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

From: PJ Wilson <pjcleanenergy@gmail.com>
Sent: Tuesday, July 16, 2024 00:03
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Cc: Javier Rua-Jovet <javrua@sesapr.org>
Subject: SESA filing for NEPR-MI-2019-0009

IN RE: INTERCONNECTION REGULATIONS

CASE NO.: NEPR-MI-2019-0009

SUBJECT: Smart Inverter Default Utility Required Settings Profile - Comments of SESA Puerto Rico

COMMENTS OF SESA PUERTO RICO

SESA herein submits this comprehensive counter-proposal to the April 1st 2024 version of the Smart Inverter Settings which was posted on LUMA's website.

We affirm our full support for the comments submitted by Sunrun and by Enphase Energy, and we ask that this full counterproposal be considered, and that every attempt be made to facilitate consensus between LUMA, OIPC, SESA, and any other interested parties.

Our hope is that substantial agreement can be in place in the coming days, so that by August 1st 2024, this Honorable Energy Bureau may formally issue Smart Inverter Settigns, with an implementation date 3 months later.

Thank you for considering this full counterproposal.

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LUMA Energy publishes the Technical Bulletin 2024-001 to provide supporting technical information to the current regulation, *Regulation for the Interconnection of Generators with the Distribution System of the Puerto Rico Electric Power Authority and to Participate in Net Metering Programs*, Regulation No. 8915, February 6, 2017. This bulletin seeks to apply the IEEE 1547-2018 standard for smart distributed energy resources (DERs) settings. Regulation 8915 in its Article of Control and Protection, #2 indicates that "In addition to the requirements contained in this Section, the customer's DG must comply with applicable standards, including, but not limited to, IEEE 1547, IEEE 519 and IEEE/ANSI C37.90 (Standard for Relays and Relay Systems Associated with Electric Power Apparatus)".

☐ **SESA Edit #1: Replace "June 1" with "November 1".**

Industry needs at least a 3-month implementation window, AFTER the specific Smart Inverter Settings are finalized by PREB. The November 1st date assumes that PREB issues final Smart Inverter Settings by August 1st 2024.

☐ **SESA Edit #2: Replace all references to "applications" with the words "notices of certification".**

Law 17-2024 specifies the start date for the 30-day Net Metering application to customer bills begins the day that the utility receives a "receipt of notice of the certification of the distributed generator installed by an engineer or an expert electrician".

☐ **SESA Edit #3: Replace "default setting requirements" with "utility required settings and functions".**

IEEE-1547 contains "default settings", some of which are identical to what is included in this document, and some of which are very different.

It's important to make the distinction that what is in this document is "utility required" as opposed to "default".

The main purpose of adopting the requirements in this bulletin is to improve the system stability and operations under high penetration of DERs. Starting November 1 ~~June 1~~, **2024**, all new Net Energy Metering notices of certification ~~applications~~ must indicate use of inverters meet the utility required settings and functions ~~default setting requirements~~ that are specified in this bulletin.

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1. Required Smart Inverter Functions

☐ **SESA Edit #4: Rewording needed to make it clear about what specifically within IEEE 1547-2018 is being required, because what is or isn't mandatory depends on the specific category within IEEE 1547-2018.**

Ie, there are inverters which are "IEEE 1547 compliant" which wouldn't meet the specifications in this document.

Smart Inverters must be (a) UL 1741 SB listed, b) set to ~~conform to~~ the default settings ~~requirements~~ provided in this document, and ~~–~~ (~~b~~c) ~~capable of~~ perform~~ing~~ the default functions~~, both~~ provided in this document, "Smart Inverter Settings Sheets."~~, as applicable.~~ Functions and control mode settings required in this document are based on IEEE 1547-2018 requirements for DERs that are both Normal Operating Category B and ~~,~~ Abnormal Operating Category III ~~DERs~~.

☐ **SESA Edit #5: It's necessary to be very clear about what is and isn't required, and under what circumstances.**

That isn't possible with the April 1st language that would allow LUMA to require entirely different things in an "interconnection agreement" that are different from what is in this Smart Inverter Settings, unless it's very clear what the conditions are ("as a result of a detailed interconnection study"), for when a customer would be required to have settings different from what is in this document.

Customers must comply with the requirements set forth in this "Smart Inverter Settings Sheets" except where~~or, any~~ alternative site-specific Smart Inverter settings and function~~s~~ statuses are ~~that may be~~ defined in the interconnection agreement as a result of a detailed interconnection study.

☐ **SESA Edit #6: Important wordsmithing for clarity.**

Any alternative settings and function statuses~~s~~ defined in the interconnection agreement will take precedent and ~~override~~ supersede the default settings ~~requirements~~ and function~~s~~ statuses provided in this document. Notwithstanding the ~~preceding~~ following provisions of this "Smart Inverter Settings Sheets", a customer's Smart Inverter(s) shall conform with the requirements and functions required pursuant to their interconnection agreement at the time of approval.

☐ **SESA Edit #7: These changes are needed to align the content of this subsection with language used in IEEE 1547-2018.**

1.1. Communication Requirements

Table 1-1 lists approved communication protocols per Table 41 of IEEE 1547-2018. ~~minimum communication requirements for~~ Smart Inverters connected to the distribution system shall be capable of supporting at least one of these protocols.

☐ **SESA Edit #8: The language in this table in the April 1st document originally contained language different from that of IEEE 1547-2018; these changes bring the document into alignment with IEEE 1547-2018.**

Table 1-1- ~~Minimum Requirements for~~ Approved Communication Protocols ~~and Interface~~

Protocol	Transport	Physical Interface/Layer
~~IEEE 1815 (DNP3)/ SunSpec Modbus/~~ IEEE 2030.5 (~~Sep~~ SEP 2.0)	TCP/IP	Ethernet~~/ RS-485~~
IEEE 1815 (DNP3)	TCP/IP	Ethernet
SunSpec Modbus	TCP/IP	Ethernet
	N/A	RS-485

☐ **SESA Edit #9: Reword title of section to be "Smart Inverter Functions & Control Modes".**

This subsection includes some content described as "functions" and others described as "control modes" in IEEE-1547. For example, Anti-Islanding and Ride-Through are Functions which are not Control Modes as described by IEEE 1547-2018.

1.2. ~~Control Modes~~ Smart Inverter Functions & Control Modes

Table 1-2~~1~~ lists functions and control modes that must be supported by Smart Inverters as well as their default status ~~of each control mode~~.

☐ **SESA Edit #10: The only setting missing from this list, as detailed in IEEE 1547-2018, is Reactive Power Mode, also called "Watt-Var". We recommend adding Watt-Var to this list, as "Required" and "Deactivated" by default, to fully define all Control Modes in IEEE 1547-2018.**

☐ **SESA Edit #11: Activating Volt-Watt triggers concerns about curtailment of export of solar power to the power grid, which reduces customer compensation of Net Metering credits on their bill. Because of this chance of loss of customer compensation, we are opposed to the Volt-Watt setting being Activated, unless it's accompanied with clear assurances of LUMA performing grid upgrades within a pre-established, reasonable amount of time.**

☐ **SESA Edit #11: Frequency Droop (Frequency/Watt) improves stability of power line frequency of the grid, and is required by IEEE 1547-2018 to be Activated by default.**

☐ **SESA Edit #12: Enter Service is a mandatory part of IEEE 1547-2018. It specifies the conditions of the grid (allowable Voltage & Frequency Range, Delay Rime, and Connection & Reconnection Ramp Rate).**

☐ **SESA Edit #13: Normal Ramp Rate is not defined in IEEE 1547-2018 and, therefore, should be excluded.**

Table 1-2- Smart Inverter Functions & Control Modes

Applicable to Retail Customers Interconnected			
~~Mode of Operation~~**Function/Control Mode**	Required/Optional	Description	Default Activation Status
Anti-Islanding	Required	Refers to the ability to detect loss of utility source and cease to energize	Activated
~~Adjustable C~~constant ~~power~~ Power ~~factor~~Factor	Required	Refers to Power Factor set to a fixed value~~.~~	Deactivated
~~Adjustable~~ Constant Reactive Power	Required ~~(If available)~~	Refers to Reactive Power set to a fixed value	~~If capable, d~~Deactivated
Voltage ~~Ride~~ Ride ~~-~~through	Required	Refers to ability of Smart Inverter to ride through a certain range of voltages before tripping off	Activated
Frequency ~~Ride~~ Ride ~~-~~through	Required	Refers to ability of Smart Inverter to ride through a certain range of frequencies before tripping off	Activated
Voltage – Reactive Power (Volt/Var)	Required	Refers to control of reactive power output as a function of voltage	Activated
Voltage – Active Power (Volt/Watt)	Required ~~(If available)~~	Refers to control of real power output as a function of voltage	Deactivated ~~Activated~~
Frequency Droop (Freq/Watt)~~Frequency - Watt~~	Required ~~(If available)~~	Refers to control of real power as a function of frequency	~~If capable, deactivated~~ Activated
Enter Service	Required	Refers to the ability of a Smart Inverter to begin operation with an energized utility source	Activated
~~Ramp Rates~~	~~Required~~	~~Refers to ability to have an adjustable entry service ramp rate when a DER restores output of active power or changes output levels over the normal course of operation.~~	~~Activated~~

2. Smart Inverter Function & Control Mode Settings

This section lists the required settings for ~~smart~~ Smart ~~inverter~~ Inverter functions and control modes.

2.1 Anti-Islanding ~~Settings~~

Smart Inverters shall detect the unintentional island and trip as specified in Table 2-1 per Section 8.1 of IEEE 1547-2018~~.~~

Table 2-1- Responses to Islanding and Open Phase Conditions - ACTIVATED

Applicable to Retail Customers Interconnected	
Condition	**Maximum Trip Time (s)**
Islanding/Open Phase	2

☐ **SESA Edit #14: This change is needed to align with IEEE-1547-2018.**

2.2 Response to Abnormal Voltage ~~Settings~~

2.2.1 Voltage Trip Settings

Smart Inverters shall meet the abnormal voltage response requirements~~, as~~ specified in Table 2-2.

☐ **SESA Edit #15: This change simply corrects what was clearly a clerical error in the April 1st document. These two values were inadvertently swapped by LUMA. This table is not implementable without correcting this.**

Table 2-2- Smart Inverter Response to Abnormal Voltage

Voltage Trip Settings	Default Voltage (pu)	Adjustable Range for Voltage (pu)	Default Trip/Clearing Time (s)	Adjustable Range for Trip Time (s)
Over Voltage 2 (OV2)	V ≥ 1.2	~~0.16~~Fixed at 1.2	~~Fixed at 1.2~~0.16	Fixed at 0.16
Over Voltage 1 (OV1)	V ≥ 1.1	1.1 - 1.2	13	1 - 13
Under Voltage 1 (UV1)	V ≤ 0.88	0 - 0.88	21	11 - 50

Under Voltage 2 (UV2)	V ≤ 0.5	0 - 0.5	2	2 - 21

☐ **SESA Edit #16: There is no such thing as changeable "Settings" for Voltage Ride-Through; the specifications are clearly defied in IEEE-1547-2018 and aren't changeable.**

2.2.2 Voltage Ride-Through ~~Settings~~

Smart Inverters shall meet the Low/High Voltage Ride-Through requirements~~, as~~ specified in Table 2-3.

☐ **SESA Edit #17: Delete the first column. These shouldn't be described as "Settings". The terms in this columns are not used in IEEE-1547 2018.**

☐ **SESA Edit #18: Change "Smart Inverter Response (Operating Mode)" to "Operating mode / response". This change aligns the terms with IEEE 1547-2018.**

Table 2-3- Low/High Voltage Ride-Through Minimum Requirement – ACTIVATED

~~Voltage Ride-Through Settings~~	Voltage Range (p.u.)	~~Smart Inverter Response (Operating Mode)~~ Operating mode/response	Maximum Response Time (s)	Minimum Ride-Through Time (s)
~~High Voltage 2 (HV2)~~	V ≥ 1.2	Cease to Energize	0.16	N/A
~~High Voltage 1 (HV1)~~	1.1 ≤ V ≤ 1.2	Momentary Cessation	0.083	12
~~Near Normal Voltage (NNV)~~	0.88 ≤ V ≤ 1.1	Continuous Operation	N/A	Infinite
~~Low Voltage 1 (LV1)~~	0.7 ≤ V ≤ 0.88	Mandatory Operation	N/A	20
~~Low Voltage 2 (LV2)~~	0.5 ≤ V ≤ 0.7	Mandatory Operation	N/A	10
~~Low Voltage 3 (LV3)~~	V ≤ 0.5	Momentary Cessation	0.083	1

2.3 Response to Abnormal Frequency ~~Settings~~

2.3.1 Frequency Trip Settings

Smart Inverters shall meet the abnormal frequency response requirements~~, as~~ specified in Table 2-4.

☐ **SESA Edit #19: In the third column, change "OF1" to "Frequency". This fixes what is very obviously a type-o in the April 1st document.**

☐ **SESA Edit #20: Second column, last row: This is different from**

the default IEEE 1547-2018 standard. The IEEE 1547-2018 value is 56.5 Hz, and LUMA is proposing 57.

We suggest keeping it at the IEEE 1547-2018 standard of 56.5 Hz unless there is a clear valid reason why 57 Hz is needed for Puerto Rico. This is one of many issues that would need to be talked through in PREB-overseen workshops in order to be well understood.

Table 2-4- Smart Inverter Response to Abnormal Frequency

Frequency Trip Settings	Default Frequency (Hz)	Adjustable Range for Frequency ~~OF1~~ (Hz)	Default Trip/Clearing Time (s)	Adjustable Range for Trip Time (s)
Over Frequency 2 (OF2)	f ≥ 62	61.8 - 66	0.16	0.16 - 1000
Over Frequency 1 (OF1)	f ≥ 61.2	61.2 - 66	300	21 - 1000
Under Frequency 1 (UF1)	f ≤ 58.5	50 - 58.8	300	21 - 1000
Under Frequency 2 (UF2)	f ≤ 56.5 ~~57~~	50 - 57	0.16	0.16 - 1000

☐ **SESA Edit #21: Again, these are not adjustable "settings"; this Frequency Ride-Through behavior is mandatory as specified in IEEE 1547-2018.**

2.3.2 Frequency Ride-Through ~~Settings~~

Smart Inverters shall meet the Low/High Frequency Ride-Through requirements~~, as~~ specified in Table 2-5.

☐ **SESA Edit #22: Delete "High" from header of second column label so that this reads "Frequency Range (Hz)". This was clearly a type-o in the April 1st draft.**

☐ **SESA Edit #23: Remove the first column, because it is information not included with the tables in IEEE 1547-2018. Keeping this column as it appears in the April 1st document would give the false impression that ride-through is adjustable as referenced.**

Table 2-5- Low/High Frequency Ride-Through Minimum Requirement – ACTIVATED

~~Frequency Ride-Through Settings~~	~~High~~ Frequency Range (Hz)	~~High Smart Inverter Response~~ (Operating Mode)	Minimum Ride Through Time (s)
~~High Frequency 2 (HF2)~~	f ≥ 62	N/A	N/A
~~High Frequency 1 (HF1)~~	61.2 ≤ f ≤ 62	Mandatory Operation	299
~~Near Normal Frequency (NNF)~~	58.8 ≤ f ≤ 61.2	Continuous Operation	Infinite
~~Low Frequency 1 (LF1)~~	57 ≤ f ≤ 58.8	Mandatory Operation	299
~~Low Frequency 2 (LF2)~~	f ≤ 57	N/A	N/A

2.4 Voltage-Reactive Power Control Mode Settings

An example Volt-Var characteristic is shown in Figure 2-1. The voltage-reactive power characteristic shall be configured in accordance with the default parameter values specified in Table 2-6.

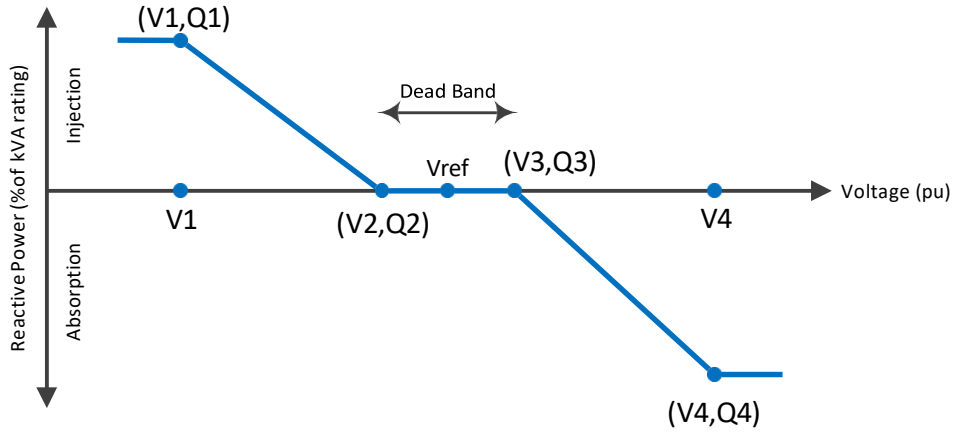

Figure 2-1. Example Volt-Var characteristic

Table 2-6- Volt-Var Settings – ACTIVATED

Volt-Var Parameters	Definitions	Default Values (% of nominal rating)	Allowable Range	
			Minimum	Maximum
Vref	Dead band center	VN	95% VN	105% VN
V2	Dead band lower voltage limit	98% VN	Vref – 3%VN	Vref
Q2	Reactive power injection or absorption at voltage V2	0	maximum reactive power capability, absorption	maximum reactive power capability, injection
V3	Dead band upper voltage limit	102% VN	Vref	Vref + 3%VN
Q3	Reactive power injection or absorption at voltage V3	0	maximum reactive power capability, absorption	maximum reactive power capability, injection
V1	Voltage at which DER shall inject Q1 reactive power	92% VN	Vref – 18%VN	V2 – 2%VN
Q1[(1)]	Reactive power injection at voltage V1	44%	0	maximum reactive power capability, injection
V4	Voltage at which DER shall absorb Q4 reactive power	108% VN	V3 + 2%VN	Vref + 18%VN
Q4[(1)]	Reactive power absorption at voltage V4	44%	maximum reactive power capability, absorption	0
Open loop response time	Time to 90% of the reactive power change in response to the change in voltage	5 sec	1 sec	90 sec

[(1)] This requires that the Smart Inverter operates with a reactive power priority and generate/absorb reactive power to the ranges specified in this table irrespective of active power production.

2.5 Voltage-Active Power Control Mode Settings

Two examples of these characteristics are shown in Figure 2-2. The characteristic shall be configured in accordance with the default parameter values specified in Table 2-7.

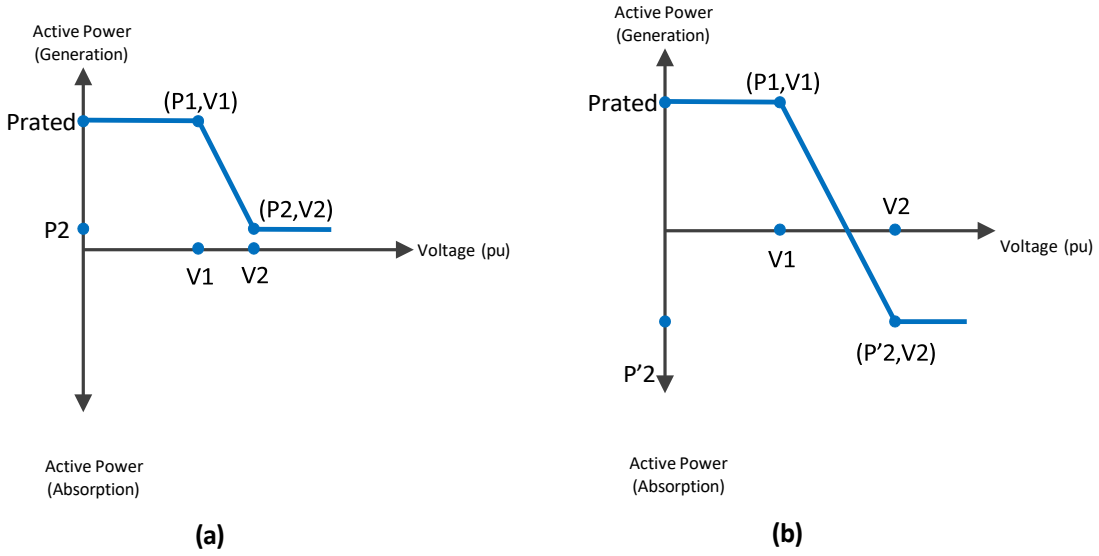

Figure 2-2. Example Volt-Watt characteristics

☐ SESA Edit #24: Volt-Watt: Change to DEACTIVATED by default.

Further detail: * By default, this control mode will be deactivated except where a supplemental study requires it implemented because of high DER penetration to support local distribution equipment upgrades that will be performed in a timely manner. After upgrading the local distribution equipment, this setting may be deactivated upon request with approval from LUMA.

It's important to understand that when Volt-Watt is activated for an inverter, it means that when the voltage in their neighborhood gets 6% higher than normal (so since normal voltage is 120 Volts, 6% higher is 127.2 Volts), when the voltage reaches 127.2 Volts, then the amount of solar output to the grid starts being reduced ("curtailed"), and that it curtails more the higher the voltage goes. So when voltage reaches 106% of normal, the solar output is reduced by 20%; with voltage is 107% of normal, it's reduced by 40%, when it's 108% it's reduced by 60%, when it's 109% it's reduced by 80%, and when it's 100%, the customer's solar system is not able to export any solar power to the grid at all.

Table 2-7- Volt-Watt Settings – DEACTIVATED*

Voltage-active power parameters	Default Settings	Ranges of allowable settings	
		Minimum	Maximum
V1	106% VN	105% VN	109% VN
P1	P_{RATED}	NA	NA
V2	110% VN	V1 + 1% VN	110% VN
P2 (applicable to DER that can only generate active power)	The lesser of 0.2 P_{RATED} or P_{MIN}[(1)]	P_{MIN}	P_{RATED}
P'2 (applicable to DER that can generate and absorb active power)	0	0	P'_{RATED}[(2)]
Open-loop response time	10 sec	0.5 sec	60 sec

(1) P_{MIN} is the minimum active power output in p.u. of the DER rating (i.e., 1.0 p.u.).
(2) P'_{RATED} is the maximum amount of active power that can be absorbed by the DER.

* By default, this control mode will be deactivated except where a supplemental study requires it implemented because of high DER penetration to support local distribution equipment upgrades that will be performed in a timely manner. After upgrading the local distribution equipment, this setting may be deactivated upon request with approval from LUMA.

☐ **SESA Edit #25: "Enter Service Settings" means the ranges within inverters can connect to the grid initially, and re-connect after tripping off to to grid irregularities.**

All values in this chart are identical to the defaults of IEEE 1547-2018, except for Applicable voltage within range.

Whereas the standard in IEEE 1547-108 is 91.7% to 105%, we are proposing 88% to 110%, due to the actual reality of Puerto Rico's grid conditions today.

The values we're suggesting cause no harm to the grid, and allow the customer's inverters to function more often given the current reality in Puerto Rico.

2.6 Enter Service Settings

Smart Inverters shall be set to the Enter Service settings in Table 2-8.

Table 2-8- Enter Service Settings

Enter Service Criteria		Default Setting	Ranges of allowable settings
Permit Service		Enabled	Enabled/Disabled
Applicable voltage within range	Minimum value	≥ 0.88 p.u.	0.88 p.u. to 0.95 p.u.
	Maximum value	≤ 1.10 p.u.(2)	1.05 p.u. to 1.06 p.u.
Frequency within range	Minimum value	≥ 59.5 Hz	59 Hz to 59.9 Hz
	Maximum value	≤ 60.1 Hz	60.1 Hz to 61.0 Hz
Enter Service Delay		300	0 seconds to 600 seconds
Enter Service Randomized Delay		N/A(3)	1 second to 1000 seconds
Enter Service Ramp Rate(1)		50	1 second to 1000 seconds

(1) This corresponds to the time from zero to 100% maximum power. The default value of 50 seconds implements a 2% ramp in active output power that is either linear or stepwise linear per Section 4.10.3 in IEEE 1547-2018. Per Section 4.10.3, the maximum active power increase of any single step during the enter service period shall be no greater than 20% of the Smart Inverter nameplate active power rating.

(2) This setting is outside the allowable settings however it is consistent with the maximum service voltage guaranteed to customers.

~~(1)~~(3) Optional feature in IEEE 1547-2018.

☐ **SESA Edit #26: All relevant content from the April 1st document version of Section 2.6 have been relocated to new section 2.6, "Enter Service Settings".**

"Normal Ramp Rate" is not defined in IEEE 1547-2018, and should not be in this document.

~~2.6 Normal Ramp Rate Settings~~

~~The following is the ramp-rate requirement during normal and reconnection operation of Smart Inverters applicable only when the function is activated by mutual agreement between LUMA and the customer:~~

- ~~Normal ramp-up rate: For transitions between energy output levels over the normal course of operation, the default value is 100% of maximum current output per second with a range of adjustment between 1% and 100%.~~
- ~~Connect/Reconnect Ramp-up rate: Upon starting power into the grid, following a period of inactivity or a disconnection, the inverter shall wait for 300 seconds before reconnecting and shall be able to control its rate of increase of power from 1 to 100% maximum current per second. The default value is 2% of maximum current output per second. The maximum active power step during restoring output is 20%~~