



## Virtual Net Metering: An Innovative Venture in Energy Sector by Maharashtra Government

Nitin Tejmal Kale<sup>1</sup>, Dr. Amit Aggrawal<sup>2</sup>

<sup>1</sup>Research Scholar, School of Commerce and Management Studies, Sandip University, Nashik, Maharashtra, India.

<sup>2</sup>Associate Professor, School of Commerce and Management Studies, Sandip University, Nashik, Maharashtra, India.

**Emails:** nitinkale1976@gmail.com<sup>1</sup>, amit.aggrawal@sandipuniversity.edu.in<sup>2</sup>

### Abstract

Virtual Net Metering (VNM) is an innovative policy initiative introduced by the Maharashtra Government through the Maharashtra Electricity Regulatory Commission (MERC) to promote renewable energy adoption and enable consumers to benefit from offsite solar energy generation. This study provides a comprehensive analysis of Maharashtra's VNM policy, its operational framework, potential benefits, challenges, and implications for residential, commercial, and public entities. VNM allows multiple energy users to share the benefits of a single renewable energy generation system, particularly beneficial for entities lacking the capability or space to install their own renewable energy resources. Under VNM, energy generated from a shared or offsite solar installation is allocated to multiple participants based on their energy consumption, and corresponding credits are applied to their electricity bills. The Maharashtra government has established a framework for VNM implementation, outlining key components such as registration, energy trading, tariff structure, and grid integration. VNM offers several advantages, including increased solar adoption, improved grid stability, reduced carbon footprint, and economic benefits. However, challenges exist in terms of technical infrastructure, regulatory constraints, and consumer awareness. Case studies from global examples provide valuable insights into the practical implementation and outcomes of VNM programs. Recommendations to overcome challenges and ensure successful VNM adoption in Maharashtra include public awareness campaigns, stakeholder collaboration, regulatory reforms, incentive programs, and pilot projects. VNM represents a significant advancement in Maharashtra's pursuit of a cleaner and more inclusive energy future, empowering residents to manage their energy consumption and costs while promoting sustainable energy practices. It also assesses how VNM promotes energy democratization and improves grid stability through decentralized energy systems.

**Keywords:** Consumer Empowerment; Decentralized Energy Systems; Maharashtra Government; Renewable Energy Policy; Virtual Net Metering (VNM).

### Nomenclature

**MSEDCL-** Maharashtra State Electricity Distribution Company Limited

**VNM-** Virtual Net Metering

**MERC-** Maharashtra Electricity Regulatory Commission

### 1. Introduction

The global energy landscape is transitioning towards sustainability, with states and governments adopting innovative strategies to increase renewable energy adoption. The transition to a sustainable energy future is a global imperative, and India has made significant strides in the promotion of renewable energy sources. Maharashtra, one of India's largest and most

industrialized states, is making strides in the renewable energy sector. Among the various initiatives undertaken by the Indian government, the introduction of VNM in Maharashtra is a significant step towards fostering a more equitable and efficient energy ecosystem. Traditional net metering allows consumers to generate solar power onsite and receive

credits for the excess energy supplied to the grid. However, VNM extends this concept by enabling consumers to benefit from solar energy generated at remote or shared locations. This study aims to provide an in-depth understanding of Maharashtra's VNM policy, its comprehensive overview, its potential benefits, the challenges it faces in Maharashtra, and its expected contribution to the state's clean energy goals [1-3].

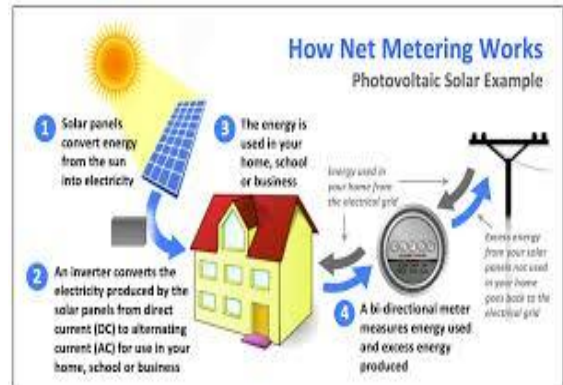


**Figure 1 Virtual Net Metering Scheme Launched by Government of Maharashtra in Co-Ordination with Central Government**

### 1.1. Concept of Virtual Net Metering

In traditional net metering, a single meter measures the energy consumption and generation of a household or business with an installed renewable energy system. Any excess energy produced is fed back into the grid, and the owner receives credits that offset the future electricity consumption [4]. However, this model has limitations, particularly for communal or multi-tenant buildings, farms, or communities where individuals cannot install their own renewable systems. Virtual net metering addresses these limitations by allowing the output from a renewable energy source such as a solar farm to be allocated to multiple users. Virtual net metering (VNM) is an innovative approach to renewable energy utilization and management that allows multiple energy users to share the benefits of a single renewable energy generation system [5]. This system is particularly beneficial for entities that may not have the capability or space to install their own renewable energy resources such as solar panels. VNM is particularly beneficial in urban areas or multi-

dwelling units where individual installations are impractical.



**Figure 2 Traditional Net Metering**

Virtual Net Metering allows energy consumers who cannot install solar panels onsite (owing to space, ownership, or technical constraints) to participate in the renewable energy economy. Under VNM, the energy generated from a shared or offsite solar installation is allocated to multiple participants based on their energy consumption and the corresponding credits are applied to their electricity bills. Unlike traditional net metering, where surplus energy is credited to the same consumer's account, thereby reducing individual electricity bills, VNM allows energy credits to be shared across multiple consumers. This creates a virtual energy market, in which consumers can buy and sell excess solar power, leading to greater energy efficiency and grid stability [6].

### 1.2. Definition and Framework

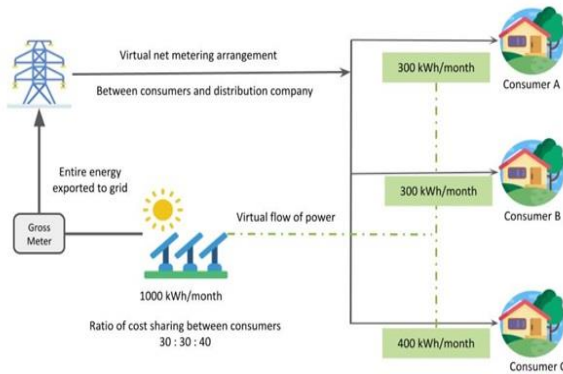
Through this model, the government aims to enable housing societies, small commercial establishments, and government bodies to participate in solar generation [7-10].

### 1.3. Working Mechanism

- **Solar Energy Generation:** The Energy is produced at a remote solar plant or rooftop.
- **Energy Allocation:** A share of the total generated energy is assigned to different consumers based on predefined agreements.
- **Billing Credits:** The allocated energy is credited to the participants in proportionate ratio of generation in their electricity bills, thereby reducing their overall consumption and cost.

- **Grid Interaction:** Surplus energy fed into the grid strengthens the distribution system and supports the energy balance [11].

Figure 1. Simple virtual net metering arrangement



Source: CEEW-CEF analysis

**Figure 3** Concept of Virtual Net Metering

## 2. Literature Review

Virtual Net Metering (VNM) has emerged as a promising approach for harnessing the full potential of distributed solar energy. Several studies have explored the concepts, benefits, and challenges associated with the implementation of VNM. Early studies focused on the technical feasibility and economic viability of VNM and examined the potential for increased solar adoption and grid stability. More recent research has delved into the policy implications of VNM by exploring the role of regulatory frameworks and incentives in promoting its adoption. Case studies from various regions, including California, Australia, and Europe, have provided valuable insights into the practical implementation and outcomes of VNM programs.

**Topic Importance:** Virtual net metering has the potential to encourage more people to participate in green energy generation, thereby contributing to a more sustainable future. Similarly, it can effectively reduce the peak load and improve the system reliability.

**Existing Knowledge:** Previous research has shown that virtual net metering has been successfully implemented in several countries, including the United States and Australia, and has been found to be an effective tool for promoting renewable energy generation.

**Research Gap:** Despite the success of the concept of virtual net metering in other countries, there is a lack of research on its implementation in India, particularly in the state of Maharashtra.

**Rationale:** The rationale behind this study is to explore the potential of virtual net metering as a means of promoting green energy generation in Maharashtra, and to identify the challenges and opportunities associated with its implementation.

**Research Question:** What is the potential of virtual net metering as a means of promoting green energy generation in Maharashtra and what are the challenges and opportunities associated with its implementation?

**Aim/Objective:** This study aimed to evaluate the potential of virtual net metering as a means of promoting green energy generation in Maharashtra and to identify the challenges and opportunities associated with its implementation.

**Hypothesis:** It is hypothesized that virtual net metering has the potential to encourage more people to participate in green energy generation in Maharashtra, but its implementation may be hindered by certain challenges, such as lack of awareness and inadequate infrastructure.

## 3. Virtual Net Metering: A Strategic Initiative by Maharashtra

### 3.1.Key Features of the Initiative

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### 3.2.Benefits of Virtual Net Metering

VNM offers several advantages to consumers, utilities, and the environment.

#### 3.2.1. Promoting Clean Energy and Sustainability

**Increased Solar Adoption:** VNM can encourage and facilitate more consumer participation in installing solar panels that lack access to rooftop installations, as they can now monetize their surplus energy.

**Grid Stability:** VNM helps balance supply and demand, which helps reduce the peak load and



improve grid stability. promotes grid-supportive renewable energy and helps balance supply demand fluctuations [12].

**Emission Reductions:** Encourages the adoption of solar energy, contributing to the carbon neutrality targets of Maharashtra.

### 3.2.2. Economic and Social Impact

**Lower Energy Costs:** VNM allows participants to offset energy bills with solar credit.

**Equity and Accessibility:** Empowers underserved sectors and consumers with limited access to solar installations.

**Enhanced Participation:** Engages in residential communities, SMEs, and institutions in renewable energy generation.

**Improved Grid Stability:** By, the VNM can help improve grid stability because the demand–supply gap is effectively maintained [13].

**Reduced Carbon Footprint:** VNM contributes to the reduction of greenhouse gas emissions by promoting renewable energy generation.

**Economic Benefits:** VNM can create new business opportunities and jobs in the renewable energy sector.

### 3.3 Implementation and Future Prospects

The Maharashtra Electricity Regulatory Commission (MERC) issued draft regulations to facilitate the implementation of VNM, inviting suggestions and objections from stakeholders<sup>1</sup>. This collaborative approach ensures that the final regulations are well rounded and effective in promoting solar energy adoption. Beyond Maharashtra, other states like Delhi and Jharkhand have also explored VNM, indicating a growing trend towards community-based renewable energy solutions<sup>2</sup>. As Maharashtra moves forward with this initiative, it sets a precedent for other regions to follow, potentially transforming India's renewable energy landscape.

### 3.4 Policy Overview

The Maharashtra government, through its energy department and Maharashtra State Electricity Distribution Co. Ltd. (MSEDCL) has launched VNM as part of a broader effort to encourage solar energy utilization and promote decentralized energy production. The policy provides an alternative for consumers without rooftop access and targets the state's goal of achieving 22 GW of solar capacity by

2025. Key beneficiaries include the following.

- Housing societies and apartment owners
- Public institutions like schools, hospitals, and government offices
- Small and medium enterprises (SMEs)

### 3.5 Alignment with National Policies

The VNM initiative aligns with **India's National Solar Mission** that aims to install 100 GW of solar power by 2030. It supports government programs such as the **KUSUM and UDAY schemes** by promoting decentralized energy and reducing distribution losses [14].

### 3.6 Methodology

This study adopts a mixed-methods approach to investigate the implementation of VNM in Maharashtra. The methodology includes the following components.

- **Literature Review:** A comprehensive review of the existing literature on VNM, including academic articles, policy documents, and case studies, was conducted to identify the key concepts, benefits, challenges, and best practices.
- **Policy Analysis:** An analysis of the Maharashtra government's policies and regulations related to VNM was undertaken to understand the framework governing its implementation.
- **Data Collection and Analysis:** Relevant data, such as solar energy generation, grid stability metrics, and consumer adoption rates, were collected and analyzed to assess the performance and outcomes of VNM in Maharashtra.
- **Case Studies:** Case studies of specific VNM projects along with initiatives in Maharashtra were examined to provide in-depth insights into the implementation challenges and successes.

### 3.7 Operational Framework of VNM in Maharashtra

The Maharashtra government has established a framework for VNM implementation, outlining the key components and processes involved. These include:

- **Registration and Verification:** Consumers interested in participating in VNM must register with the designated authority and provide necessary documentation.

- **Energy Trading Platform:** A platform will be created to facilitate the exchange of energy credits between consumers.
- **Tariff Structure:** Appropriate tariffs are set for the purchase and sale of solar energy credits to ensure fairness and transparency.
- **Grid Integration:** Measures will be taken to integrate the VNM into the existing electricity grid to ensure seamless operation and safety.

### 3.8 Steps to Participate in A VNM Project

Participation in a Virtual Net Metering (VNM) project involves several steps. Here, a general guide circulated by utility to help consumers.

- **Form a Group:** A group of interested consumers' needs to be gathered, such as neighbors or members of a housing society who want to participate in the VNM project.
- **Identifying a Suitable Location:** A common location for solar power installation is required. This could be the rooftop of a building within the same distribution licensee's supply area.
- **Engage with a Solar Developer:** A solar developer or energy service company (ESCO) must be engaged in the design, installation, and maintenance of the solar power system.
- **Sign Agreements:** An agreement with the solar developer and among the group members to outline the terms of the project, including cost sharing, maintenance, and benefit distribution.
- **Apply to VNM:** Apply to the local distribution company (DISCOM) to approve the VNM project. This will include details of the solar installation, participating consumers, and proposed benefit-sharing arrangement.
- **Installation and Commissioning:** Once approved, the solar developer installs the solar power system. After installation, the system was commissioned and connected to a grid.
- **Benefit from Solar Energy:** The generated solar power is credited to the participating consumers' electricity bills based on the agreed-upon ratio. This reduces the overall electricity cost.

### 3.9 Ratio Calculation Procedure

The ratio calculation procedure for virtual net metering involves several key steps to ensure that energy credits are fairly allocated among

participants. The comprehensive breakdown of the process is as follows:

- **Determination of total energy Production:** The first step is to measure the total energy produced by the renewable energy system over a specific billing period. This is typically performed using a single production meter that records the amount of electricity generated.
- **Identifying Participants:** The next step is to identify all participants who will share their energy credits. This includes residential customers, businesses, and other entities that have agreed to participate in the VNM program.
- **Establishing Allocation Percentages:** Each participant's share of the generated energy was determined based on their energy consumption or other agreed-upon criteria. For instance, if a participant consumes 20% of the total energy consumed by all the participants, they may receive 20% of the credits generated by the renewable facility.
- **Calculating Energy Credits:** For participant, energy credits can be calculated by multiplying the total energy produced by the facility by their respective shares. For example, if a solar farm produces 1000 kWh in a month and a participant is entitled to 20%, they receive 200 kWh of credit.
- **Applying credit to bills:** The calculated credits are then applied to the participants' utility bills in the following billing cycle. This reduces the overall electricity cost and promotes the financial viability of renewable energy systems.
- **Adjustments and Reconciliation:** VNM programs typically include provisions for adjustments based on changes in participation or variability in energy production. Regular reconciliations ensure that credits are accurately reflected and any discrepancies are addressed.

## 4. Challenges in Implementing VNM in Maharashtra

### 4.1 Technical Challenges

- **Grid Integration:** Managing the intermittency of solar energy on a large scale may require additional grid infrastructure.
- **Metering Infrastructure:** Upgrading meters to support virtual net metering and accurate



crediting.

- **Energy Loss Accounting:** Monitoring the energy flow from off-site installations to multiple participants requires robust tracking systems.

#### 4.2 Regulatory and Policy Constraints

- **Policy Coordination:** Coordination between Maharashtra's energy regulators, utilities, and consumers is essential.
- **Tariff Structure:** Determine the right pricing and tariff model for VNM credits to ensure viability.
- **Billing System:** MSEDCL's billing infrastructure requires modifications to accommodate the VNM credits seamlessly.

#### 4.3 Consumer Awareness

- **Lack of Awareness:** VNM is a relatively new concept that requires public education to ensure its widespread adoption.
- **Adoption Barriers:** Many consumers may hesitate to participate because of a lack of clarity regarding the benefits and technical aspects.

However, these challenges present opportunities for innovation and collaboration. By proactively addressing these issues, Maharashtra can position itself as a leader in VNM implementation and set an example for other states in India.

### 5. Case Studies and Global Examples

#### 5.1. New York's Community Solar Garden

In New York (United States), similar to VNM, community solar gardens have successfully implemented projects to provide solar energy benefits from shared solar projects to multiple households. The model has witnessed significant success, with improved consumer engagement and reduced energy costs.

#### 5.2. Germany's Renewable Energy Cooperatives

Germany's cooperatives promote shared energy generation and consumption, a model akin to VNM, allowing individuals and communities to invest in decentralized solar farms and share profits. Maharashtra can draw inspiration from global initiatives to improve its policy design.

#### 5.3. Solterra Eco Luxury Apartments,

#### California

The Solterra Eco Luxury Apartments in the Scripps Ranch, California, is a pioneering example of a successful Virtual Net Metering (VNM) project with a capacity of 338 kW. This project was successfully implemented in a residential community on rooftops, carports, and ground-mounted solar arrays to achieve significant energy savings and a sustainable annual output goal of approximately 992,325 kWh green energy generation. This project became San Diego's first Zero Net Energy apartment complex, meaning that the total amount of energy used by the building annually is roughly equal to the amount of renewable energy created on-site.

#### 5.4. ICAST's Multifamily Affordable Housing Projects

The International Center for Appropriate and Sustainable Technology (ICAST) has been instrumental in deploying solar PV systems for low-income residents of multifamily affordable housing (MFAH) through VNM.

#### 5.5. Truth or Consequences Housing Authority (TCHA), New Mexico

This project involved a 230kW ground-mounted solar system installed in a common recreational area of a low-rise, single-story row home complex for seniors and low-income families. The solar system offsets 90% of the property's electricity load, significantly reducing the utility costs for residents.

#### 5.6. Santa Fe County Housing Authority (SFCHA), New Mexico

This project included a 220 kW rooftop solar system with three different properties, offsetting 45% of the electricity load for 196 units. The project successfully reduced fossil fuel consumption and provided substantial energy savings to low-income families.

#### 5.7. California's Multifamily Affordable Solar Housing (MASH) Program

The MASH program provides incentives to install solar PV systems in low-income multifamily housing. Utilizing VNM to distribute benefits among tenants is an example of a successful VNM. A multifamily housing complex in Southern California installed a solar PV system under the MASH program, benefiting from VNM tariffs. The project provided significant energy savings for the tenants



and reduced the overall electricity demand.

## 6. Recommendations for Successful Implementation of VNM

To ensure the successful and widespread adoption of VNM in Maharashtra, the following recommendations were proposed:

- **Public Awareness Campaign:** Conduct awareness campaigns to educate consumers about the benefits and processes of VNM and provide technical assistance for participation, ensuring that they understand how the system works and how it will impact their electricity bills.
- **Collaborate with Stakeholders:** Engage with all stakeholders, including regulatory bodies, government agencies, utilities, private sector players, and consumers, early in the project to ensure smooth coordination, compliance, and promote VNM adoption.
- **Regulatory Reforms:** Streamline policy frameworks to ensure smoother coordination between regulatory bodies and utilities to ensure that the VNM project complies with the regulations set by the Maharashtra Electricity Regulatory Commission (MERC).
- **Incentive programs:** Introduce incentives such as subsidies or tax breaks to encourage housing societies and SMEs to participate in VNM.
- **Technical infrastructure:** Hire experienced contractors and technical experts familiar with VNM systems and invest in advanced metering infrastructure and data analytics tools to support VNM operations so that seamless credit allocation is possible.
- **Pilot Projects:** Plan the financial aspects, including initial investment, maintenance costs, and expected savings; launch pilot projects in selected areas; and monitor the performance to test the effectiveness of VNM before statewide implementation.

## Conclusion

Virtual Net Metering (VNM) represents a major advancement in Maharashtra's pursuit of a cleaner and more inclusive energy future. Through community-based solar installations, the Maharashtra

Government not only promoted sustainable energy practices but also empowered residents to manage their energy consumption and costs. VNM enables multiple users, especially those in urban areas that lack space for rooftop solar panels, to participate in solar energy generation. By broadening access to renewable energy, the VNM addresses the critical challenges of accessibility, sustainability, and grid stability. Despite certain technical and policy challenges, the successful implementation of VNM has the potential to transform Maharashtra's energy landscape and set precedents for other states to adopt similar models. Maharashtra's proactive VNM policy not only supports its clean energy goals but also enhances consumer empowerment and provides long-term economic benefits. This initiative is an inspiring model for other regions in India that aims to expand renewable energy integration, making VNM a significant step towards a greener future for the nation.

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