IEEE 1547 Adoption: Decision Options Matrix

Key:

Suggested for TIR	Original color
Suggested for Rule	
Rule or TIR	
Other	

			Decisions To make	
	Issue	**What to consider?**	**Decision Option (DO) Description**	**Utilize?**
Near Term	Adoption Timeline	Consider equipment availability, the use of UL 1741 SA certification in the interim (if needed), and whether naming a date is necessary. Compliance requirements are usually based on the interconnection application submission date. Some projects have long interconnection review and lead times and may not be installed long after the application date. A mechanism to require some of those projects with earlier application dates to be 1547-2018 compliant once installed could be beneficial for grid support. Installed MW with 1547-2018 compliance could be increased if compliance is based on installation date, but this may be challenging for developers from a planning perspective, as they may have to specify equipment that is not yet certified for 1547-2018. This issue may be mitigated if UL 1741 SA inverters are utilized, which can have similar features as those required by UL 1741 SB/1547-2018. Also consider how an interim adoption period will be implemented, allowing for 1547-2018 compliance before the deadline. Widely available UL 1741 SB certified equipment is expected on the market by around April 1, 2023.	**DO 1a-1:** Comply with IEEE 1547-2018 beginning [some date before ~April 1, 2023].	☐
			DO 1a-2: Comply with IEEE 1547-2018 beginning ~March 28, 2023 based on installation.	☒
			DO 1a-3: Comply with IEEE 1547-2018 when the equipment is readily available (TBD by Commission action).	☐
			DO 1b-1: Base compliance date on application submission.	☐
			DO 1b-2: Base compliance date on installation (may be useful for larger projects with long lead times).	☐
			DO 1b-3: Differentiate compliance date mechanism between smaller and larger projects.	☐
			DO 1c-1: Allow interim compliance with IEEE 1547-2018 beginning April 1, 2022.	☐
			DO 1c-2: Define another interim compliance pathway.	☐
	Abnormal Operating Performance Category	Consider input from transmission operators or regional reliability coordinator when assigning ride-through categories, plus local distribution utility protection practice.	**DO 2-1:** IEEE 1547-2018 Category III Ride-Through capabilities must be supported for inverter-based DER. Rotating DER must meet Category I Ride-Through capabilities.	☒
			DO 2-2: IEEE 1547-2018 Category II Ride-Through capabilities must be supported for inverter-based DER. Rotating DER must meet Category I Ride-Through capabilities.	☐
	Normal Operating Performance Category	The selection of A or B will impact the use of voltage regulation controls. Some DER types cannot meet the full scale of reactive power support. Consider specifying category assignment based on technology type.	**DO 3-1:** Inverter-based DER shall meet reactive power requirements with 1547-2018 Category B. Rotating DER must meet Category A.	☒
			DO 3-2: All DER types (Inverter-based and rotating) shall meet reactive power requirements with 1547-2018 Category A.	☐

	Alternative Performance Category	If a technology that cannot meet the specified Abnormal or Normal Operating Performance Category, a defined process may be useful for determining that the technology can safely interconnect without unduly impacting grid support requirements.	**DO 4-1:** Define process for how exceptions to these category assignments are handled (e.g., for an inverter-based technology that cannot meet Category III capabilities).	☐
			DO 4-2: Leave process undefined for how exceptions to these category assignments are handled.	☐
	Voltage Trip Settings & Ranges	Consider local distribution utility protection practices and make sure appropriate trip settings are selected. As desired, select default settings or settings within the adjustable range. Trip settings should not hinder ride-through capability required at the transmission level.	**DO 5-1:** Align default settings with 1547.	☐
			DO 5-2: Select other default settings within 1547 ranges of adjustment.	☐
	Frequency Trip Settings & Ranges	Ensure that the UF and OF trip settings are coordinated between the utility and transmission operator. As desired, select default settings or settings within the adjustable range. Trip settings should not hinder ride-through capability required at the transmission level.	**DO 6-1:** Align default settings with 1547.	☐
			DO 6-2: Select other default settings within 1547 ranges of adjustment.	☐
	Frequency Droop Settings	This capability is required for all DERs (with some limitations on Category I types) during the under/over frequency conditions.[1] Consider using default settings or adjust within ranges of allowable settings. Consider input from transmission operators or regional reliability coordinator.	**DO 7-1:** Align default settings with 1547.	☐
			DO 7-2: Select other default settings within 1547 ranges of adjustment.	☐
	Voltage regulation modes by reactive power[2]	If desired, consider activating a non-unity power factor, volt-var, watt-var, or constant var function. Also, consider statewide (or similar) default settings for such mode.	**DO 8a-1:** Adjustable constant power factor is activated.	☐
			DO 8a-2: Utilize volt-var without autonomously adjusting Vref.	☒
			DO 8a-3: Utilize volt-var with autonomously adjusting Vref.	☐
			DO 8a-4: watt-var is activated.	☐
			DO 8a-5: constant var[3] is activated.	☐
			DO 8b-1: Align default settings with 1547.	☒
			DO 8b-2: Select other default settings within 1547 ranges of adjustment.	☐
			DO 8c-1: Specify process for selecting settings on site-by-site basis.	☐
			DO 8c-2: Leave process undefined.	☐
	Voltage regulation modes by active power[4]	If desired, consider statewide (or similar) activation of volt-watt function (with default setting). Notably, the utilization of volt-watt will require changes to the interconnection applications forms (online portals) to allow an applicant to specify how volt-watt is implemented.	**DO 9-1:** Volt-watt[5] is activated with default 1547 settings.	☒
			DO 9-2: Volt-watt is activated with non-default settings.	☐
			DO 9-3: Volt-watt is not activated.	☐
	Interconnection Rule	Update interconnection rule to be inclusive of IEEE 1547-2018.	**DO 10a-1:** Change 1547 date and title in standards references.	☐
			DO 10b-1: Define timeline for adoption of new requirements in line with 1547-2018 per DO 1.	☐

[1] Per IEEE 1547-2018, this function cannot be disabled

[2] The voltage support functions by reactive functions (constant power factor, volt-var, watt-var, constant var) are mutually exclusive. By default, these functions are deactivated – meaning certified equipment will come out of the box to operate at unity power factor.

[3] Note: "constant var" mode is only required for normal performance Category B.

[4] The voltage support by active power (volt-watt) is deactivated by default – if desired, consider statewide (or similar) default setting for volt-watt.

[5] Note: "volt-watt" mode is only required for normal performance Category B.

			DO 10c-1: Update applicable power quality or other references (such as IEEE 519 or IEEE 1453) to IEEE 1547-2018.	☐
Mid-term	Reference Point of Applicability (RPA)	Consider process related improvement that allows RPA designation by applicant and for utility to review. This may involve changes to application forms (such as online application portals), initial reviews processes and provision to allow RPA review/discussion scoping meeting.	**DO 11-1:** Require RPA to be noted in the application forms and use RPA recommended language from Appendix E and F of BATRIES Toolkit as a starting point.	☐
			DO 11-2: Specify elsewhere how the RPA information is processed.	☐
			DO 11-3: (Do nothing) Do not introduce new requirements related to the RPA.	☐
	Enter service settings	It is important to consider whether non-default enter service settings are preferred for voltage and frequency ranges, delay time, and ramp rate. The standard allows for the duration of *enter service* period (ramp rate) to be adjustable over 1-1000 second with a default time of 300 seconds. For DERs less than 500kVA, individual DER units may use a randomized time delay with a default maximum interval at 300 seconds as an alternative to ramping. It is likely even the smallest inverter-based DER can utilize the enter service ramp. Enter Service ramp rate is also known as connect/reconnect or soft start ramp rate.	**DO 12a-1**: Utilize 1547 default settings for voltage range, frequency range, delay and duration.	☐
			DO 12a-2: Specify default settings within the ranges allowed by 1547.	☐
			DO 12b-1: Give further guidance on how randomized delay times are to be used for DER smaller than 500 kVA (consider application form addition).	☐
			DO 12b-2: Leave process for randomized delay selection undefined for DER smaller than 500 kVA.	☐
	Normal ramp rate	This capability is based on SA certification (not SB), consider whether the capability is utilized (if available).[6] Though not required by 1547-2018, this feature may be useful, especially for energy storage technologies. Per CA Rule 21, the default value is 100% of maximum current output per second (with an adjustable range of between 1% to 100%).	**DO 13a-1**: Normal ramp rate certification is required, and ranges of adjustment are specified.	☐
			DO 13a-2: Normal ramp rate **c**apability/certification is optional, and ranges of adjustment are specified.	☐
			DO 13a-3: Normal ramp rate is not required.	☐
			DO 13b-1: Normal ramp rate is activated by default using specified settings.	☐
			DO 13b-2: Normal ramp rate is not activated by default.	☐
	Communication protocols & ports	Consider specifying protocols and ports if known and of interest to utilities.	**DO 14-1**: Specify protocols and ports to be used at the DER interface.	☐
			DO 14-2: Do not specify protocols and ports at the DER interface.	☐
	Utility Required Profile (URP)	Finalize URP with all default settings and consider posting that in the EPRI URP database (publicly available).	**DO 15-1**: Utility to create and post URP of default settings.	☐
			DO 15-2: Do not create and post URP of default settings.	☐
	Application Forms	Update application forms (including online portals) for the following items: RPA selection Enter service randomized delay Volt-watt implementation Limit active maximum power function implementation Frequency droop implementation Intentional islanding Emergency backup systems DER communication capabilities	**DO 16-1**: Update application forms (use recommended language from Appendix F of BATRIES toolkit as a starting point).	☐
			DO 16-2: Do not update application forms.	☐

[6] The Normal Ramp Rate (NRR) is used when transitioning between energy output levels over the normal course of operation.

		Export/import limiting Power Control Systems (PCS) Inverter fault current		
	Volt-watt process/reporting	Volt-watt can have impact on customer's energy production. Curtailment is based on utility voltage that the customer has no control of. Consider a reporting process to understand if volt-watt curtailment becomes an issue for customers now or in the future.	**DO 17-1:** Implement a reporting process	☐
			DO 17-2: Do not implement a reporting process	☐
	Nameplate ratings	Consider addressing nameplate ratings issues related to volt-watt, limit maximum active power, and frequency droop. The interconnection application forms may need to allow applicants to describe how the functions are achieved.	**DO 18a-1:** Provide guidance on volt-watt implementation i.e., whether the DER unit(s) implement volt-watt based on the same or different per unit curves, and individual or total nameplate ratings (see BATRIES Toolkit Chapter VIII and IEEE 1547.2).	☐
			DO 18a-2: Do not provide further guidance on volt-watt nameplate ratings designation.	☐
			DO 18b-1: Provide guidance on how limit maximum active power function is implemented i.e., via PCS, via plant controller, or other means (see BATRIES Toolkit Chapter VIII and IEEE 1547.2).	☐
			DO 18b-2: Do not provide further guidance on how limit maximum active power is implemented.	☐
			DO 18c-1: Provide guidance on frequency droop implementation i.e., whether the DER unit(s) implement frequency droop based on individual or total nameplate ratings (see IEEE 1547.2).	☐
			DO 18c-2: Do not provide further guidance on how frequency droop is implemented.	☐
	Standard Interconnection Agreements	As required, include provisions for adhering to default functional settings and updating settings over time.	**DO 19-1:** Update interconnection agreement to meet contractual obligations (operating requirements).	☐
			DO 19-2: Do not update interconnection agreement to meet contractual obligations	☐
	Interconnection screens and study	The Fast Track and detailed study interconnection review processes should be updated based on 1547-2018 and additional information supplied by 1547.1 certification testing. Address the following issues: Shared secondary transformer screen Line configuration screen Effective grounding/supplemental grounding review Inverter fault current	**DO 20a-1:** Update "shared secondary transformer screen" based on likelihood of overvoltage occurring with default voltage regulation settings.	☐
			DO 20a-2: Keep screen conservative as is.	☐
			DO 20a-3: Determine alternative methods for screening overvoltage risk with voltage regulation.	☐
			DO 20b-1: Update line configuration screen to treat inverters and rotating machines distinctly (see BATRIES Toolkit Chapter VIII).	☐
			DO 20b-2: Use existing or alternative line configuration screens.	☐
			DO 20c-1: Revise Supplemental Review to include new grounding review for three-phase inverters based on LN connected load (see BATRIES Toolkit Chapter VIII).	☐
			DO 20c-2: Revise Supplemental Review to utilize a tool to determine supplemental grounding needs for inverters (see BATRIES Toolkit Chapter VIII).	☐
			DO 20c-3: Use existing or alternative grounding review practices.	☐

			DO 20d-1: Revise review practices for provision of inverter fault current test data (see BATRIES Toolkit Chapter VIII).	☐
	Power Control Systems (may be optional or long-term)	Include certification requirements for PCS in interconnection rule and/or technical requirements. Revise interconnection application to note if PCS is used and denote on one-line diagram.	**DO 21-1:** Include specific certification requirements for PCS in interconnection rule (see BATRIES Toolkit Chapter III).	☐
			DO 21-2: Add information on PCS to application forms (see BATRIES Chapter VIII).	☐
Long-term	DER communications/ control roadmap	Identify goals and strategies for deploying IEEE 1547 standardized communications/control of DER over time. Consider timeline for utilization of monitoring data, changes to autonomous function settings, scheduled function changes, and continuous direct control. Consider deployment for larger systems versus numerous small systems, and utility communications infrastructure versus DER aggregator model. Will communications infrastructure, DER equipment requirements and protocols be harmonized to any degree amongst utilities? How can investments in ADMS, DERMS or AMI be optimized to meet various goals? Consider linkage to grid modernization discussions.	**DO 22-1:** Establish a formal roadmap development process to take into account Commission's, stakeholders' and utilities' DER management goals.	☐
			DO 22-2: Allow individual utilities to determine needed communications investments based on internal DER management goals without external direction.	☐
			DO 22-3: Avoid directive management of communications deployment.	☐
	Communications deployment	DER communications deployment is still nascent and best practices for interconnection rules and technical requirements are still in development. The decision option list at right is a list of potential actions to consider, but is not intended to be exhaustive. Consider the need to change the interconnection rule's "telemetry," "SCADA," or "monitoring" DER size threshold. What requirements apply to the DER site/equipment? What actions need to be taken to adopt a DER aggregator model?	**DO 23a:** If not done previously, specify protocols and ports to be used at the DER interface or aggregator.	☐
			DO 23b: Define equipment requirements for DER or aggregator.	☐
			DO 23c: Create or reference guide for utilization of communications protocol (e.g., California Common Smart Inverter Profile).	☐
			DO 23d: Update "telemetry" requirements to change size threshold.	☐
			DO 23e: Update "telemetry" and/or other communication requirements to reference IEEE 1547 communications requirements.	☐
			DO 23f: Include certification/validation requirements for communications equipment (e.g., California Common Smart Inverter Profile).	☐
			DO 23g: Define standard aggregator requirements and agreements.	☐
	Interconnection agreement updates for communications/ control	As DER communications becomes deployed more widely, standard interconnection agreements should reflect such utilization. Control of the reactive power, volt-watt, limit maximum active power, permit service and other functions can affect energy production/delivery and have financial repercussions on the affected DER. It should be understood and agreed as to how these functions will be used. These aspects should be memorialized in the interconnection agreement. A standardized agreement can be developed to help establish expectations and limits while streamlining the interconnection process.	**DO 24a-1:** Develop standard interconnection agreements language to define whether a communications pathway is required and of which type it will be (e.g., utility direct to inverter, utility direct to gateway, or aggregator participation).	☐
			DO 24a-2: Establish communication requirements within each individual interconnection agreement.	☐
			DO 24b-1: Define expectations for control in the standard interconnection agreement (e.g., when and how long will the DER be curtailed or controlled and over what range of adjustment for specific parameters).	☐
			DO 24b-2: Establish expectations for control within each individual interconnection agreement.	☐
	Prioritization vs. export limiting	TBD	**DO 25-1:**	☐
			DO 25-2:	☐

	Ongoing reevaluation of default settings	Investigate whether fielded functional settings (voltage regulation and voltage/frequency settings) are optimized. Address the following: Are voltage regulation settings working well or should they be revised? Are new functionalities or insights available that can be leveraged to improve grid integration? Are volt-watt issues present that need to be addressed?	**DO 26-1:**	☐
	Evaluation/ commissioning	TBD	**DO 27-1:**	☐
			DO 27-2:	☐