Consultation Paper

This paper seeks your opinion on following potential regulatory changes. These changes are aimed to enhance solar energy production by addressing the issue of inverter tripping caused by grid-overvoltage in low voltage (LV) distribution lines.

1. **Implementing voltage quality response modes (volt-var, volt-watt) in the inverters of grid-connected (low voltage) rooftop solar PV systems. (as the first approach).**

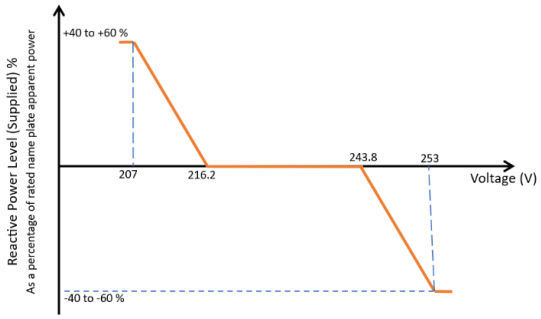


Figure-1

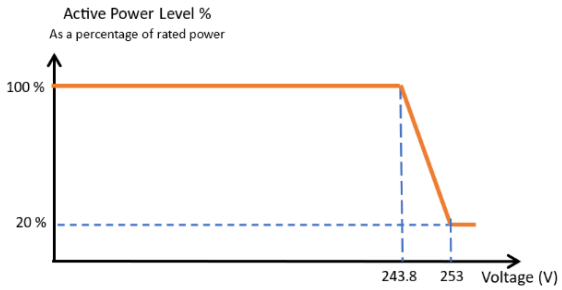


Figure-2

2. **Relaxing the statutory voltage limits of Low voltage electricity supply from 230V ±6% up to 230V ±10% (as the next approach if the curtailment issue persists even after the first approach).**

Figure-3

<u>Consultation Process</u>:

You are invited to provide feedback, comments, and suggestions on the proposals outlined in this paper. We appreciate your time and interest in this regard. Please provide your feedback on or before 17th May 2024.

<u>Please send your feedback to :</u>

By Email: **voltage@pucsl.gov.lk** or

By Post : Director General, Public Utilities Commission of Sri Lanka, Level-6, BoC Merchant Tower, St. Michael's Road, Colombo 03.

For any clarification please contact: Lilantha Neelawala, Deputy Director (Inspectorate), Public Utilities Commission of Sri Lanka, via *lilanthan@pucsl.gov.lk*

Disclaimer: This consultation paper is intended to stimulate dialogue and provide an overview of proposed concepts. The information contained herein is for discussion purpose only and does not constitute a final decision, policy, or commitment. The ideas, proposals, and recommendations are subject to further refinement based on stakeholder input and regulatory considerations.

Key Points

At present statutory voltage limits are 230V ± 6% for low voltage electricity supply (Voltage between the phase and neutral conductors).

International standards have specified 230V ± 10% for low voltage electricity supply.

Tripping of rooftop solar PV inverter can happen as a result of grid overvoltage.

Tripping of inverter due to grid overvoltage result loss of renewable energy input to the grid.

Rooftop solar PV energy curtailment can be reduced by implementing power quality response modes (eg: volt-var and volt-watt control) in inverters. Present day inverters are already equipped with this technology.

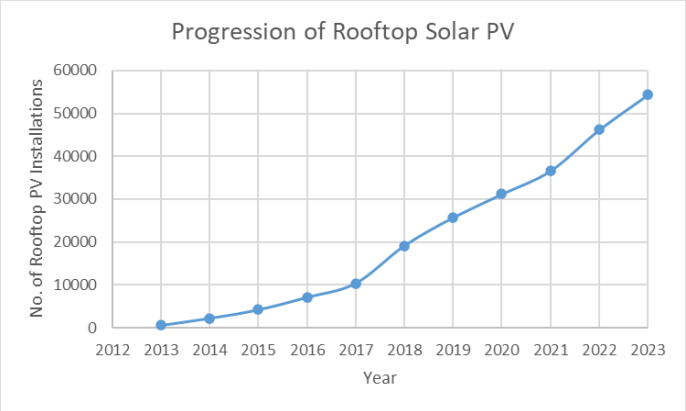
Rooftop solar PV energy curtailment can be reduced by expanding the statutory voltage levels beyond 230V ±6%, followed by adjusting the over-voltage trip and Under-voltage trip settings of inverters accordingly.

The extension of the utility supply voltage up to 230V±10%, remains compliant with internationally accepted standards.

Box-1

1 Purpose of this Consultation

The growing utilization of rooftop solar PV systems has drawn attention to a critical issue – inverters sometimes disconnect from the electricity grid automatically due to high voltage in the electricity grid. This poses a challenge for increasing rooftop solar energy input into the grid. Following graph illustrates the rapid increase in rooftop solar installations. Therefore, proactive measures must be implemented promptly to mitigate the looming challenge related to the voltage quality of the distribution network.



Graph-1

In areas with low electricity demand during the day time, introducing rooftop solar PV systems can gradually elevate voltage levels. Inverters shut down as a protective measure when local voltage exceeds the safe limits, often happens during mid-day peak solar energy production.

To tackle this challenge, employing voltage quality response modes in inverters and adjusting voltage regulations are proposed solutions. These solutions can prevent unnecessary shutdowns of rooftop PV systems and enable increased clean energy production.

Importantly, Public Utilities Commission of Sri Lanka (PUCSL) has engaged in discussions with the Sustainable Energy Authority, CEB, LECO, SLSI and Solar Industrial Association in this regard. These stakeholders are in the view that implementing voltage response modes in inverters is required. Further, relaxing of statutory voltage limits beyond the 230V ±6% is also considered as possible solution if the overvoltage problem continues, as international standards have specified 230V ±10%.

This paper explores into the importance of such regulatory changes, i.e.

- **Implementing voltage quality response modes (volt-var, volt-watt) in rooftop solar PV systems as the first approach.**
- **Relaxing the statutory voltage limits from 230V ±6% up to 230V ±10%, as the next approach if the grid overvoltage issue is persisting.**

Your inputs on the suggested regulatory adjustments, aiming to enhance the contribution of renewable energy from rooftop solar PV systems, are earnestly invited.

2 Understanding the Statutory Voltage Limit: A Brief Overview

The statutory voltage limit of 230V ± 6% refers to the officially set range within which the voltage of electricity supplied to the consumers is supposed to stay. In simpler terms, it's like a defined boundary for the supply voltage.

The main number, 230V, represents the nominal voltage. The "± 6%" part allows for a bit of flexibility. The plus and minus sign indicate that the actual voltage can vary by 6% above or below the nominal value. So, in reality, the voltage can range from 216.2V (230V - 6%) to 243.8V (230V + 6%).

This limit is set to ensure that the electrical devices we use daily, like appliances and electronics, receive a stable and safe amount of supply voltage. If the voltage goes too far outside this range, it can cause problems for these devices and potentially impact the overall stability of the electrical system.

3 Enhancing Solar Power Integration: Volt-var and Volt-watt Control

It's crucial to understand the smart technologies behind rooftop solar installations. There are two essential features - Volt-Var and Volt-watt control - employed by rooftop solar inverters to

overcome overvoltage challenges. This facility is becoming standard feature in present-day inverter models.

When the sun shines bright, rooftop solar panels generate substantial electricity, potentially causing overvoltage issues in the power lines that these solar PV systems are connected. Here's where volt-var control and volt-watt comes into play. these control enables solar inverters to dynamically adjust the reactive power (var) and active power (watt) they produce. By doing so, they regulate the voltage levels in the locality. The Volt-var function can help reducing voltage issues by using available reactive power (var) capabilities instead of curtailing the generation. It's like having a vigilant supervisor ensuring that the voltage doesn't soar to unsafe levels, maintaining a stable and reliable power supply for your homes and businesses.

4 Recommendations

In order to reduce the curtailment of rooftop solar PV energy, owing to the grid overvoltage, following actions are recommended to be implemented.

I. To activate volt-var, volt-watt power quality response modes of existing inverters (if the facility is available).

II. To specify the volt-var, volt-watt controlling capability of inverters as a mandatory requirement when importing inverters to Sri Lanka.

III. Distribution Licensees to propose volt-var and/or volt-watt settings that are suitable for the LV connected inverters (of roof top solar systems) to maintain the steady state voltage quality of LV distribution system. The licensee may obtain the guidance from the values stated in IEEE 1547 and AS/NZ 4777.2 standards. Then to introduce volt-var and volt-watt settings in the operational and technical codes and standards of licensees.

IV. To update the relevant Sri Lanka standards to incorporate the ability of the inverters to set volt-var and volt-watt power quality response modes.

V. To implement OEM level integration of default volt-var/volt-watt settings (specific to Sri Lanka), and periodic inspection scheme to guarantee the volt-var, volt-watt configurations of inverters are in alignment with prescribed settings.

VI. To change the statutory LV voltage limits from 230V ±6% up to 230V ±10%, if the roof top solar PV energy curtailment owing to grid overvoltage is persisting significantly even after the implementation of volt-var and volt-watt response modes of the inverters.

5 Discussion Paper (for more details) :

Please refer https://www.pucsl.gov.lk/wp-content/uploads/2024/04/Voltage-Discussion-Paper.pdf