style-type: none"> - Better economies of scale as for all the consumers. - Residents without rooftop space has easier access to renewable energy. 	Net Metering Program which allows host customer allocation and market net metering credits such as the one in Massachusetts
	Third party VNM	A third party installs a plant on the premises of a consumer with excess rooftop space and sells excess energy to other subscribed consumers.	Third party	Consumer A, B, C etc.	A RESCO installing a solar plant on the roof of a warehouse supplying the warehouse consumer and selling excess energy to urban residential consumers who do not have rooftop space.	<ul style="list-style-type: none"> - Capital constrained customer can buy renewable energy without capital outlay. - Renters or households without an appropriate site can access renewable energy generation. 	Community Solar program in Colorado

4 NEIGHBORHOOD NET METERING MODEL IN MASSACHUSETTS

Background: Massachusetts state rolled out net metering in 1980's to promote grid connected solar systems to develop shared renewables system. The state enacted a law to allow Neighborhood Net Metering in 2008. A specific section was added to serve the needs of residential consumers. Later, Massachusetts removed limits on maximum capacity on solar installations and linked it to the historic peak load. Market net metering credit is a new concept which was fashioned by another legislative act in 2016 under Section 138.

Key Stakeholders: State of Massachusetts, Massachusetts Department of Public Utilities, Utilities in Massachusetts.

Market Segment: The Neighborhood Net Metering¹¹ scheme predominantly caters to the residential consumers. Non-residential consumers can co-own and share the benefits of the system.

Scheme Design: "Neighbourhood Net Metering" is available for solar plant owned and serving the needs of a group of 10 or more residential customers served by a single utility. The neighbourhood facility may also serve additional customers once residential consumers are locked in. Credits from neighbourhood net metering facility can be allocated to customers in the neighbourhood that own, or are served by the facility. Thus, residents without rooftop space can receive solar plant benefits. Massachusetts¹² also allows host consumers to allocate credits to other consumers under VNM models. The neighborhood net metering model utility that allocates excess net metering credits from a host consumer to another consumer is captured in Figure 5.

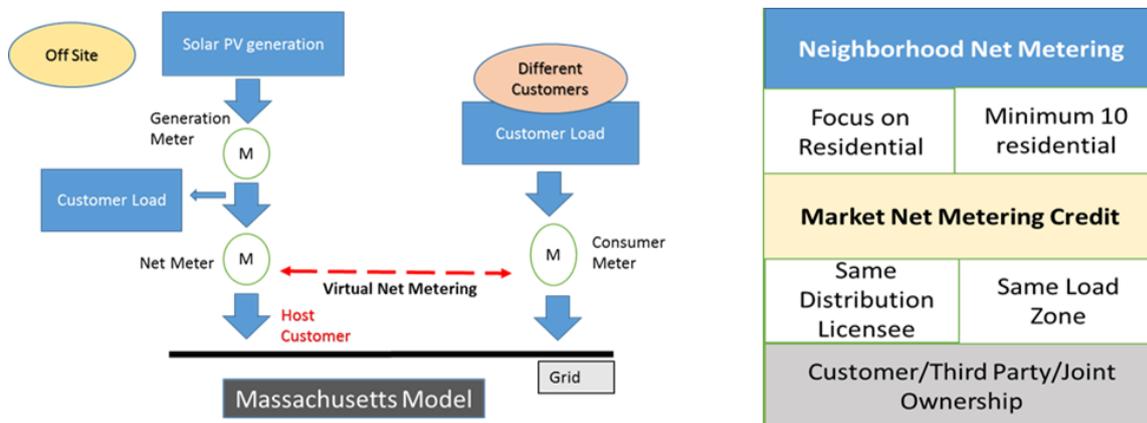


Figure 5: Schematic Representation of Neighborhood Net Metering Model of Massachusetts

¹¹ General Laws of Commonwealth of Massachusetts, Part 1, Title XXII, Chapter 164, <https://malegislature.gov/Laws/GeneralLaws/PartI/TitleXXII/Chapter164>.

¹² Renewable Energy Power Purchase and Net Metering Credit Purchase Agreement Guidance for State Entities, Department of Energy Resources, Massachusetts, 2013.

Highlights from the program:

In April 2016, Massachusetts¹³ removed limitations on system capacity and created different net metering credit values for solar net metering facilities called **Market net metering** credits¹⁴ which is the credit provided for excess generation that is fed into the grid. This allowed setting up of Neighborhood net metering facilities of which receive a lower credit for excess generation that is fed into the grid.

Massachusetts net metering has provisions for **minimum reliability charge**¹⁵ to be imposed on consumers that receive market net metering credits which will cover fixed costs for ensuring the reliability proper maintenance and safety of the electric distribution system. The law also states that the minimum reliability contribution can only be imposed when a set aggregate capacity is reached and low - income consumers may be exempted from it.

Massachusetts also allows **joint ownership**¹⁶ under neighbourhood net metering programs where the net metering facility may be jointly owned by residential customer with other customers. The minimum ownership requirement for a neighbourhood net metering program is for a group of 10 or more residential customers. However even non-residential customers who reside in the same neighbourhood and is served by the same distribution company can co-own the system.

Learning: Market Net Metering concept

Market net metering credits are allocated for excess generation, which receives lower credit. In Massachusetts 60 % is allocated which are subject to additional transmission and distribution charges to arrive at the final tariff

Learning: Minimum reliability Charge

Minimum reliability charges are imposed designed in such as a way to offset the costs of maintenance and safety of the electrical distribution system without burdening the low income consumers who are under net metering regime.

Learning: Joint Ownership

Massachusetts net metering allows residential consumers to jointly own the solar systems with other customers who reside in the same neighbourhood and is served by the same company.

Credit Allocation for Different Consumer Categories

The application of lower credit (60 percent) across all consumer categories for excess generation from one site may end up dis-incentivizing consumer categories with lower energy rates to adopt solar. Creating a win-win situation may require a variable rate for credit allocation across all consumer categories. For example, the following allotment may be used:

- Industrial – 65 percent
- Commercial – 90 percent
- Residential – 100 percent

¹³ Massachusetts Solar Energy Act 2016

¹⁴ Net metering credit calculation and billing section of Massachusetts net metering guide available at <https://www.mass.gov/guides/net-metering-guide>

¹⁵ Massachusetts General Law Part 1, Title XXII, Chapter 164, Section 139

¹⁶ Massachusetts net metering guidelines 220CMR18

5 MULTI-TENANT NET METERING MODELS IN CALIFORNIA

Background: The State of California took the first step to enable VNM through the MASH program¹⁷ meant to provide benefits of solar to low income multi-storey housing tenants. The California Solar Initiatives, created through California Senate Bill in 2006, set aside 10 percent (USD 216 million) of their funds to promote the adoption of solar for residential low income consumers by providing financial assistance for installation of solar. In 2013, the California Legislative Assembly Bill (AB 217) authorized additional funding to MASH program and extended the program to 2021.

Key Stakeholders: California Public Utilities Commission, Centre for Sustainable Energy, Pacific Gas and Electric, Southern California Edison, San Diego Gas, and Electric.

Market Segment: Californian¹⁸ model was rolled out for multi-tenant buildings and low income housing. Later, the VNM model was opened for general market.

Scheme Design: In this, the energy generated from rooftop solar plant of an apartment complex was fed directly to the grid. All the tenants living in the apartment shared credits which are allocated by the utility to the tenants based on the apartment size¹⁹. The PV system was not physically connected to the client meters thereby avoiding significant hardware and installation costs. Third party installers undertook the benefit of MASH funding and tax making it a viable business model. A schematic representation of the Californian MASH model is shown in **Figure 6**.

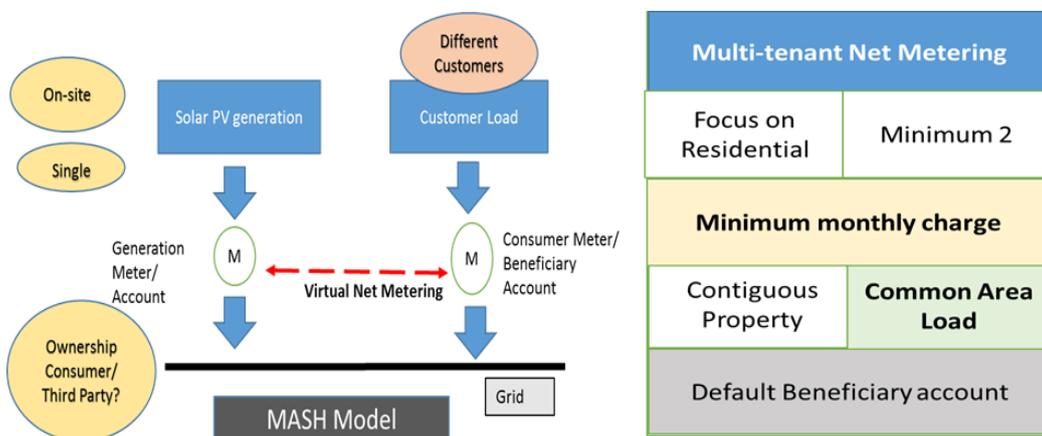


Figure 6: Schematic Representation of Multi-Tenant VNM in California

¹⁷ Case Study California Multifamily Affordable Solar Housing Program, US Environment Protection Agency, 2017.

¹⁸ Multifamily Affordable Solar Housing Program Handbook, First Edition, 2015. Available at: www.gosolarcalifornia.com/documents/MASH_Handbook.pdf.

¹⁹ California Public Utilities Commission(CPUC) resolutions E-4610, E-40303, E- 38157, E-37825.

Highlights from the Program

Based on the positive response for VNM from the MASH program, the CPUC extended VNM program to the general market for all types of multifamily and multi-metered buildings²⁰. It was easier for California to extend the programs as the **changes in billing software** which constitutes the major cost component for VNM implementation was already undertaken. Both the VNM model were similar with mandate for generation from adjacent or contiguous properties.

The key takeaways from the multi-tenant models in California represented in figure 6 include the provision for a minimum monthly service charge for the general market, inclusion of common area load for net metering benefits and selection of a **default account** for credit allocation. By selecting a default account as the primary beneficiary to allocate the net metering the utility billing process was simplified. In MASH program the common area load of the multi-tenant building was selected as the default account.

Learning: Billing Software Change

Major cost component for VNM implementation was billing software change and inclusion of more consumer categories under VNM helped in recovering the costs

Learning: Default account for Billing

Billing mechanism can be simplified by defining one Consumer account as default account. In MASH the common area load was defined as the default account.

CHALLENGE OF OPEN ACCESS

Challenge: VNM models may require use of distribution network for transferring power from the generating station to the consumer. The concern about open access charges were relevant even when VNM was piloted in MASH in California. The program coordinators of MASH program were of the opinion that use of utility grid to move the power from the point of production to the point of consumption constitutes a form of retail wheeling. The fair allocation of transmission and distribution costs vis a vis application of open access charges are regulatory challenges in VNM program design.

How is the open access concerned addressed elsewhere?

There is no single approach to deal with the challenge of open access. Some states have tried to restrict the distance between generation and load while others have decided to introduce transmission and distribution charges allowing load and generation within the same discom.

Solution:

Overcoming the regulatory barrier for operationalising VNM requires regulators to adopt a constructive approach towards eligibility for open access and exceptions in wheeling and banking charges.

²⁰ Virtual Net Energy Metering at Multitenant Buildings, SF Environment, 2013

6 VNM MODELS IN AUSTRALIA

Background: Australia is witnessing a marked increase in the number of prosumers with wide adoption of distribution generation and the state decided to roll back the incentives for the distributed generation. In 2015, the Australia Renewable Energy Agency initiated five trials in New South Wales, Victoria, and Queensland to investigate the potential impact of VNM (local energy trading) and local network charge.

Key Stakeholders: Australian Renewable Energy Agency, Institute of Sustainable Futures, University of technology Sydney, City of Sydney, Byron Shire Council, Moira Council, Swan Hill Council, Consumers in New South Wales, Victoria, Queensland

Market Segment: VNM was first understood in Australia as a reduced set of charges for local generators and/or for local electricity customers in situations where a formal link is established between an individual local generator and an individual local electricity customer. VNM or local electricity trading is an arrangement whereby a generation at one site is “netted off” at another site on a time-of-use basis, so that Site 1 can sell or assign generation to nearby Site 2.²¹ This will reduce the combined energy and retail portion of electricity bills for local generation.

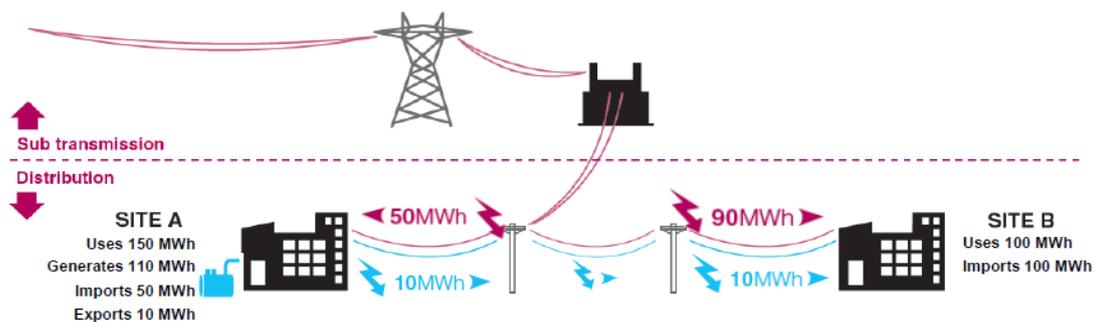


Figure 7: Representation of VNM Model in Australia

Source: ISF

Scheme Design: Byron Shire Council allowed Origin Energy to set up a PV plant in Cavanbah Sports Centre (generation site) and the West Byron Sewage Treatment Plant (netting off site). The Cavanbah Sports Centre with low consumption and good roof space transfers energy to the nearby sewage treatment work which has high consumption but little space. The virtual trial was also undertaken for Moira²² and Swan Hill council for feasibility of one-to-many community solar farm using Local Electricity Trading to supply generation from the solar array to the owners/members.

²¹ Institute of Sustainable Futures and University of Technology Sydney, Byron Shire Trial Fact Sheet, 2016.

²² Rutovitz, J., McIntosh, L., Langham, E., and Atherton, A. (2016) Virtual trial of Local Electricity Trading and Local Network Credits: a community solar farm. Prepared for Moira Shire Council and Swan Hill Rural City Council. Institute for Sustainable Futures, UTS.

COST ALLOCATION PROBLEM

Challenge: VNM models allow setting up consumer owned solar rooftop plants away from load centers. The consumer is allocated credits according to the share of his ownership, limited by the connected load. This model necessitates the use of utility's distribution system to supply power. At times, the generation centers do not have transmission/distribution infrastructure. Additional expenses for infrastructure needs consideration while designing such projects. Viability of VNM project depends on the costs of the new VNM technology implementation weighed against the potential benefits.

Who pays for distribution system upgrades elsewhere?

The utility generally pays for distribution system upgrades required to interconnect a VNM project unless there is a single beneficiary of a required interconnection facility, e.g., customers are responsible to pay for an upgrade of a dedicated transformer, if the transformer serves only one property and account/s. Customers do not pay for transformers serving other consumers.

Solution:

- a) The consumer invests to develop a transmission network till the point of interconnection with the grid and receives 100 percent solar credits.
- b) Utility and consumer share the cost of transmission network in equal or any predetermined ratio.
- c) The utility bears the cost of augmenting grid to evacuate renewable generation from a cluster where excess rooftop potential is available, and the net solar credits for the consumer can be calculated taking into consideration transmission costs.

7 LEARNINGS FROM THE CASE STUDY

7.1 GENERAL LEARNINGS

- **Need for enabling policy:** The primary learning from the international experience in VNM is that though VNM was implemented globally by regulatory decisions, there exists an enabling policy stance which allowed the application of net metering to cases other than 'behind-the-meter' generation. Clubbing net metering to off-site generation and aggregation of loads necessitate reframing of existing policies. Clarity on administrative limit for credit allocation is essential while defining VNM. The policy should address supplementary components of a program design including marketing and consumer interface, facility maintenance, and dispute resolution process.
- **Role of regulators:** It is evident from international experiences that VNM is developed as a platform from progressive regulatory vision that can be customised to different models. The regulator is a key stakeholder in determining the parameters such as minimum and maximum size of the system and the minimum load requirement at site of generation. The regulator should determine if lower credits such as market net metering credits should be applicable for VNM. Additionally, the regulators should also decide the role of utility in VNM systems.
- **Solar for low income communities:** VNM aided in achieving 'Solar for All' by improving the access of low income communities to solar as it helps avoid significant hardware and installation costs, lowering the total cost of the system. VNM also allows credit from a community sized off-site generation plant making solar more affordable to low income households. Several states in USA including Massachusetts have explicitly enabled third-party ownership of shared renewable energy systems where **subscription method** is followed to facilitate participation of low income communities.

7.2 KEY LEARNINGS FROM MASSACHUSETTS

Following are the key learning from Massachusetts:

1. **Market net metering credits:** Market net metering credits are allocated for the excess generation which are at a lower percentage than generation for self-consumption. This can help remove limitations on system capacity and attract those customers with sufficient roof space availability to install larger systems. For example, Massachusetts allots 60% of the net metering credit for such customers, and these are subject to additional transmission and distribution charges to arrive at final tariffs.
2. **Minimum reliability charge:** For customers installing larger systems, and availing market net metering credits, Massachusetts imposes minimum reliability charge to offset costs of maintenance and safety of the electrical distribution system. This ensures that the state protects consumers under net metering regime from the burden of cost from distribution system maintenance, while encouraging participation by larger generators.
3. **Joint Ownership:** Massachusetts net metering allows residential consumers to jointly own the solar systems with other customers who reside in the same neighbourhood and is served by the same company.

7.3 KEY LEARNINGS FROM CALIFORNIA

- **Billing software changes:** California was able to extend its program to all categories of consumers as changes in billing software, which constituted the major cost component for VNM implementation, had already undertaken. Both VNM models were similar with mandate for generation from adjacent or contiguous properties.
- **Minimum monthly service charge:** When the scheme designed for low income communities was extended to the general market, the provision added a monthly minimum service charge covering the operational and maintenance costs.
- **Default account:** By selecting a default account as the primary beneficiary to allocate net metering, the utility billing process was simplified. In MASH program, the common area load of the multi-tenant building was selected as the default account.
- **Restrictive approach:** California adopted a restrictive approach towards VNM and restricted the load and generation to be in contiguous properties. Citing the use of distribution networks without any open access or wheeling charges against the single service delivery point restriction, multiple buildings within the same compound were denied installation under VNM.

7.4 KEY LEARNINGS FROM AUSTRALIA

- **Wheeling charges:** Australia found that VNM arrangement becomes more attractive when wheeling charges are available. This can substantially improve the business proposition for generators by crediting a greater value to locally generated electricity.
- **Local generation network credits:** Sydney has proposed a change in rules to allow small-scale local generators to monetise benefits that they collectively provide to the grid. The credit can assist localized generators of sufficient aggregate size and scale to be treated as a diversified portfolio, as opposed to being treated as individual generators.

The key learnings from VNM international experience is summarized in Table 3.

Table 3: Learnings From International Experiences in VNM

Learnings	Description	Learning From	Concerned Stakeholder	Remarks
Market net metering credits	Facilitates where the upper cap on generation is not available and receives compensation for excess generation at a lower, market net metering rate.	Massachusetts Net Metering Program	Regulator and Policy	Market net metering credits are allocated for the excess generation which are at a lower percentage than the excess generation.
Minimum reliability charge	Minimum reliability charge covers the costs incurred by the utility for maintaining reliability, proper maintenance, and safety. It also covers the fixed cost of the electric distribution system which is not caused by volumetric consumption.	Massachusetts Net Metering Program	Regulator and Utility	Utilities are allowed to charge the consumers a minimum reliability charge. Residential VNM consumers other than low income housing pays either the minimum monthly service charge or the net energy bill, whichever is greater.
Joint ownership	Under VNM, solar systems of larger capacities can be installed which are jointly owned by group of consumers or consumer and developer together. In some places, special purpose entities are formed for the same.	Massachusetts Net Metering Program	Developer and Consumer	Joint ownership of developer with fixed percentage of consumers who are locked in is a good risk reduction measure. Massachusetts residential consumers should jointly own the solar generation systems with commercial consumers.
Administrative limit for VNM	VNM allows net metering when generation is not equal to load. The administrative limit is the boundary settings on how far the consumers can be from the generation.	California and Massachusetts Net Metering and Metering Aggregation Programs	State Government, Regulator and Utility	Within U.S., while some states like Massachusetts allow generation site to be anywhere within the distribution company service territory, many states like California allow only generation within contiguous property.
Subscription method	Under subscription method, consumers pay a specific fee decided according to kW or kWh to the owner of the plant.	Massachusetts Net Metering Program	Developer and Consumer	Subscription models can be considered for credit allocation from third party owned projects especially for low income consumers who cannot bear the capital cost.
Portability and transferability	Consumers especially in rented premises are allowed to move in and out of the VNM programs.	Shared renewable programs in USA	Utilities, Consumer	In VNM, portability and transferability of consumers is an attractive feature for marketing. Utilities charge the consumer administrative charges for account additions and modifications.

Learnings	Description	Learning From	Concerned Stakeholder	Remarks
Billing methods	The billing for VNM can be done with or without a net meter (see Annexure for more details).	Massachusetts Net Metering Program	Regulator, Policy	The billing can be performed by using a billing software to link the net meter with the consumer's energy meter. Alternatively, it can be performed by linking the generation meter to the customer's meter.
Wheeling charges	The distribution company levies a charge for the use of distribution network for power transfer.	Australian VNM Trials	Regulator, Utility	A VNM arrangement becomes more attractive when wheeling charges are available as it can substantially improve the business proposition for the generator by crediting a greater value to the locally generated electricity.
Local network credits	Local network credits reflect the benefits associated with electricity generation that is embedded within distribution networks.	Australian VNM Trials	Regulator, Utility	Local network credit will have two parts comprising of long-term component not having to augment the network and short-term component based on avoided operational costs.

7.5 APPLYING LEARNINGS IN VNM FOR INDIA

The program has already proposed a few VNM models for India as part of the revisions required for existing policy regulatory framework facilitating consumers without adequate rooftop space to adopt solar²³. The key features of these models and the possible learnings that can be adopted to strengthen the models identified by the program are as below.

7.5.1 Group VNM (GVNM)

Description: GVNM scheme as explained in **Figure 8**, means a single consumer is allowed to acquire energy metering credits against solar rooftop generation at one of the premises owned or leased by the consumer. The consumer should have adequate rooftop space in at least one of his premises.

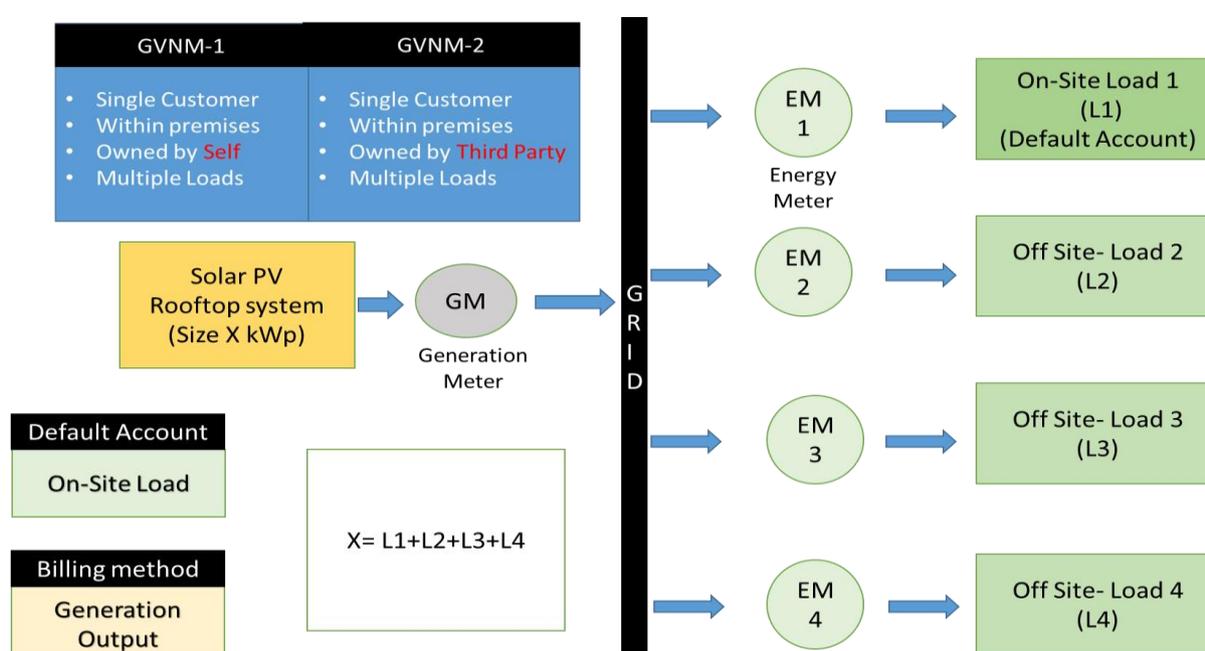


Figure 8: Representation of GVNM

Learnings Applicable:

- **Default account:** The load at the generation location can be used as default account for ease of billing.
- **Market net metering credits:** The excess generation from the generation site which is used to offset another meter from the consumer can be given a lower credit.
- **Generation based billing:** Billing can be performed by linking the generation meter to the energy meter of the consumers.
- **Administrative limit:** The regulator can decide on the administrative limit of VNM in terms of how far the generation site is and the beneficiary meters.

²³ HERC Regulations.

7.5.2 Bulk Supply VNM (BSVNM)

Description: BSVNM scheme as represented in Figure 9, is designed for consumers who receive bulk supply from the utility and have adequate but shared space within the premises to set up solar rooftop systems. The systems can be developed under consumer or third-party ownership.

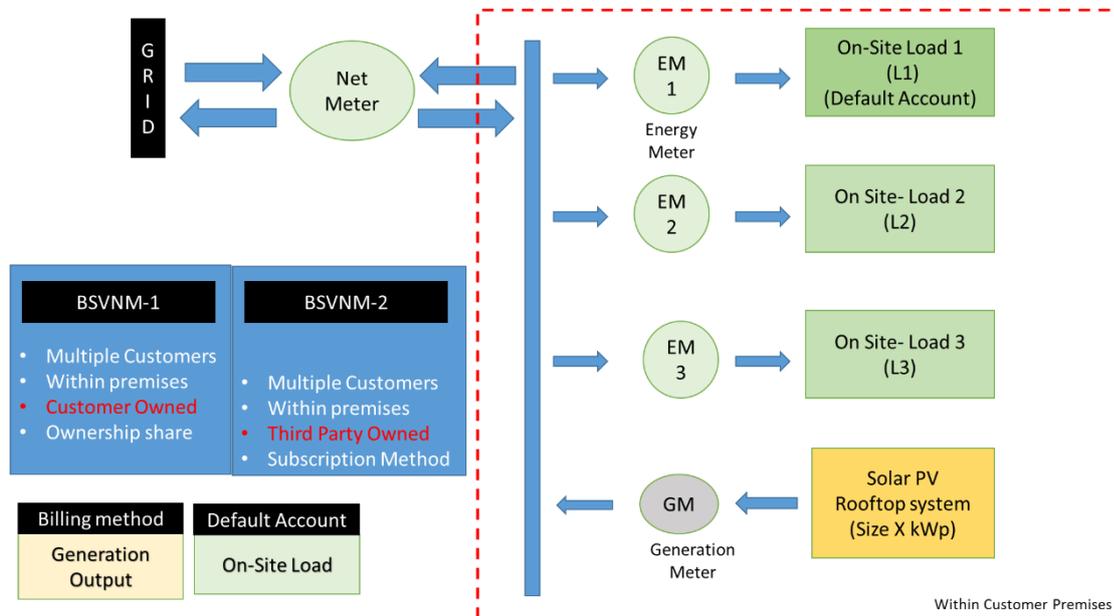


Figure 9: Representation of BSVNM

Learnings Applicable:

- **Ownership share or subscription method:** For systems which are owned by the consumers themselves, the credit allocation can be performed based on the ownership share. For third-party owned systems, subscription method can be used to decide on the allocation.
- **Minimum charges:** The utility can determine a minimum reliability charge applicable for the residential consumers such that residential VNM consumer pays either minimum monthly service charge or the net energy bill, whichever is greater.
- **Allocation for low income group:** A portion of the third-party owned systems can be allocated to cater to the needs of low income communities near-by especially if without adequate rooftop space.
- **Joint ownership:** A consumer without adequate rooftop space may be allowed to co-own a system with the residential community if they have more rooftop potential than the connected load.

7.5.3 Community VNM (CVNM)

Description: A separate model designed for residential consumers without adequate rooftop space is called CVNM system and is represented in Figure 10. The generation system is set up within the same distribution zone where all the customers reside. This model is beneficial for urban consumers.

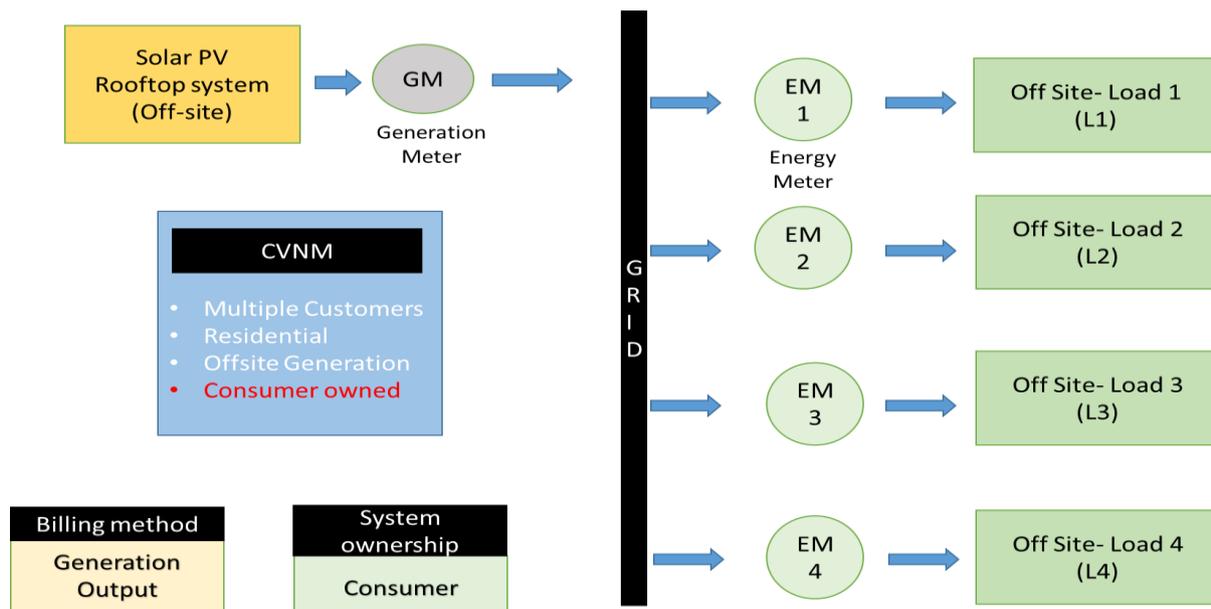


Figure 10: CVNM

Learnings Applicable:

- **Joint ownership:** To avail the benefit of better economies of scale, the consumer should co-own the system with another set of customers. A customer with excess rooftop space may also be a feasible partner for joint ownership.
- **Third party ownership and subscription method:** Many of the residential consumers especially living in multi-storey apartments might be on rent. Such consumers may benefit by subscribing to a third-party owned system.
- **Minimum charges:** The utility can determine a minimum reliability charge applicable for the residential consumers such that residential VNM consumer pays either the minimum monthly service charge or the net energy bill whichever is greater.
- **Allocation for low income group:** A portion of the third party owned systems can be allocated to cater to the needs of low income communities nearby especially if without adequate rooftop space.

8 ANNEXURE

8.1 BILLING METHODS

VNM can be performed with or without a net meter. VNM as allowed in the MASH model was developed via modifying the billing software without a net meter. Additionally, VNM can be performed using a net meter. The following are the two major methods of billing used in the U.S.

8.1.1 Generation Output Method

Description: In the generation output accounting method, the generation is metered separately, and there is no physical net meter. The consumer or the utility can allocate the credits to the any number of consumer accounts of the same client. The client or utility can perform the allocation based on the connected load to all the accounts to be aggregated. A schematic representation of the generation output system is shown in Figure 11.

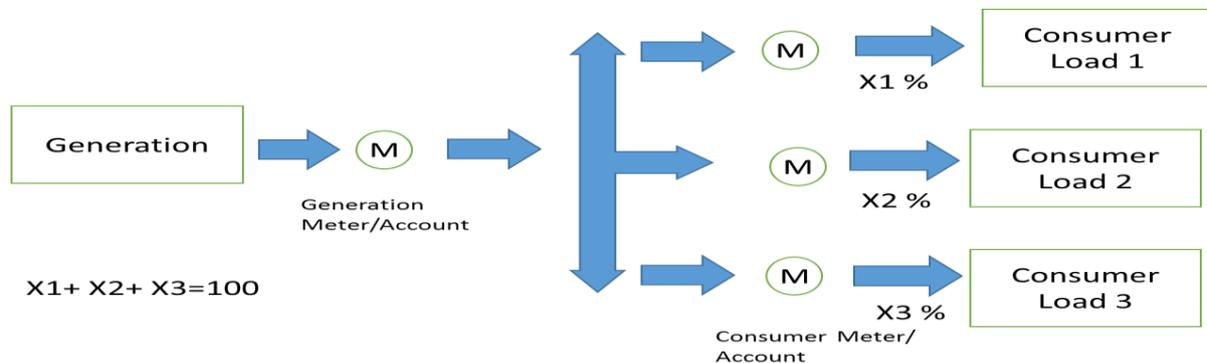


Figure 11: Schematic Representation of Generation Output Method

Applicability: Allows setting up of VNM without the added cost of net meters. Applicable for setting up of community-based net metering projects and also for consumers having excess rooftop area in one premises than connected load.

8.1.2 Billing Accounting Method

Description: Billing account method is an innovative VNM technology which allows a consumer already under net metering to aggregate other loads. The excess credit from one generation site can be allocated to other meters of the same consumer. The generation is sized to meet all the aggregated loads of the consumer. Generally, it is a practice to let the consumer perform the allocations under this VNM method. The schematic representation of the billing account method is given below in Figure 12.

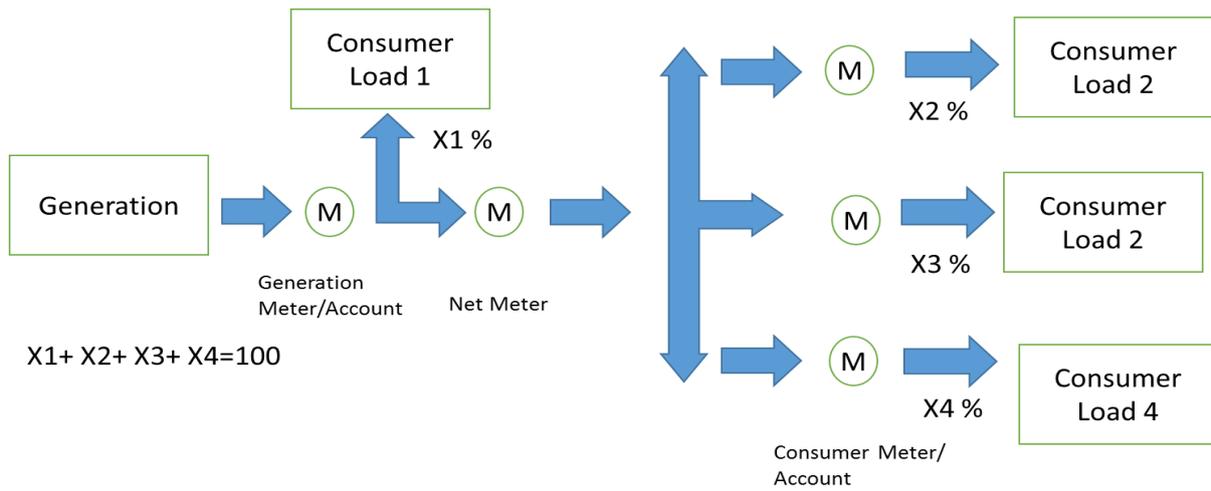


Figure 12: Schematic Representation of Billing Account Method

Applicability: For consumers already under net metering schedule with excess rooftop area than connected load

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