SUMMARY

The advanced inverter working group prepared this proposal for adoption of the most current IEEE 1547 standard and its associated equipment certification standards. The proposal was developed during Phase II of the New Mexico PRC Interconnection stakeholder engagement efforts in 2022. Technical details of the proposal are included in Annex A and background information is provided in Annex B.[1] The proposal is intended to ensure that DER systems shall be capable of actively regulating voltage, shall ride-through abnormal voltage/frequency, and are able provide the greatest degree of grid support possible. In addition, this proposal provides an interconnection framework that accommodates the largest amount of Distributed Energy Resources (DER) penetration while preserving electric system reliability and safety. Finally, the proposal aims to make advanced inverter settings transparent to all interested parties.

PROPOSAL

This three-part proposal addresses the definitions, activations and settings of the autonomous functions required by IEEE 1547-2018 and its amendment 1547a-2020. A recommendation regarding the categories for performance, specific functionalities, and settings are included, as these determinations are critical for implementation of the IEEE 1547 requirements.

Part 1 – Category Determination: Rotating equipment-based systems (both induction and synchronous) must meet Category A requirements for normal performance and Category I requirements for abnormal performance. Inverter-based systems must meet Category B requirements for normal performance and Category III requirements for abnormal performance.

Part 2 – Function Activation: Inverter and rotating equipment functions shall be activated according to the table below. Note that the term "disabled" means that an advanced inverter is likely to have this capability, but this function is initially disabled to comply with New Mexico interconnection requirements.

The recommendation for voltage regulation is to enable volt-var as the reactive power function and volt-watt as the active power function. This combination of functions provides active adjustment of the DER as conditions change on the circuit, thus allowing for better voltage regulation as DER penetration increases over time. In addition, implementation of these two voltage regulation functions avoids the need to study and determine a static control setting, thus possibly simplifying the interconnection application review process. Selection of an alternative voltage regulation strategy, if warranted by a distribution system study, may be documented by a system operator, submitted as a variance for commission approval, and if approved, reflected in an operator's published interconnection requirements.

Default activation status may be modified

Function	**Default Activation and Purpose**
Reactive Power Functions. Only one of the four options below can be activated:	**Voltage regulation**
Voltage-Reactive Power Control (volt-var)	Enabled for Categories A & B. Modulates reactive power in relation to measured grid voltage.
Constant Power Factor	Disabled. No voltage support is realized when this function is enabled with its default setting. Constant Power Factor does not respond directly to voltage and as such, in this mode, the

[1] Additional background and context regarding adoption of IEEE 1547-2018 is available from the Interstate Renewable Energy Council. See *"Making the Grid Smarter, Primer on Adopting the New IEEE 1547™-2018 Standard for Distributed Energy Resources,"* January 2019.

	DER might be injecting or absorbing reactive power when it is not needed.
Active Power-Reactive Power Control (watt-var)	Disabled. Modulates reactive power in relation to active power output (and absorption of active power for systems that can store energy). Watt-var does not respond directly to voltage and as such, in this mode, the DER might be injecting or absorbing reactive power when it is not needed.
Constant Reactive Power Control	Disabled. Does not allow reactive power to adjust as power output from DER fluctuates.
Active Power Function	**Voltage regulation**
Voltage-Active Power Control (volt-watt)	Enabled for Category B. Reduces active power to reduce voltage (normally only once voltage is outside of the normal range)
Voltage and Frequency Disturbance Functions	**Supports bulk system stability and maximizes grid support from DERS**
Voltage Disturbance Ride-Through and Trips	Required for both inverter-based & rotating DER systems
Frequency Disturbance Ride-Through and Trips	Required for both inverter-based & rotating DER systems
Enter Service Functions	**Avoids abnormal voltages**
Enter Service	Enabled
Enter Service Ramp Rate or Randomized Start Time, depending on system size	Enabled
Anti-Islanding Function	**Avoids unintentional islanding**
Anti-Islanding	Enabled

Part 3 –Settings: Default settings for the functions outlined in the table above are to be based on IEEE 1547-2018 (as amended in IEEE 1547a-2020). Allowed settings also include site-specific settings as determined by System Impact Study and documented in the Interconnection Agreement (assuming these are available for inspection by the PRC).

ACKNOWLEDGEMENT

The working group appreciates the work of the people who provided their time and expertise to develop this proposal. Key contributors were Travis Dorr (SPS), Brian Lydic (IREC), Midhat Mifazy (IREC) and Michael Ropp (SNL). Critical input was also received from Tom Key (EPRI) and Steve Wurmlinger (SMA).

ANNEX A – PROPOSAL TECHNICAL DETAILS

The three-part proposal is intended to ensure that DER systems shall be capable of actively regulating voltage, shall ride-through abnormal voltage/frequency, and are able provide the greatest degree of grid support possible. In addition, it provides an interconnection framework that accommodates the largest amount of DER penetration while preserving electric system reliability and safety. Finally, the proposal aims to make advanced inverter settings transparent to all interested parties.

Selection of categories for both normal and abnormal operating performance impacts which advanced inverter functions are to be enabled as well as the settings for these control functions. The normal operating performance category (choices are Category A or B) specifies how the Distributed Energy Resource (DER) system should perform with regards to voltage control during normal grid operations, and therefore impacts the use of voltage regulation controls. The abnormal operating performance category (choices are Category I, II, or III) specifies DER performance or "ride-through" capabilities during a grid disturbance such as a transmission fault or loss of a generator.

Part 1 – Category Determination: Rotating equipment-based systems (both induction and synchronous) must meet Category A requirements for normal performance and Category I requirements for abnormal performance. Inverter-based systems must meet Category B requirements for normal performance and Category III requirements for abnormal performance.

Equipment is allowed to meet the requirements of the highest category it is capable of being certified to, with category B being higher than category A (under normal performance) and category III being the highest under abnormal performance.

Part 2 – Function Activation: Inverter and rotating equipment functions shall be activated according to Table 1. Note that the term "disabled" means that an advanced inverter is likely to have this capability, but this function is initially disabled to comply with New Mexico interconnection requirements. Default activation status may be modified if determined as advantageous by System Impact Study.

TABLE 1. Functions, Activations, and Settings Summary

Function	**Activation**	**Purpose**
Voltage-Reactive Power Control (volt-var)**	Enabled for Categories A & B; utilize category-appropriate default settings in IEEE 1547-2018, Table 8	Voltage Regulation
Constant Power Factor	Disabled***	Voltage Regulation
Active Power-Reactive Power Control (watt-var)	Disabled	Voltage Regulation
Constant Reactive Power Control	Disabled	Voltage Regulation
Voltage-Active Power Control (volt-watt)	Enabled for Category B; use default settings in IEEE 1547-2018, Table 10	Voltage Regulation
Voltage Disturbance Ride-Through and Trips	Rotating DERS use Category I defaults, inverter-based DERS systems, use Category III defaults	Bulk System Stability; maximum grid support from DERS

Frequency Disturbance Ride-Through and Trips	Rotating DERS use Category I defaults, inverter-based DER systems, use Category II defaults	Bulk System Stability; maximum grid support from DERS
Enter Service	Use default settings from IEEE 1547-2018, Table 4	Avoidance of abnormal voltages
Enter Service Ramp Rate	DER installations shall use the ramp rate specified in IEEE 1547-2018, 4.10.3. DERS smaller than this limit may use the randomized start time described in IEEE 1547-2018, 4.10.3, Exception 1 if mutually agreed to by the system operator.	Avoidance of abnormal voltages
Anti-Islanding	Enabled	Avoid unintentional islanding

**Regarding volt-var settings: the autonomously adjusting Vref function should also be turned off by default unless otherwise determined as advantageous by System Impact Study.
***Under normal circumstances, the Constant Power Factor control function will be disabled by default. However, in some cases, the Area EPS Operator has the jurisdiction to specify in the Interconnection Agreement (IA) when Constant Power Factor control function is to be enabled. If this function is enabled, Voltage-Reactive Power Control (volt-var) must be disabled. If the IA does not specify a power factor or if an interconnection agreement is not required for interconnection, then assume -0.98 (absorbing).

Part 3 – Settings: Default settings for the functions outlined in the table above are to be based on IEEE 1547-2018 (as amended in IEEE 1547a-2020). Allowed settings also include site-specific settings as determined by System Impact Study and documented in the Interconnection Agreement (assuming these are available for review by the PRC).

Note: EPRI developed Utility Required Profiles may be useful for formatting and exchanging files of parameter settings.

ISSUES NOT YET ADDRESSED BY THE SUBGROUP:

1. NEED CONVERSATION REGARDING ABNORMAL VOLTAGE AND FREQUENCY SETTINGS
2. NORMAL RAMP RATE FOR ENERGY STORAGE SYSTEMS (not in latest IEEE 1547)

HOW OFTEN WOULD SETTINGS BE UPDATED, DOCUMENTED, AND PARTIES NOTIFIED? WHO IS AUTHORIZED TO MAKE CHANGES IN SETTINGS? DISCUSS IN COMMUNICATIONS/CONTROLS MEETINGS IN JULY.

NEW CONTENT AS OF 29June2022

DRAFT Recommendation Regarding the Reference Point of Applicability (may include as part 1b of the draft proposal)

The RPA for all performance requirements shall be the PCC, unless allowed by alternate options described in IEEE-1547-2018. The proposed RPA shall be identified in the interconnection application and one-line diagram. If the utility determines that the applicant's preferred RPA is inappropriate because it is not in conformance with IEEE 1547-2018 subclause 4.2, the applicant may select a different RPA that will bring the system into conformance. In all cases, the RPA shall be documented in the Interconnection Agreement.

SUPPLEMENTAL DETAILS AND DEFINITIONS RELATED TO RPA:
Per IEEE 1547-2018, the reference point of applicability (RPA) is the location where the interconnection and interoperability performance requirements specified in this standard apply. The location of the RPA is affected by system rating and export capability, load demand, and zero-sequence continuity. The point of common coupling (PCC) is the point of connection between the Area EPS and the Local EPS. The point of DER connection (PoC) is the point where a DER unit is electrically connected in a Local EPS and meets the requirements of this standard exclusive of any load present in the respective part of the Local EPS. Figures H.1 and H.2 of IEEE 1547-2018 provide decision trees regarding the determination of the RPA and the IREC BATTRIES Toolkit includes recommendations on this topic.

Definitions from IEEE Std 1547-2018

Point of DER connection (PoC): "The point where a DER unit is electrically connected in a local EPS and meets the requirements of this standard exclusive of any load present in the respective part of the local EPS."

Supplemental DER device: "Any equipment that is used to obtain compliance with some or all of the interconnection requirements of this standard."

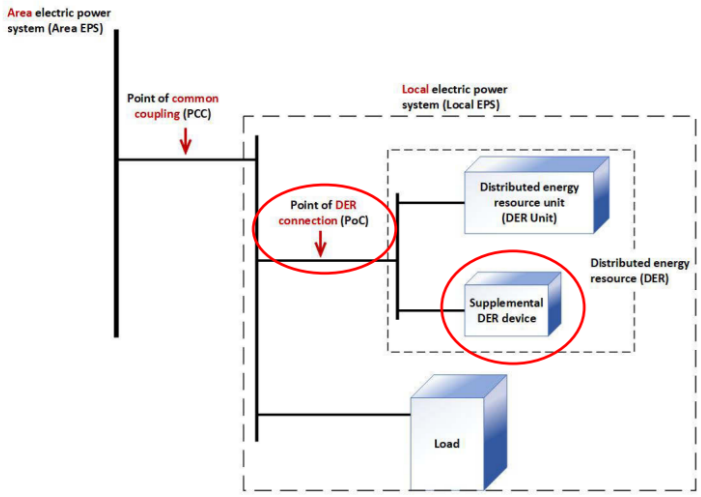

Figure courtesy of NREL