NARUC
National Association of Regulatory Utility Commissioners

Questions for Public Utility Commissions Related to Assessing Potential Risks to the Distribution System from Older Inverter-based Distribution Generation

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Background and Summary of Project Findings

The National Association of Regulatory Utility Commissioners (NARUC)NARUC released a request for proposal for a project "Assessing Potential Risks to the Distribution System from Older Inverter-based Distribution Generation" in November 2022 (Solicitation Number: NARUC-2023-645-DCH163). The Electric Power Research Institute (EPRI) was awarded a contract in January 2023 with a period of performance through March 2024. EPRI's scope of work focuses on bulk system impacts of legacy distributed energy resources (DERs) conforming with Institute of Electrical and Electronics Engineers (IEEE) 1547-2003 in the ISO New England (ISO-NE) reliability region.

EPRI's analysis identified ~160,000 legacy DER sites totaling ~4,400 MW across the ISO-NE area. ISO-NE's *Transmission Planning for the Clean Energy Transition* (*TPCET) pilot study and subsequent improvements to its modeling assumptions*[1] have identified a risk that about 950 MW of DERs could trip for the worst fault, which was a single-line-to-ground (SLG) fault with breaker failure on the Southeast Massachusetts Load Zone/Rhode Island 345 kilovolt system in a spring weekend mid-day minimum load study condition. The main findings of EPRI's study were:

1. **Legacy inverter-based DERs can pose a risk to bulk power system reliability:**

   The ISO-NE area has ~160,000 legacy DER sites totaling ~4,400 megawatt (MW) at risk of tripping. ISO-NE's reliability assessments are not robust enough to draw firm conclusions regarding the needs for reconfiguration of legacy DERs to reduce risk.

2. **Modern inverter-based DERs can provide advanced grid support, if adequately configured:**

   A subset of the ~170,000 existing modern inverter-based DER sites (~2,700 MW), and an increasing amount of newly interconnecting modern inverter-based DER sites, may provide opportunities to support some legacy DERs to ride through certain contingencies by being (re-)configured to utilize advanced DER capabilities that are not mandatory but optional, per IEEE 1547-2018.

3. **The costs and benefits of six potential solutions to reduce risk were analyzed qualitatively:**

   Plans for retrofits often face strong objections from potentially affected stakeholders. Voluntary incentives are preferred over mandatory requirements. Efforts should focus on modern DERs that have capability for remote configuration by the original equipment manufacturer (OEM) or another DER managing entity.

Based on these findings, EPRI recommends expanding the stakeholder collaboration to further assess, and possibly mitigate, the residual risk. Such explorations with a broad set of stakeholders can also prepare for future risks as they may emerge in the power system transformation process.

1 M. Saravanan, Updates to IEEE 1547-2003 DER Modeling Assumptions, Planning Advisory Committee Meeting (ISO New England, August 24, 2022), https://www.iso-ne.com/static-assets/documents/2022/08/a8_updates_to_ieee_1547_2003_der_modeling_assumptions_2.pdf.

Questions Regulators Can Ask

The following high-level issues and related questions serve as discussion prompts for Public Utility Commissions (PUCs) wishing to explore aspects of utilities' distribution and bulk power system risk management programs related to potential re-configuration or retrofit of older (legacy) DERs.

Internal Questions for PUC Staff

Questions PUCs can ask themselves to prepare for distribution and bulk power system risk management programs related to potential re-configuration or retrofit of older (legacy) DERs

Personnel and Internal Capabilities

1. Does the PUC have a dedicated staff member working on legacy DER issues?
    a. Who is responsible for monitoring and understanding DER capabilities, performance, and technology evolution? Do you have contacts with DER developers or their engineering firms?
    b. Who is responsible for monitoring and understanding bulk power system reliability issues? Do you have contacts with the relevant regional reliability coordinator or ISO/RTO in your state?
    c. If you do not have a dedicated staff member or existing relationships with key stakeholders, what would it take to prepare and build up those capabilities? How could contacts be identified? How long could it take to build trust in new relationships? What existing stakeholder forums could be leveraged in the interim?
2. Can the PUC use consultants to assist with the independent review and analysis of utility and stakeholder concerns and proposals?
    a. What options are available to the PUC to hire consultants, and what lead work is necessary to access funds or approvals to do so?
3. Does the PUC have access to datasets with detailed information about existing DER installations?
    a. What information do existing datasets include? Do they include information such as installation date, location, DER rating, DER technology, energy resource type, inverter brand and model, and inverter firmware version?
    b. What agreements exist with utilities regarding sharing of DER data with the PUC?
4. Does the PUC have access to relevant standards and materials associated with those standards? Consider engaging in and/or reviewing the following:
    a. IEEE1547-2018 and its amendments are available to anyone with an IEEE.org account free of charge for "view only" in the IEEE Standards Reading Room.[2]
    b. Applicable standards development organizations (e.g., IEEE, International Electrotechnical Commission (IEC), American National Standards Institute (ANSI), North American Energy Standards Board (NAESB)). One example is the IEEE's Electric Energy Resources Interconnection Standards Collaborative (ISC).[3]

2 IEEE, "1547-2018 – IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces," IEEE Standards Reading Room, https://ieeexplore.ieee.org/browse/standards/reading-room/page.

3 IEEE Standards Association, "Electric Energy Resources Interconnection Standards Collaborative (ISC)," https://standards.ieee.org/industry-connections/activities/electric-energy-resources-interconnection-standards-collaborative-isc/.

5. How does your PUC incorporate the applicable standard(s) into your state rules, process, or policy? IEEE Standards that are "incorporated by reference" in the U.S. Code of Federal Regulations (CFR) "along with other initiatives" are recognized and available in the IEEE Standards Reading Room[4] for "view only."

6. Does the responsibility for developing potential re-configuration or retrofit of older (legacy) DERs reach across different organizations and offices?

    a. What other state government agencies have equities in executing a potential re-configuration or retrofit of existing DER installations, including older (legacy) DER technologies?

Plans and Policies

1. What regulatory or informal processes exist to convene workshops, working groups, or other meetings to inform and educate stakeholders and the PUC regarding DER standards and practices?

2. What role can the PUC play regarding the assessment of the need for—or regarding the planning and execution of potential—re-configurations and retrofits of DERs?

    a. Can the PUC take a proactive position in developing re-configuration/retrofit programs and policies, or must it wait for a relevant docket or utility filing?

    b. Are there other national standards, guides, or recommended practices that have been or could be adopted or developed to address the need for potential future re-configuration or retrofits of DERs? How are neighboring states or those with similar policy contexts addressing this issue? Consider engaging in IEEE 1547/.x series of standards, guides, and recommended practices' ongoing and potential future revisions, as recognized on the IEEE SC21 website,[5] and other places.

    c. Should the PUC provide general guidance, best practices, or principles for re-configurations and retrofits of older DERs? Would the PUC specify roles and responsibilities for DER re-configuration/retrofit programs?

3. How and where will the review and considerations of a specific utility proposal to re-configure or retrofit older DERs (or a broader re-configuration/retrofit plan) fit within a PUC's purview? Will this occur within the cost-benefit assessment of a specific proposal, through a general rate case, or elsewhere?

    a. How can the PUC take lessons learned from an existing utility re-configuration/retrofit program and apply them to new utility proposals?

    b. What resources exist in other regions/countries to help develop and execute re-configuration/retrofit programs successfully and cost-effectively?

4. How does the state law protect private property if re-configuration or retrofit of older (legacy) DERs became necessary?

    a. Can consumers be mandated to make changes? Would this require legislation to be changed?

    b. Could incentive programs encourage voluntary action by owners of existing installations?

4 IEEE, IEEE Standards Reading Room, https://ieeexplore.ieee.org/browse/standards/reading-room/page.

5 IEEE Standards Association, "IEEE Standards Coordinating Committee 21 (SCC21)," February 2023, https://sagroups.ieee.org/scc21/standards/.

5. What policies, rules, and programs are in place to support incentives for investment in new DERs?
    a. Could these voluntary programs be expanded to existing installations?
6. What funding mechanisms exist to incentivize or mandate re-configuration or retrofit of older (legacy) DERs?
    a. Does this include state funding or also federal funding?

External Questions for Regulated Utilities and Regional Reliability Coordinators

Questions PUCs can ask their regulated utilities and regional reliability coordinators (e.g., ISOs/RTOs) to prepare for distribution and bulk power system risk management programs related to potential re-configuration or retrofit of older (legacy) inverter-based DERs

Personnel and Key Stakeholders:

1. What relationships do you have with your DER customers?
    a. Are you in regular contact with stakeholder groups representing DER customers?Do you have a dedicated staff member working on legacy DER issues?
    a. Who do they currently work with regarding DER capabilities, performance, and technology evolution? Do they have specific contacts with inverter and other DER OEMs? Do they have contacts with DER developers or their engineering firms?
    b. Who is responsible for addressing bulk power system reliability and related requirements? Who is the regional reliability coordinator in your state? Do you have specific contacts with the ISO or RTO in your state? Are there any guidelines in place regarding preferred DER settings provided by the ISOs/RTOs within your region?
2. Do you own, produce, or have access to datasets with detailed information about existing DER installations?
    a. What information do existing datasets include? Do they include information such as installation date, location, DER rating, DER technology, energy resource type, inverter brand and model, and inverter firmware version?
3. Do you have access to the relevant standards and materials associated with those standards?
    a. Are you engaged with applicable standards development organizations (e.g., IEEE, IEC, ANSI, NAESB)?
    b. How do you incorporate applicable standard(s) into its public, customer-facing, or internal DER specifications, recommended practices, or guidelines?

Risks Assessments and Grid Studies

1. Do you consider IEEE 1547-2018 sufficient to prevent the need for potential future DER re-configuration/retrofit programs? Do they see deficiencies or gaps in IEEE 1547-2018?
2. Does the ISO or RTO consider IEEE 1547-2018 sufficient to prevent the need for potential future DER re-configuration/retrofit programs? Do they see deficiencies or gaps in IEEE 1547-2018?
3. Have you conducted risks assessments of potential impacts of older DERs on the distribution system?
    a. What methods have you used for these risks assessments (e.g., steady-state power flow or short circuit studies, fundamental frequency phasor domain studies, or electromagnetic transient studies)?

4. What is your confidence level in the risk assessment? What improvements in data acquisition or methods should be made before the potential need for DER re-configurations/retrofits can be assessed with sufficient confidence? Has the ISO or RTO conducted risks assessments of potential impacts of older DERs on the bulk power system?

    a. What methods have been used for these risks assessments (e.g., steady-state power flow or short circuit studies, fundamental frequency phasor domain studies, or electromagnetic transient studies)?

    b. What is their confidence level in the risk assessment? What improvements in data acquisition or method should be made before the potential need for DER re-configurations/retrofits can be assessed with sufficient confidence?

Plans and Policies

1. Have you adopted IEEE 1547-2018 and its amendment(s) to require technical minimum capability and performance requirements for modern DERs?

    a. What effective date is/was IEEE 1547-2018 adopted for? Does that date apply to all DERs or only a subset, whether based on date of interconnection request or commercial operation, technology (e.g., inverter/non-inverter), or rating? Are there other adoption dates?

2. What is the scope of the adoption of IEEE 1547-2018?

    a. Is assessment of compliance/conformity with the standard limited to DER unit and supplemental DER device certifications such as UL 1741 SB?

    b. Does assessment of compliance/conformity with the standard include an evaluation of the design of a whole DER facility (DER system)?

    c. Do stakeholders make use of the IEEE Conformity Assessment Program (ICAP)[6] and/or the IEEE Distributed Energy Resources Education and Credentialing program[7] for IEEE 1547-2018?

    d. Do you follow the guidance of IEEE1547.2-2023 (IEEE Application Guide for IEEE1547)[8] and the NERC Reliability Guideline "Bulk Power System Reliability Perspectives on the Adoption of IEEE 1547-2018"[9] that recommend distribution feeder protection settings to be coordinated with the DER ride-through performance and voltage/frequency trip settings per IEEE 1547-2018?

3. Do you recommend or already execute re-configurations/retrofits of DERs?

    a. When and how was that recommendation or decision made?

    b. Is there consensus between other stakeholders such as DER OEMs, developers, and customers about these measures? If not, what are the dissenting opinions?

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6 IEEE Standards Association, "IEEE Conformity Assessment Program (ICAP)," https://standards.ieee.org/products-programs/icap/.

7 IEEE Standards Association, "Distributed Energy Resources Education and Credentialing Program," https://standards.ieee.org/products-programs/icap/programs/der/.

8 IEEE Standards Association, "IEEE 1547.2-2023, IEEE Application Guide for IEEE Std 1547™2018, IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interfaces," May 20, 2024, https://standards.ieee.org/ieee/1547.2/7166/.

9 North American Electric Reliability Corporation, *Reliability Guideline: Bulk Power System Reliability Perspectives on the Adoption of IEEE 1547-2018* (Atlanta, GA, March 2023), https://www.nerc.com/comm/RSTC_Reliability_Guidelines/Guideline-IEEE_1547-2018_BPS_Perspectives_PostPubs.pdf.

4. Does the ISO or RTO recommend, or already execute re-configurations/retrofits of DERs?
    a. When and how was that recommendation or decision made?
    b. Is there consensus between you and other stakeholders such as DER OEMs, developers, and customers about these measures? If not, what are the dissenting opinions?

Funding/Rate Payers

1. Are there communities in your service territory that could benefit[10] from a subsidized DER re-configuration/retrofit program?
    a. For example, benefits could include an increased reliable and resilient grid, renewable energy sources, additional emergency response capabilities, or rate decreases?
2. Do you have active grants or contracts to support DER re-configuration/retrofit programs?

10 Benefits could include increased reliability and resilience, expansion of renewable energy generation, additional emergency response capabilities, and decreased costs of DER deployment and grid operation.

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