Decision Options Matrix for IEEE 1547-2018 Adoption

IREC's Decision Options Matrix is intended to be a resource for Public Utilities Commissions, utility personnel, and other distributed energy resource (DER) stakeholders interested in adopting and implementing IEEE 1547™-2018 in their jurisdictions. The matrix includes a list of Decision Options (DOs) that stakeholders should consider before implementing the updated standard. The DOs provide step-by-step guidance on incorporating the updated standard into interconnection rules and procedures. The matrix translates technical content within the standard, as well as related issues, into easily digestible decisions that impact DER interconnection reviews and operations (e.g., timeline, voltage regulation, interoperability). The matrix includes over fifty distinct decisions, organized into three IEEE 1547-2018 adoption categories, namely:

A. Near-term items (actions needed as first steps in the adoption process),
B. Mid-term items (actions that should, for the most part, be taken before the implementation date), and
C. Long-term items (actions that may be taken after the implementation date, may require a formal roadmap, or may require ongoing reevaluations).

It may take more than six months for a working group to select the near-term DOs, including education, discussion, and formalization of consensus. Further time will then be needed for the Commission to take related actions. This matrix can be used to help guide the schedule of working groups and select a feasible implementation date. Its use should help streamline the adoption of IEEE 1547-2018 and provide a means to transparently communicate key decision points. Users can download the matrix and use the DO items to communicate and keep track of key decisions. Users may also tailor the matrix and its DOs to their respective jurisdiction and preferences (e.g., color code individual DOs based on whether such decision falls within interconnection rules and procedures versus a utility interconnection handbook/manual). IREC's publication *Making the Grid Smarter: Primer on Adopting the New IEEE 1547™-2018 Standard for Distributed Energy Resources (“MTGS”)*[1] dives deeper on many of these topics; references to relevant sections of the paper are given in brackets. Other references are mentioned as needed. Notably, *The Toolkit and Guidance for the Interconnection of Energy Storage and Solar-Plus-Storage* (“BATRIES Toolkit”)[2] offers potential solutions for several DOs.

If there is only a single decision to be made for a particular topic, then one of the numbered options should be selected. When there are multiple decisions, these are indicated by letters (i.e., 1a, 1b, 1c) and one numbered option should be selected for each letter. The Matrix may be updated from time to time as more states adopt the standard and experience is gained.

[1] https://irecusa.org/resources/making-the-grid-smarter-primer-on-adopting-the-new-ieee-standard-1547-2018/
[2] https://energystorageinterconnection.org/

Topic	What to Consider	Decision Option (DO) Description	Utilize?
A. Near Term			
Adoption timeline	Equipment listing to UL 1741 SB certifies conformance with 1547-2018 for inverter-based resources and some other interconnection equipment. Consider certified equipment availability, the use of UL 1741 SA certification in the interim (if needed), and whether naming a certain date is necessary before certified equipment is widely available. 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 until 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. However, 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 compliant 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 2023 (dependent on several factors). More information is available on IREC's research on equipment availability.[3] [MTGS II]	**DO 1a-1:** Comply with IEEE 1547-2018 beginning [some date before April 1, 2023].	☐
		DO 1a-2: Comply with IEEE 1547-2018 beginning ~April 1, 2023 or a later date.	☐
		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 date.	☐
		DO 1b-2: Base compliance date on installation date (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 immediately.	☐
		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. Since there can be conflict between distribution utility desires and bulk system reliability, 1547-2018 designates oversight of this selection to the Authority Governing Interconnection Requirements—often the Public Utilities Commission. [MTGS V.A]	**DO 2-1:** IEEE 1547-2018 Category III Ride-Through capabilities must be supported for inverter-based DERs. Rotating DERs must meet Category I Ride-Through capabilities, at minimum.	☐
		DO 2-2: IEEE 1547-2018 Category II Ride-Through capabilities must be supported by inverter-based DERs, at minimum. Rotating DERs must meet Category I Ride-Through capabilities, at minimum.	☐

[3] https://irecusa.org/blog/regulatory-engagement/new-research-sheds-light-on-when-key-smart-inverters-will-be-available/

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. [MTGS V.A]	**DO 3-1:** Inverter-based DERs must meet reactive power requirements of 1547-2018 Category B. Rotating DERs must meet Category A, and may meet Category B.	☐
		DO 3-2: All DER types (inverter-based and rotating) shall meet reactive power requirements of 1547-2018 Category A, and may meet Category B.	☐
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 if 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 and 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 and ranges	Ensure that the under/overfrequency 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[4] settings	This capability is required for all DERs (with some limitations on Category I types) during the under/overfrequency conditions. Consider using default settings or adjust within ranges of allowable settings. Consider input from transmission operators or regional reliability coordinator. [MTGS V.A]	**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[5]	If desired, consider activating a non-unity power factor, volt-var, watt-var, or constant var function. See PNNL research on autonomously adjusting V_{ref}.[6] Also, consider statewide (or similar) default settings for such mode. [MTGS V.B, VI]	**DO 8a-1:** Adjustable constant power factor is activated.	☐
		DO 8a-2: Utilize volt-var without autonomously adjusting V_{ref}.	☐
		DO 8a-3: Utilize volt-var with autonomously adjusting V_{ref}.	☐
		DO 8a-4: Watt-var is activated.	☐
		DO 8a-5: Constant var[7] is activated.	☐
		DO 8b-1: Align default settings with 1547.	☐

[4] Per IEEE 1547-2018, this function cannot be disabled.
[5] The voltage support functions by reactive power (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.
[6] McDermott T.E., and S.R. Abate, Adaptive Voltage Regulation for Solar Power Inverters on Distribution Systems, In IEEE 46th Photovoltaic Specialists Conference (PVSC 2019), June 16-21, 2019, Chicago, IL, 0716-0723, IEEE, doi:10.1109/PVSC40753.2019.8981277
[7] Note: Constant var mode is only required for normal performance Category B.

		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 (e.g., as determined through system impact study).	☐
		DO 8c-2: Leave process for selecting settings on site-by-site basis undefined.	☐
Voltage regulation modes by active power[8]	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. [MTGS V.B, VI]	**DO 9-1:** Volt-watt[9] 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 the interconnection rule to be inclusive of IEEE 1547-2018. To be clear which version of a standard applies and when it takes effect, it is recommended that standards be dated (with edition number, if applicable), and that the implementation date is made clear either within the rule or by Commission order. In addition to implementing adoption of the standard within the rule, requirements or references to other standards that are now addressed by IEEE 1547 should be updated to be inclusive of 1547's requirements. Note that this latter issue is reflected in DO 10c, and only one decision option is offered.	**DO 10a-1:** Change 1547 date and title in standards references.	☐
		DO 10a-2: Leave 1547 standard reference undated.	☐
		DO 10b-1: Define timeline for adoption of new requirements in line with IEEE 1547-2018 per DO 1.	☐
		DO 10b-2: Leave timeline for adoption open dependent on, e.g., Commission order (in line with DO 1a-3).	☐
		DO 10c-1: Update applicable power quality or other references (such as IEEE 519 or IEEE 1453 in SGIP's Supplemental Review Voltage and Power Quality Screen) to IEEE 1547-2018.	☐

Topic	What to Consider	Decision Option (DO) Description	Utilize?
B. 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 review processes, and provisions to allow RPA review/discussion during the scoping meeting. [MTGS IV]	**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 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	**DO 12a-1**: Utilize 1547 default settings for voltage range, frequency range, reconnect delay, and ramp duration.	☐
		DO 12a-2: Specify default settings within the ranges allowed by 1547.	☐

[8] The voltage support by active power (volt-watt) is deactivated by default—if desired, consider statewide (or similar) default setting for volt-watt.
[9] Note: Volt-watt mode is only required for normal performance Category B.

	seconds 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 DERs can utilize the enter service ramp. Enter service ramp rate is also known as connect/reconnect or soft start ramp rate. Given that DERs would ramp up upon reconnection with a default period of 300 seconds, consider whether the default delay of 300 seconds can be shortened.	**DO 12b-1:** Give further guidance on how randomized delay times are to be used for DERs smaller than 500 kVA (consider application form addition).	☐
		DO 12b-2: Leave process for randomized delay selection undefined for DERs smaller than 500 kVA.	☐
Utility-required profile (URP)	Finalize URP with all default settings and consider posting that in the EPRI URP database[10] (publicly available). Implement use of EPRI's Common File Format for DER Settings Exchange and Storage.[11] [MTGS IV, VI]	**DO 13a-1**: Utility to create and post URP of default settings.	☐
		DO 13a-2: Do not create and post URP of default settings.	☐
		DO 13b-1: Utility to implement use of common file format to transmit specified settings to customer and verify applied settings.	☐
		DO 13b-2: Do not implement common file format.	☐
Requirements for replacement units	For end-of-life or other equipment replacements, define whether or not the most recent technical requirements, certifications, and settings must be followed. It could be beneficial to ensure that "legacy" interconnection equipment (such as an inverter) is upgraded to the most recent standards over time. However, warranty replacements are usually like-for-like and should be accommodated. Additionally, DER owners may keep spare parts on hand for future use to limit downtime during repair. Contractual obligations for notifying the utility of equipment changes and the requirements for updated equipment should be clear at the time of interconnection. Note that "material modification" guidelines could be developed to ensure an easy transition to new equipment and note under which circumstances further evaluation must be conducted by the utility. [MTGS VI]	**DO 14a-1:** Allow replacement equipment to match the certification and technical requirements of originally evaluated and installed equipment. Require settings to match those specified in the Interconnection/Operating Agreement.	☐
		DO 14a-2: Require replacement equipment to conform to certification and technical requirements of rule in effect at time of replacement. Make exception for warranty work (and potentially for previously acquired equipment). Require settings to match those specified in the Interconnection/Operating Agreement.	☐
		DO 14a-3: Require replacement equipment to conform to certification and technical requirements of rule in effect at time of replacement. Make exception for warranty work (and potentially for previously acquired equipment). Require settings to match those specified by the utility or default URP at the time of replacement.	☐
		DO 14b-1: Update definitions of material modification for already interconnected DERs. Establish when notification or further evaluation (and related fees) must occur, dependent on replacement type and power specifications.	☐

[10] https://dersettings.epri.com/

[11] *Common File Format for Distributed Energy Resources Settings Exchange and Storage*, EPRI (December 2020), https://www.epri.com/research/products/000000003002020201

		DO 14b-2: Leave material modification process unchanged or undefined.	☐
		DO 14c-1: Establish process for determining changes to settings when replacement equipment is updated.	☐
		DO 14c-2: Do not define process for determining changes to settings when replacement equipment is update.	☐
Standard interconnection agreements	As required, include provisions for adhering to required functional settings and updating settings or equipment over time.	**DO 15a-1:** Update standard interconnection agreement to meet contractual obligations (operating requirements) regarding functional settings.	☐
		DO 15a-2: Do not update standard interconnection agreement to meet contractual obligations regarding functional settings.	☐
		DO 15b-1: Update standard interconnection agreement to meet contractual obligations (operating requirements) regarding future replacement equipment (see DO 14a).	☐
		DO 15b-2: Do not update standard interconnection agreement to meet contractual obligations regarding replacement equipment.	☐
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 • Export/import limiting • Power control systems (PCS) • Inverter fault current	**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.	☐
Volt-watt process/reporting	Volt-watt can have an impact on the DER customer's energy production. Curtailment is based on utility voltage that the customer has no control over. Consider a reporting process to understand if volt-watt curtailment becomes an issue for customers now or in the future. [MTGS V.B]	**DO 17a-1:** Ensure volt-watt curtailment complaints are tracked through the utilities' voltage/power quality complaint process.	☐
		DO 17a-2: Do not specify a process to track volt-watt curtailment complaints.	☐
		DO 17b-1: Implement a reporting process to Commission to review volt-watt complaints on a regular basis (e.g., yearly).	☐
		DO 17b-2: Do not implement a reporting process.	☐
Normal ramp rate	The normal ramp rate is used when transitioning between power output levels over the normal course of operation. This	**DO 18a-1**: Normal ramp rate certification is required, and ranges of adjustment are specified.	☐

	capability is based on UL 1741 SA certification (not UL 1741 SB). Consider whether the capability may be utilized (if available). Though not required by IEEE 1547-2018, this feature may be useful to avoid rapid voltage changes, 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%). At the moment, testing only supports verification of upward ramping (for increases in power), which PV systems can support. Storage systems could also support downward ramping (for decreases in power), but verification tests in UL 1741 SA do not yet evaluate this direction. This ramp rate could interfere with frequency support or matching load via a power control system, so prioritization or exceptions may be needed for implementation.	**DO 18a-2:** Normal ramp rate capability/certification is optional, and ranges of adjustment are specified.	☐
		DO 18a-3: Normal ramp rate is not required or specified.	☐
		DO 18b-1: Normal ramp rate is not activated by default.	☐
		DO 18b-2: Normal ramp rate is activated by default using specified settings.	☐
Nameplate ratings	Consider addressing nameplate rating 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 19a-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[12] and IEEE 1547.2).	☐
		DO 19a-2: Do not provide further guidance on volt-watt nameplate ratings designation.	☐
		DO 19b-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 19b-2: Do not provide further guidance on how limit maximum active power is implemented.	☐
		DO 19c-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 19c-2: Do not provide further guidance on how frequency droop is implemented.	☐
Communication protocols and ports	Consider specifying protocols and ports if known and of interest to utilities at this time. Requirements for having the necessary communications equipment (e.g., gateway with a specific port) could cause DERs to include "stranded" equipment that is never used if it is never connected to a communications system. On the other hand, having the	**DO 20a-1**: Specify protocol(s) to be used at the DER interface or aggregator.	☐
		DO 20a-2: Specify protocols and/or ports to be used at the DER interface or aggregator.	☐
		DO 20a-3: Do not specify protocols or ports at the DER interface or aggregator.	☐

[12] https://energystorageinterconnection.org/viii-incorporating-updated-interconnection-standards-into-interconnection-procedures/

	equipment installed ensures that it is available to connect at a future date, if desired. See communications/control roadmap in the Long-Term topic. [MTGS V.C]	**DO 20b-1:** Specify that systems which require "telemetry" must comply with communication equipment requirements.	☐
		DO 20b-2: Specify that systems of all sizes must comply with communication equipment requirements.	☐
		DO 20b-3: Implement equipment requirements in the future when ready to implement 1547-standardized communications.	☐
Interconnection screens and study	The Fast Track,[13] Supplemental Review (SR), and detailed study interconnection review processes should be updated to reflect IEEE 1547-2018. The existing Fast Track includes: • The "shared secondary transformer screen," which may not reflect voltage regulation (e.g., volt-var settings) activated by the DER • The "line configuration screen," which may not recognize the difference between inverters vs. rotating machines [MTGS V.D] For projects that fail the existing "line configuration screen," SR may lack new or alternate ways to evaluate effective grounding or provide means to properly evaluate the need for supplemental grounding [MTGS V.D]. Similarly, screening for "inverter fault current" needs updating to reflect 1547.1 certification testing. Inverter manufacturers may have additional information supplied by 1547.1 certification testing that indicate fault values (fault current test data). Where fault current values are made available through test certification, it should be understood and agreed if review practices (for screens and detailed study) can utilize such data. In addition, best practices for rapid voltage change (RVC) and flicker evaluation should be developed. While DO 10c-1would update the power quality references in the Supplemental Review Voltage and Power Quality Screen, the actual practices used to evaluate these issues have previously been left undefined. It is likely that utilities across the U.S. utilize varying practices, some of which may be unnecessary or overly conservative. For instance, EPRI has found that it is largely	**DO 21a-1:** Update "shared secondary transformer screen" based on likelihood of overvoltage occurring with default voltage regulation settings.	☐
		DO 21a-2: Do not update screen. Keep screen conservative as is.	☐
		DO 21a-3: Determine alternative methods for screening overvoltage risk with voltage regulation.	☐
		DO 21b-1: Update line configuration screen to treat inverters and rotating machines distinctly (see BATRIES Toolkit Chapter VIII).	☐
		DO 21b-2: Use existing or alternative line configuration screens.	☐
		DO 21c-1: Revise Supplemental Review to include new grounding review for three-phase inverters based on line-to-neutral connected load (see BATRIES Toolkit Chapter VIII).	☐
		DO 21c-2: Revise Supplemental Review to utilize a tool to determine supplemental grounding needs for inverters (see BATRIES Toolkit Chapter VIII).	☐
		DO 21c-3: Use existing or alternative grounding review practices.	☐
		DO 21d-1: Review practices for provision of inverter fault current test data (see BATRIES Toolkit Chapter VIII).	☐
		DO 21d-2: Rely on existing or undefined practices for determining inverter fault current values.	☐
		DO 21e-1: Review flicker, RVC, and other power quality screening practices to ensure they are in alignment with the standards, as well as best practice.	☐
		DO 21e-2: Leave power quality screening practices undefined and open to interpretation.	☐

[13] Note: Fast Track is the terminology used in SGIP and some states to categorize the second tier of interconnection reviews. Other states refer to such second-tier process as "Level 2."

	unnecessary to perform flicker screening for PV systems.[14] It is advised that Public Utilities Commissions review these practices to ensure current learnings and the requirements of IEEE 1547-2018 are taken into account appropriately. [MTGS V.D]		
Export control and power control systems (may be optional or long-term)	While not strictly required for IEEE 1547 adoption, export controls and power control systems (PCS) may be used for some aspects of IEEE 1547 implementation, including RPA selection, volt-watt implementation (see DO 18a-1), and limit maximum active power implementation (see DO 18b-1), in addition to other interconnection or tariff-related reasons. These export controls can be considered part of the interconnection system, and certification or compliance with certain requirements could be considered necessary in certain "fast track" or "simplified" interconnection processes. [MTGS V.H, BATRIES Toolkit]	**DO 22a-1:** Include specific technical and certification requirements for export controls and PCS in the interconnection rule (see BATRIES Toolkit Chapter III[15]).	☐
		DO 22a-2: Leave technical and certification requirements for export controls undefined.	☐
		DO 22b-1: Add information on PCS and export limiting equipment to application forms (see BATRIES Chapter VIII).	☐
		DO 22b-2: Do not update application forms with export controls information.	☐
		DO 22c-1: Implement other elements of BATRIES Toolkit export control recommendations (e.g., Chapters II,[16] IV,[17] VI,[18] VII,[19] IX[20]).	☐
		DO 22c-2: Do not implement other BATRIES Toolkit elements at this time.	☐

Topic	What to Consider	Decision Option (DO) Description	Utilize?
C. Long Term			
DER communications/ control roadmap	Identify goals and strategies for deploying IEEE 1547 standardized communications/control of DERs 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	**DO 23-1:** Establish a formal roadmap development process to take into account Commission's, stakeholders', and utilities' DER management goals.	☐
		DO 23-2: Allow individual utilities to determine needed communications investments based on internal DER management goals without external direction.	☐
		DO 23-3: Avoid directive management of communications deployment.	☐

[14] Xiaojie Shi et al., Can Photovoltaic Plants Cause Voltage Flicker? – Field Measurement and Screening, IEEE (June 2019) ("We found that PV ramping is too slow to cause light flicker in cases measured. Even the relatively large PV installations do not contribute in a noticeable way because of relatively slow power output changes."), https://ieeexplore.ieee.org/document/8980601.

[15] https://energystorageinterconnection.org/iii-requirements-for-limited-and-non-export-controls/

[16] https://energystorageinterconnection.org/ii-updating-interconnection-procedures-to-be-inclusive-of-storage/

[17] https://energystorageinterconnection.org/iv-evaluation-of-non-export-and-limited-export-systems-during-the-screening-and-study-process/

[18] https://energystorageinterconnection.org/vi-improving-grid-transparency-through-hosting-capacity-analyses-and-other-tools/

[19] https://energystorageinterconnection.org/vii-pathways-to-allow-for-system-design-changes-during-the-interconnection-review-process-to-mitigate-the-need-for-upgrades/

[20] https://energystorageinterconnection.org/ix-defining-rules-and-processes-for-the-evaluation-of-fixed-schedule-der-operation/

	requirements, and protocols be harmonized to any degree among utilities? How can investments in ADMS, DERMS, or AMI[21] be optimized to meet various goals? Consider the linkage to grid modernization discussions. [MTGS V.C]		
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[22]," 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? [MTGS V.C]	**DO 24a:** If not done previously, specify protocols and ports to be used at the DER interface or aggregator.	☐
		DO 24b: Define equipment requirements for DER or aggregator, and whether or not those apply to systems below the "telemetry" size threshold.	☐
		DO 24c: Create or reference a guide for utilization of communications protocol(s) (e.g., California Common Smart Inverter Profile).	☐
		DO 24d: Update "telemetry" requirements to change size threshold.	☐
		DO 24e: Update "telemetry" and/or other communication requirements to reference IEEE 1547 communications requirements.	☐
		DO 24f: Include certification/validation requirements for communications equipment (e.g., California Common Smart Inverter Profile).	☐
		DO 24g: Define standard aggregator requirements and agreements.	☐
Interconnection agreement updates for communications/ control	As DER communications become 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 25a-1:** Develop standard interconnection agreement 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 25a-2: Establish communication requirements within each individual interconnection agreement.	☐
		DO 25b-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 25b-2: Establish expectations for control within each individual interconnection agreement.	☐
Prioritization vs. export limiting	Export limits can potentially interfere with DER systems providing full grid support capability. For example, a non-	**DO 26-1:** Create prioritization to be used for all export-limiting DERs.	☐

[21] Advanced distribution management system (ADMS), distributed energy resources management system (DERMS), advanced metering infrastructure (AMI)
[22] Supervisory control and data acquisition (SCADA)

	exporting storage system may not be able to fully increase power output in line with frequency droop requirements for underfrequency events if output would exceed local load. IEEE 1547-2018 does not address situations related to export limiting in its prioritization of DER responses in subclause 4.7. Since this can affect bulk grid reliability, seek input from transmission operators or regional reliability coordinator when assigning priority of functions. See discussion in IEEE 1547.2.	**DO 26-2**: Allow utility and customer to agree on prioritizations for each individual interconnection application as needed.	☐
		DO 26-3: Do not address prioritization for export-limited DERs until national standards are established.	☐
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 and trip settings working well or should they be revised? • Are volt-watt issues present that need to be addressed? • Are new insights available that can be leveraged to improve grid integration?	**DO 27a-1:** Collect field data, perform modeling, and present findings at regularly scheduled meetings once IEEE 1547-2018 compliant DER systems have had significant time in the field. Determine if default settings should be updated.	☐
		DO 27a-2: Do not review effectiveness of fielded DER settings.	☐
		DO 27b-1: Regularly review nationally available research on voltage regulation deployment to determine if adjusted DER settings or voltage regulation practices may be desirable.	☐
		DO 27b-2: Do not review DER voltage regulation research.	☐
Evaluation/ commissioning	IEEE 1547-2018 and 1547.1-2020 contain expanded guidance on how evaluation of DER systems should be performed and what commissioning tests are to be completed. The different options for type tests, DER evaluations, and commissioning tests are dependent on the RPA of the DER system, whether or not it is fully certified, and other factors. Interconnection rules often do not explicitly require specific commissioning tests or give direct guidance on how evaluations should be performed by the utility. Utility handbooks may address commissioning in more detail. [MTGS IV]	**DO 28-1:** Update interconnection rule to address different evaluation and commissioning concepts introduced by the standards.	☐
		DO 28-2: Update utility handbooks to address evaluation and commissioning.	☐
		DO 28-3: Do not address evaluation or commissioning updates.	☐