COMMONWEALTH OF PUERTO RICO
PUBLIC SERVICE REGULATORY BOARD
PUERTO RICO ENERGY BUREAU

In Re:	**Case No. NEPR-MI-2019-0009**
INTERCONNECTION REGULATIONS	**Subject: Enphase Energy, Inc. Comments to PREB Smart Inverter Working Group re: Customer Protections for System Curtailments under the Volt-Watt Smart Inverter Function**

Enphase Energy, Inc. ("Enphase") respectfully submits the following comments to the Puerto Rico Energy Board's ("PREB") Smart Inverter Working Group ("SIWG") regarding Customer Protections for System Curtailments under the Volt-Watt Smart Inverter Function. Enphase participated in the initial November 21, 2024, meeting of the SIWG, which per the November 7, 2024, PREB Resolution ("the Resolution") approving smart inverter settings is tasked with considering the potential activation of the Volt-Watt function.

I. Enphase background

Enphase is a market leading manufacturer of residential and commercial clean energy technologies including solar photovoltaic microinverters, battery energy storage systems, and electric vehicle service equipment. A significant majority of all Puerto Rico residential solar installations use Enphase microinverters.

Enphase products are certified by UL 1741-SB to meet IEEE 1547-2018 requirements and are available to channel partners for installation across North America, including Puerto Rico. Enphase is prepared to activate IEEE 1547-2018-compliant smart inverter settings on January 1, 2025, as ordered by the Resolution.

II. Introduction and Context

Enphase thanks PREB for launching this stakeholder process and appreciates the opportunity to provide initial feedback on the potential for implementing Volt-Watt. Our July 15, 2024, comments in this docket expressed concern about enabling Volt-Watt, owing to the Puerto Rico grid's persistent high voltage issues and the significant curtailment to a customer's PV production that can result, if the function is activated.

To corroborate our concern, Enphase analyzed inverter data from Puerto Rico systems that demonstrated consistent reporting across all hours in 2023 – i.e., including overnight hours when PV systems aren't generating energy – to gauge the voltage of the LUMA grid. The results show that half of all systems recorded at least one hour when voltage readings exceeded

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106%-of-nominal, the threshold that triggers production curtailment under the Volt-Watt function:

% of 2023 hours spent above voltage 106% p.u.	% of sites
At least 1 hour	49.9%
>10%	25.3%
>20%	16.5%
>30%	11.9%
>40%	8.9%
>50%	6.6%
>60%	4.9%
>70%	3.6%
>80%	2.4%
>90%	1.3%

To set the context for our ensuing comments, Enphase stresses that Volt-Watt should be thought of as one of several tools in the toolbox to meet the island's 100% renewable energy-by-2050 goal. Transitioning to an entirely inverter-based energy system requires backfilling lost inertia through energy storage and grid hardening.

Volt-Watt is a strategy that can help mitigate circuit-level voltage issues associated with adding DERs to the system. The above data clearly show that the LUMA grid faces broader voltage challenges than just those associated with adding more DER. Volt-Watt alone will not resolve these issues, and in fact Volt-Watt can *exacerbate* challenges and threaten the success of the 2050 transition if not implemented in tandem with broader strategies to improve overall grid voltage.

From this vantage, any implementation of Volt-Watt must be simultaneously accompanied by complimentary strategies and grid modernization investments to help mitigate the overall voltage issues affecting the LUMA grid. Volt-Watt can help address circuit level voltage by adjusting power output in response to voltage excursions, but strategies like dynamic rate tariffs, VPP programs, and import / export limits through flexible interconnection options can

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also appropriately signal DER behavior that shifts voltage in response to grid conditions. Distribution investments must also be prioritized for persistent voltage issues that befall specific circuits or substation footprints.

III. Responses to Prompts from November 21, 2024 SIWG Meeting

Enphase provides the below comments in response to four high-level prompts or themes found in the SIWG presentation deck from November 21, 2024: Defining "Excessive Curtailment," Monitoring and Reporting, Resolving Excessive Curtailment, and Estimating Lost PV Production. These represent Enphase's initial views and positions, though we look forward to further discussion and consensus building within the SIWG that may result in refinement to these positions.

a. Defining "Excessive Curtailment"

The ANSI C84.1 Standard requires grid voltages to remain below 105% of nominal, with occasional excursions up to 110%. The Volt-Var autonomous setting is triggered above 105%, which will absorb VARs in an attempt to reverse high voltage conditions. If Volt-Var doesn't resolve voltage rise, as currently prescribed, then the Volt-Watt function will activate when voltage exceeds 106% of nominal, decrease power output up to the trip point, greater than or equal to 110% of nominal voltage, at which point the system will fully trip offline. Once tripped, grid voltage needs to revert to nominal range (specified as less than or equal to 106%) and remain under 106% for at least five minutes before production resumes. In other words, if voltage vacillates above 106% momentarily it will restart the five-minute timer.

Enphase believes that, as a threshold matter, anytime a homeowner *notices* a decrease in production, this should be considered "excessive curtailment." Obviously, full curtailment (0 production) can easily be deemed excessive and will be imminently noticeable, while smaller degrees of curtailment can be imperceptible to the customer.

Defining "excessive curtailment" in terms of a kW or kWh threshold would seem to be an arbitrary exercise. Instead, "excessive curtailment" should primarily focus on whether Volt-Watt is activated for a discernable, persistent pattern, either arising for a consecutive amount of time within a day (e.g., for a minimum of 15-30 minutes) or consistently occurring during the same time period across consecutive days (e.g., every morning during the solar ramp).

b. Monitoring and Reporting

Enphase microinverters monitor grid voltage and record voltage data in our backend cloud platform, called Enlighten. Enlighten records a flag for voltage data between 106% and 110%, when Volt-Watt is actively engaged and stepping down power production, and when voltage is greater than 110% and production is fully curtailed.

Enphase has the capability to create an alarm for 15-minute voltage measurements that exceed 106% or when power production trips offline above 110%. We could have the system send a push notification to the homeowner or installer alerting the voltage excursion and activation of Volt-Watt, or have the system generate a high voltage or full system curtailment report covering individual customers, one or more circuits, or the entire LUMA territory.

We believe customers or installers should be responsible for submitting a report generated by Enphase, in a standardized / agreed upon format, to an agreed upon customer support channel at LUMA.

Enphase does not have such alarm and report generation features available today and would need to expend additional engineering resources to develop. Setting up automated reporting from the Enlighten cloud to LUMA would be possible through API, though perhaps more complicated and expensive, and could entail lengthy development work to make available.

c. Resolving Excessive Curtailment

After receiving an Excessive Curtailment report documenting persistent high voltages and / or fully curtailed production, LUMA should launch an investigatory process, in coordination with Original Equipment Manufacturers ("OEMs"), to determine the root cause of an underlying persistent voltage issue. In some instances, it may be the case that a grid upgrade is needed, e.g., if a distribution transformer voltage tap changer is malfunctioning and needs replacing, or if new capacitor banks or voltage regulation equipment are required. OEMs should be allowed to disable Volt-Watt for customers facing these issues until any required upgrade is completed.

Binary grid upgrade determinations may not be indicated in all instances. If the root cause for persistent curtailment due to overvoltage is not immediately clear, Enphase recommends that PREB allow OEMs the flexibility to amend the Volt-Watt function as currently prescribed by the Resolution. Options include:

- Allow the system to operate in self-consumption / non-export mode, allowing batteries to discharge overnight and have spare capacity to charge from PV during the day, rather than curtailing overall kW output per the Volt-Watt curve.
- Allow the OEM to utilize Power Control Systems certified to UL 3141 second edition to program time-variant export limits, in a way that responds to persistent patterns of overvoltage at certain times of day on a given circuit.
- Raise the voltage level within the Volt-Watt curtailment window at which a system is allowed to reconnect to the grid after full curtailment, e.g., raising the reconnect voltage from less than or equal to 106% to 109%. (Enphase has certified its products under UL 1741-SB to reconnect anywhere from 105% to 120%, after Volt-Watt fully curtails production.)

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- Update the Volt-Watt curves for specific customers, either through coordination with the OEM or by direct communication to the DER. (Though, the latter option would require significant time and investment on behalf of LUMA to develop communication systems, development work to integrate communications between LUMA and OEMs, and further discussion and negotiations between LUMA and OEMs on how to roll these features out while minimizing disruptions to customers.)

d. Estimating Lost PV Production

If a customer experiences excessive curtailment due to Volt-Watt implementation, they should be made whole for any PV production losses that result.

Unfortunately, Enphase does not currently have out of the box capabilities to calculate such lost PV production due to Volt-Watt activation.

Enlighten does have a "low PV production" alarm to flag when a system's monthly power production is lower than a production estimate generated for that system by PV Watts, which can be programmed to flag when a system produces between 50% to 95% of the PV Watts estimate. This is obviously not very precise, as the PV Watts estimate bakes in various assumptions and confounding variables such as weather patterns, cloud cover, etc., making it difficult to simply divide by 31 days or 744 hours and compare against ongoing production on a daily or hourly basis.

If an alarm is created to flag voltage excursion conditions in real-time, as discussed above, Enphase could compare the power production immediately before and after the alarm was triggered to get a sense of how Volt-Watt affects production. That said, the same confounding variables affecting PV production (cloud cover, time of day, angle of the sun, etc.) apply here as well and would need to be accounted for. E.g., if a system is already underproducing relative to nameplate capacity due to lower irradiance, activating the Volt-Watt step-down curve might not have any impact on power production at all. For instance, the Volt-Watt curve is programmed to initially curtail production down to 50% of nameplate, but production might have already been at 45% of nameplate due to the angle of the sun.

Enphase will continue exploring methods to accurately account for PV production loss owing to Volt-Watt. One possibility is to keep a single microinverter in an array always operating without Volt-Watt, allowing Enphase to extrapolate from direct observation the array's full likely production absent the activation of Volt-Watt, any time voltage exceeds 106%.

IV. Conclusion

Enphase appreciates the opportunity to provide its initial perspectives on consumer protections that need to be in place before Volt-Watt is implemented. It remains our position that Volt-Watt should only be enabled by mutual agreement between LUMA and the customer,

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as expressed in our July 15 comments, and only after adequate consumer protections are agreed upon and ordered.

As the SIWG gives further consideration to these issues, Enphase recommends that the PREB delay the potential implementation date of Volt-Watt from July 1, 2025 to January 1, 2026, in order to allow for a full year of data collection on how the Volt-Var autonomous function does or does not work to counteract overvoltage conditions by absorbing reactive power. To assist in this exercise, Enphase would support sending updated Volt-Var settings to existing systems in Puerto Rico (i.e., deployed before the January 1, 2025 effective date) that have UL 1741-SA-certified inverters and are able to be re-programmed. Analyzing how Volt-Var operates in practice could better inform how Volt-Watt could complement or enhance this feature, pursuant to the consumer protection guardrails being discussed in the SIWG.

Respectfully submitted,

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Dated: December 11, 2024

CERTIFICATE OF SERVICE

I hereby certify that these comments were filed using the electronic filing system of the Puerto Rico Energy Bureau and that a copy of these comments was delivered by electronic mail to: aconer.pr@gmail.com, Agustin.Irrizary@upr.edu, Andrew.Cote@generac.com, arivera@gmlex.net, azayas@azeng.net, cfl@mcvpr.com, contratistas@jrsp.pr.gov, gcordero@crmjv.com, gferrer@enphaseenergy.com, hrivera@jrsp.pr.gov, jalmodovar@enphaseenergy.com, javrua@sesapr.org, jberdner@enphaseenergy.com, john.jordan@nationalpfg.com, jordgraham@tesla.com, julian.angladapagan@us.dlapiper.com, kkoch@tesla.com, laura.rozas@us.dlapiper.com, lionel.santa@prepa.pr.gov, markb@enphaseenergy.com, mgs@mcvpr.com, mrosenfeldt@enphaseenergy.com, mvalle@gmlex.net, pjcleanenergy@gmail.com, Steven.rymsha@sunrun.com, and valeria.belvis@us.dlpiper.com.