Incorporating updated standards, IEEE 1547

IREC's Decision Options Matrix

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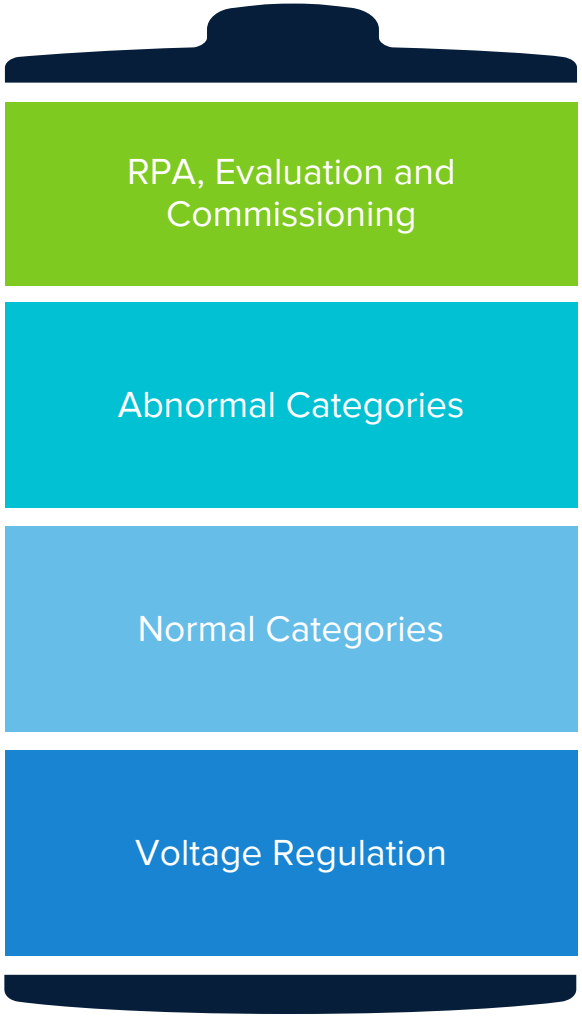
IEEE 1547-2018

Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces



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Additional 1547-2018 Requirements

Power Quality

- Load rejection and ground fault overvoltage must be limited
- Rapid Voltage Change (RVC) limitation
- Flicker evaluation

Fault Current

- >500 kW systems must have fault current waveforms (inverters)

Communications

- Must be capable of talking DNP3, 2030.5 or SunSpec
- Specific monitoring and control parameters required

IREC Decision Options Matrix as Guide for adopting IEEE 1547-2018

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Development of Decision Option Matrix

- IREC has participated in 1547, 1574.1, 1547.2, UL 1741, etc. development
- Helped develop MN Technical Interconnection and Interoperability Requirements (TIIR)
- Led stakeholder group to update HECO's Rule 14
- Participated in CA
- Utilized matrix in NM, OR

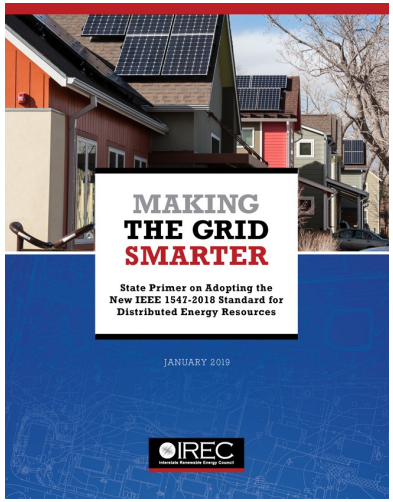
Overview of Decision Option Matrix

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

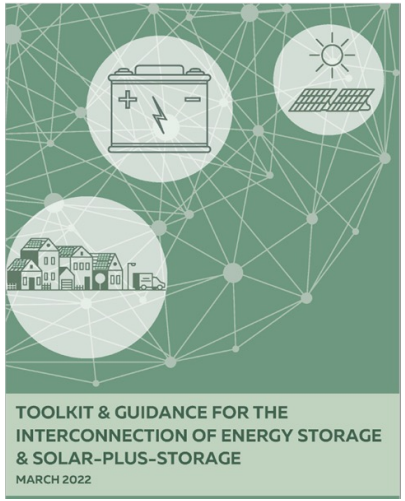
Overview of Decision Option Matrix

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.	☐

More Guidance Available



Available at:
https://irecusa.org/resources/making-the-grid-smarter-primer-on-adopting-the-new-ieee-standard-1547-2018/



Available at:
https://irecusa.org/programs/batries-storage-interconnection/

See NREL for further resources:
https://www.nrel.gov/grid/ieee-standard-1547/

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Rule vs. Manual

- Commission Oversight
  - Authority Governing Interconnection Requirements (AGIR)
  - Stakeholder engagement
  - Goal-directed (e.g., voltage regulation to increase hosting capacity)
- Flexibility
  - Evolution of the grid
  - Locational specificity
- Default settings/functions
  - Statewide
  - Utility specific

Scheduling and Prioritization of Topics

- Stakeholders:
  - Involve as many as early as possible
  - Manufacturers and developers need lead time to transition
- Scheduling:
  - What is the timeline for implementation vs. the schedule of the workshop?
  - Does this timeline coincide with efforts in other WGs (screens/processes)?
- Prioritization:
  - Matrix is in general order of priority
  - Consider state's minimum goals

Priority Decision Options

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Adoption Timeline

It is challenging to get certified equipment to market in less than 18 months.

Adoption Timeline

Weeks	Expected Accumulation
0	0.0%
18	1.9%
36	12.3%
54	47.1%
72	67.1%
90	80.6%
108	84.5%
216	100.0%

Chart shows cumulative certifications for each NRTL testing pathways over time. Vertical line represents one year

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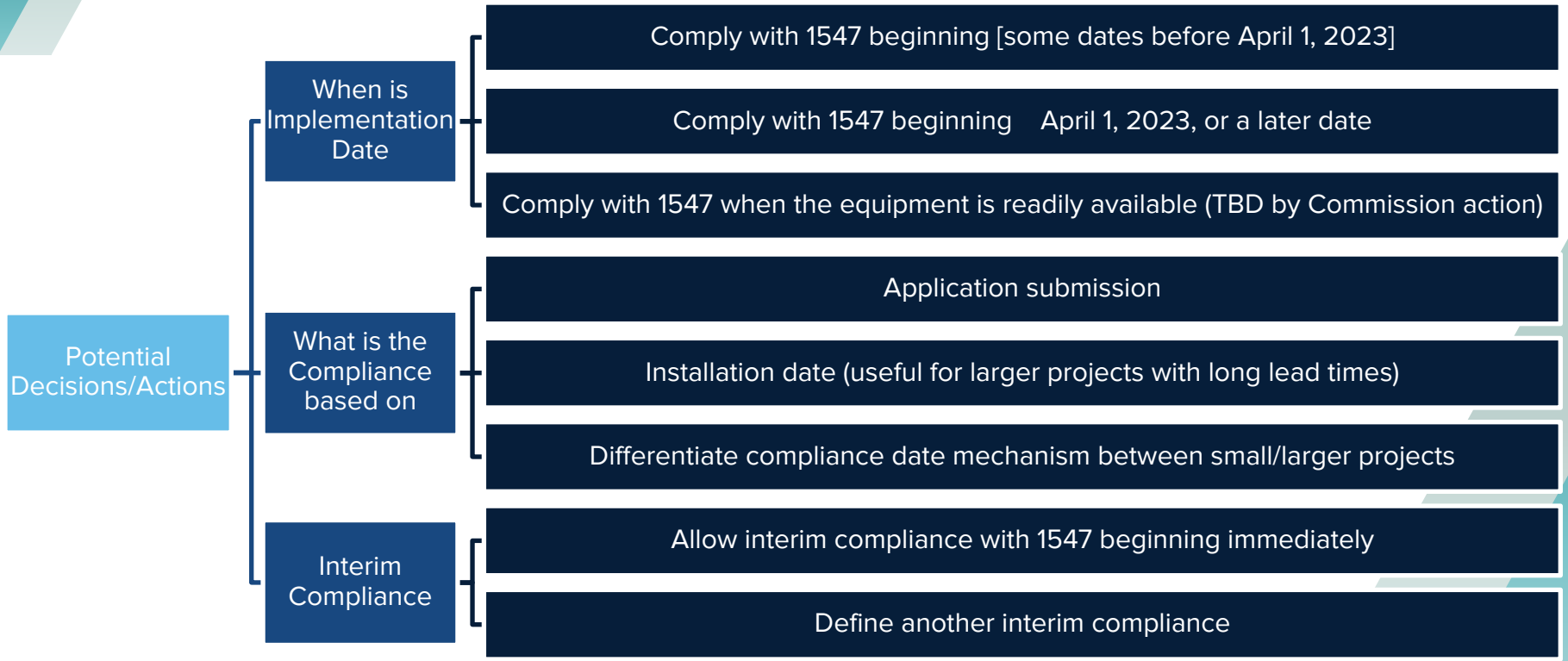
Adoption Timeline – What Are Your Options?



Abnormal Operating Performance Categories

Why abnormal category matters

- Bulk system reliability will be more dependent on DER, and massive tripping could cause instability
- DER should ride-through transmission faults that are quickly cleared

What are the three categories

- Cat I: minimum capability needed to support bulk grid
- Cat II: much improved capability for high-penetration
- Cat III: Extreme ride-through, including distribution grid effects (e.g., FIDVR)

More on why this matters

- Some equipment may not be able to achieve higher levels of capability

The Authority Governing Interconnection Requirements (AGIR, typically the utilities commission) should integrate bulk system needs into selection of the Abnormal Category. Consider specifying category assignment based on technology type.

Abnormal Performance, Voltage – CAT I

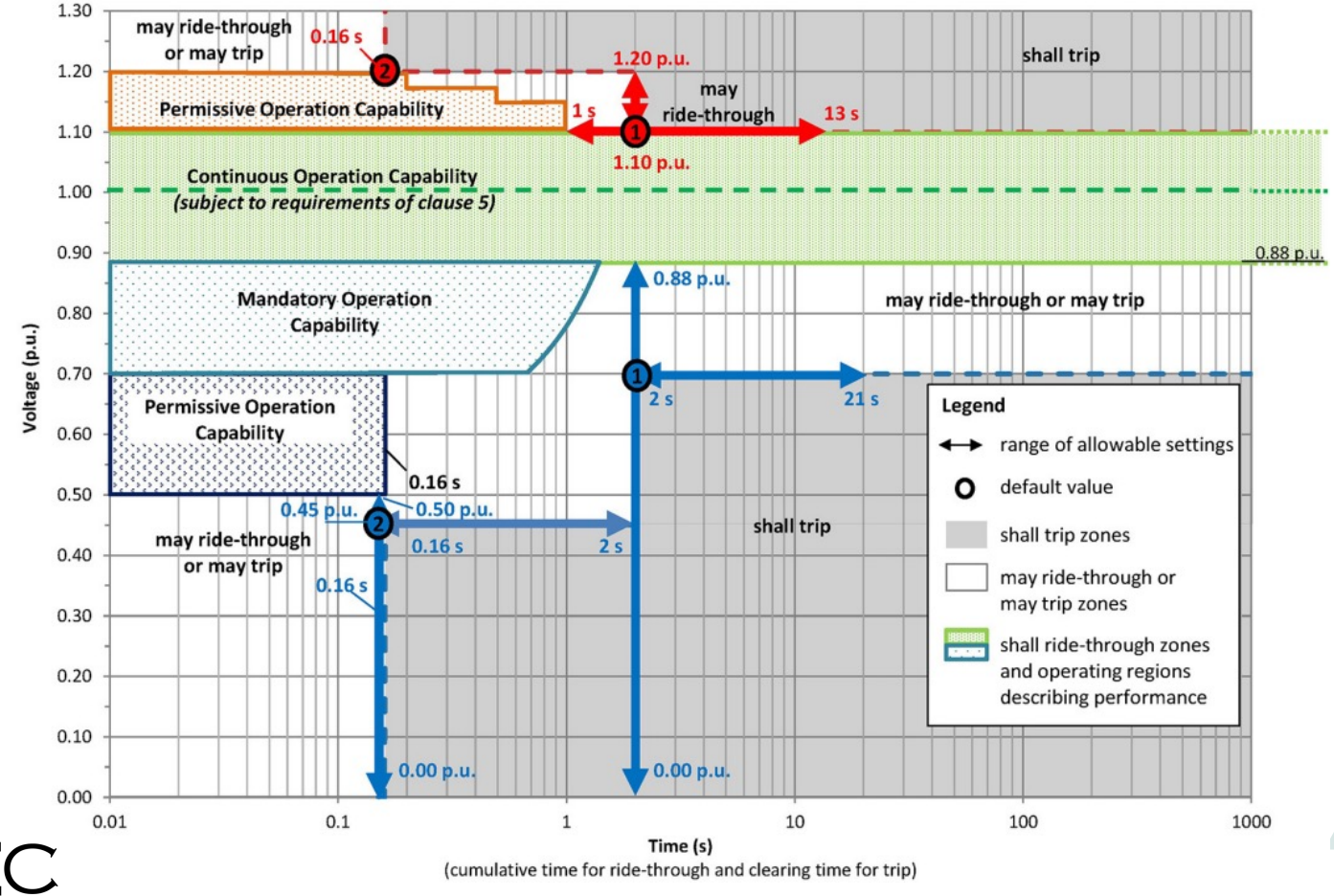


Figure H.7 of IEEE 1547-2018

Abnormal Performance, Voltage – CAT II

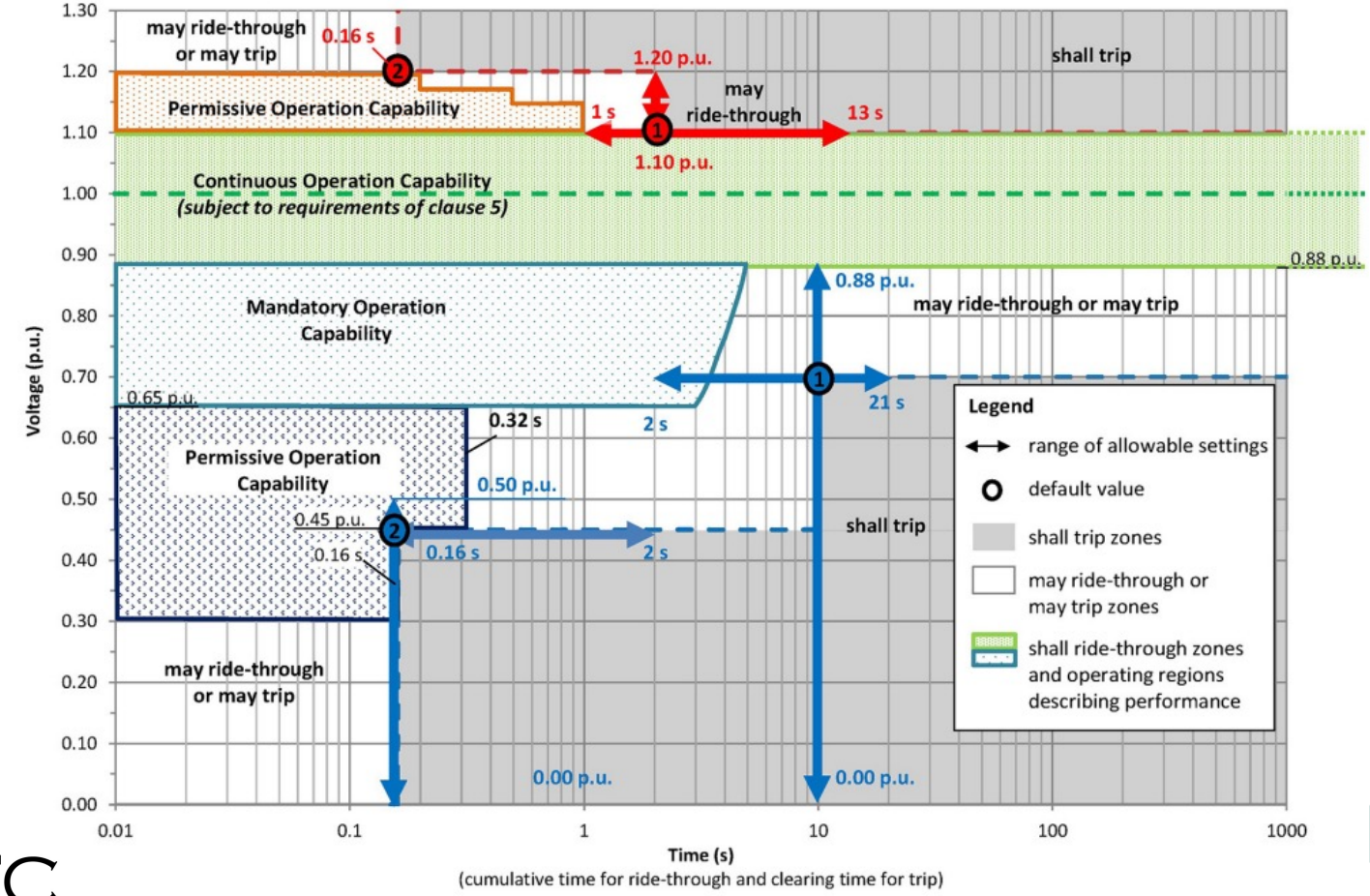


Figure H.8 of IEEE 1547-2018

Abnormal Performance, Voltage – CAT III

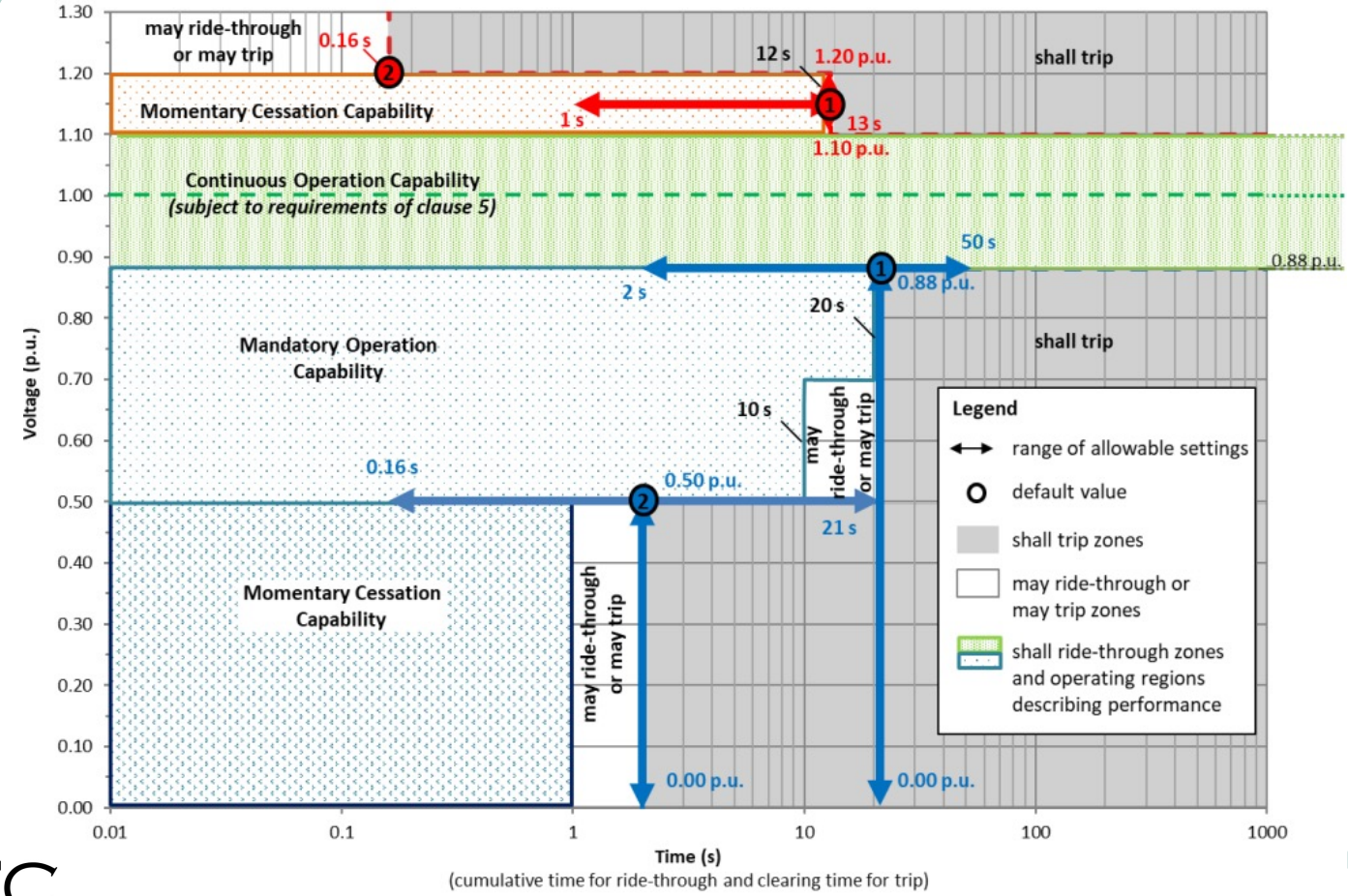


Figure H.1 of IEEE 1547a-2020 (replacing figure H.9 of IEEE 1547-2018)

Abnormal Performance, Frequency – CAT I, II, III

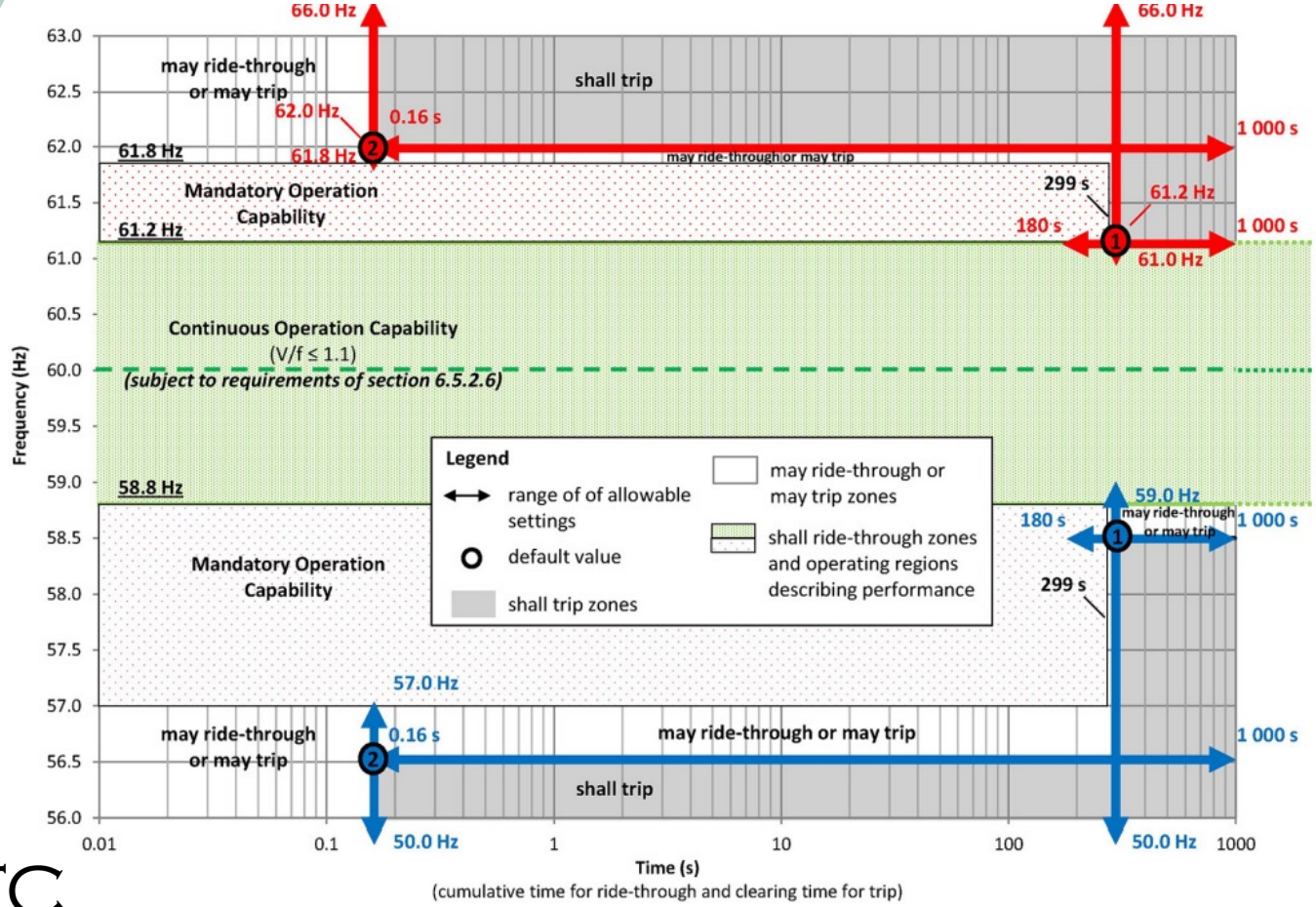


Figure H.10 of IEEE 1547-2018

Normal Operating Performance Categories

Why normal category matters

- Voltage regulation capability
- DER should mitigate voltage effect on distribution system, through changes in reactive or active power

What are the two categories

- Cat A: Minimum capability needed to support voltage, allowance for rotating machines
- Cat B: Better regulation capability for high-penetration

More on why this matters

- Some functions are not required for Cat A

Consider specifying category assignment based on technology type.

Cat A/B Set the Stage for Reactive/Active Power Control Functions

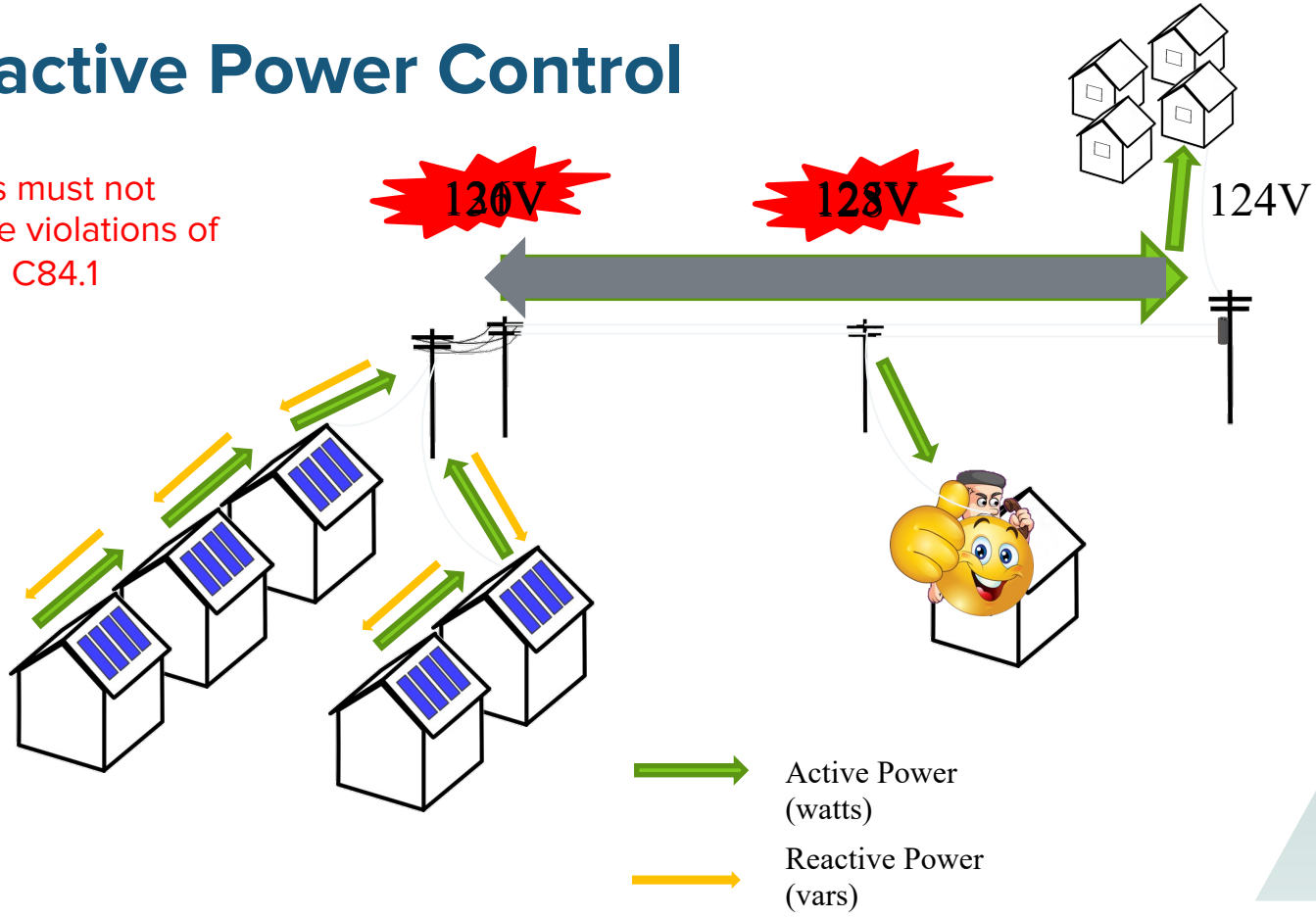
DER category	Category A	Category B
Voltage regulation by reactive power control		
Constant power factor mode	Mandatory	Mandatory
Voltage—reactive power mode[a]	Mandatory	Mandatory
Active power—reactive power mode[b]	Not required	Mandatory
Constant reactive power mode	Mandatory	Mandatory
Voltage and active power control		
Voltage—active power (volt-watt) mode	Not required	Mandatory

[a]Voltage-reactive power mode may also be commonly referred to as "volt-var" mode.
[b]Active power-reactive power mode may be commonly referred to as "watt-var" mode.

Table 6 of IEEE 1547-2018

Reactive Power Control

DERs must not cause violations of ANSI C84.1



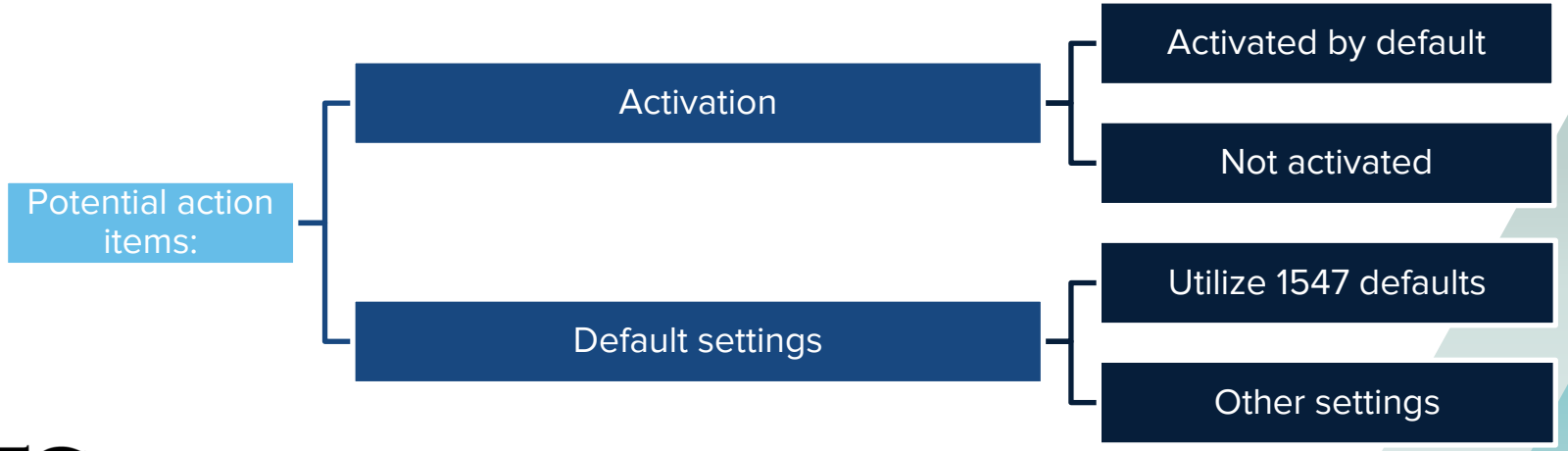
Voltage Regulation Considerations

- IEEE 1547-2018 default is the constant power factor mode with PF=1
  - i.e., **no reactive power = no voltage support**
- Voltage regulation works best if all/most DER are participating
- States/utilities to clarify which voltage regulation function DERs should use; adjust from Standard defaults accordingly
- Potential for DER customer impacts

Volt-Watt Activation and Settings

Why it matters

- Volt-watt mitigates high voltage outside Range B caused by backfeed
- Could be considered mitigation alternative to secondary upgrades
- Potential to cause major financial losses for owner



Mid-Term Decision Option Example

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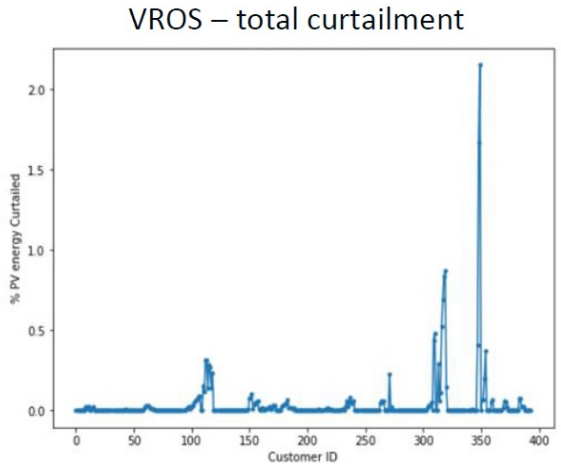
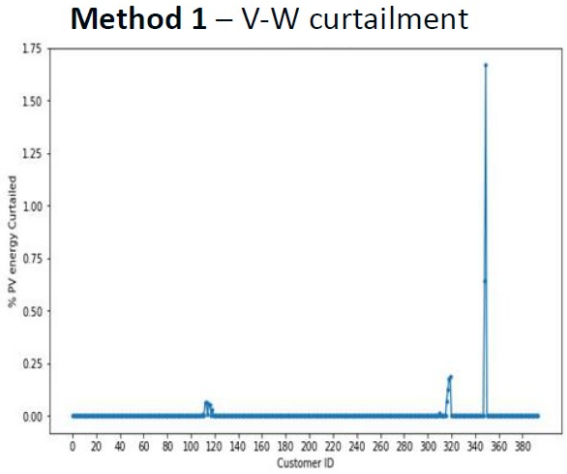
Volt-Watt Curtailment

- Ensure complaint process handles DER complaints appropriately
- Consider reporting on how many voltage-based curtailment issues arise
- Consider metric based on voltage data to determine potential for curtailment



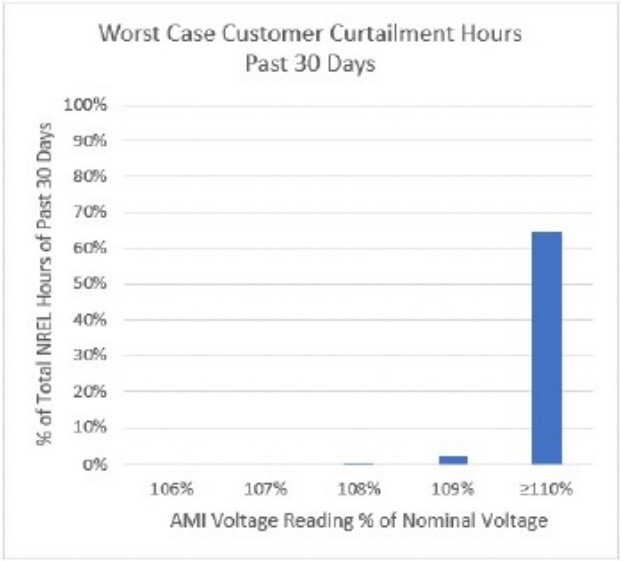


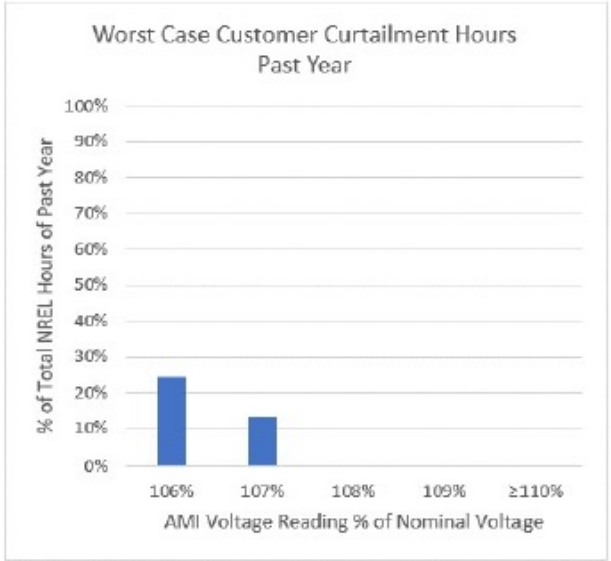
Credit: NREL

Summary Results for Utility (or Pending) Mitigations		
NREL Method 1 Estimation of Curtailment %	# of Customers with 1 year Curtailment %	# of Customers with 1 month Curtailment %
≤ 2%	15	10
> 2% ≤ 4%	0	1
>4%	4	8
Total	19	19

Summary Results for Customer Issues		
NREL Method 1 Estimation of Curtailment %	# of Customers with 1 year Curtailment %	# of Customers with 1 month Curtailment %
≤ 2%	16	15
> 2% ≤ 4%	2	0
>4%	0	3
Total	18	18

Worst Case Customer (>5% Curtailment) Voltage Histograms





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Volt-Watt Curtailment Reports

California Experience

- PG&E (largest IOU) reported only 9 customers with potential yearly curtailment >4%
- Worst yearly potential loss reported was 38.7% (failing distribution transformer)
- Next highest was 7.3%
- It appears true that volt-watt is unlikely to cause widespread curtailment, but individual customers can be highly impacted

Long Term Decision Option Examples

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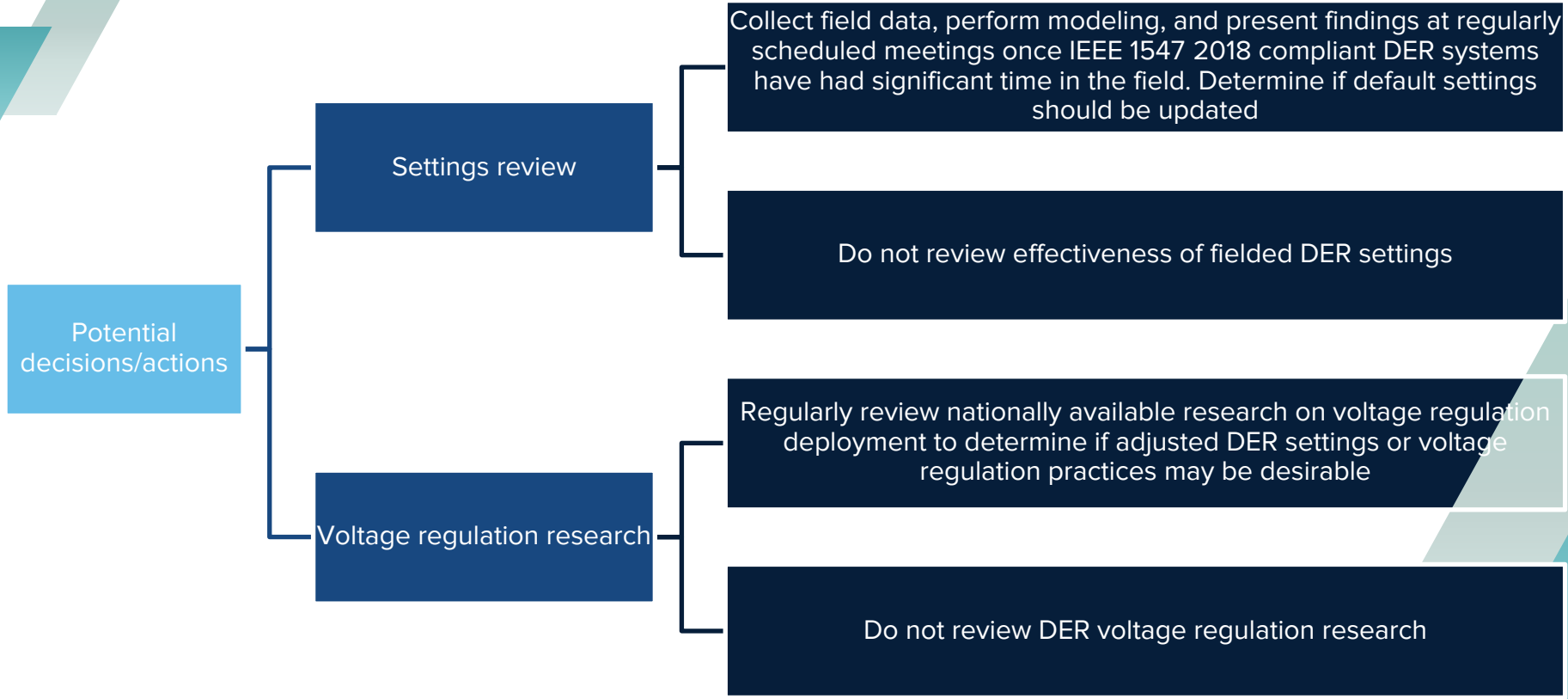
DER Communications/Control Roadmap

Identify strategy and goals for deploying comms over time – What to consider?

- Timeline for utilization of monitoring data, changes to autonomous function settings, scheduled function changes, and continuous direct control.
- Deployment for larger systems versus numerous small systems
- Utility communications infrastructure versus DER aggregator model.

Ongoing Reevaluation of Default Settings



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