McGuireWoods LLP
501 Fayetteville St.
Suite 500
Raleigh, NC 27601
Phone: 919.755.6600
Fax: 919.755.6699
www.mcguirewoods.com

E. Brett Breitschwerdt
Direct: 919.755.6563

McGUIREWOODS

bbreitschwerdt@mcguirewoods.com

December 22, 2021

VIA Electronic Filing

Ms. A. Shonta Dunston, Interim Chief Clerk
North Carolina Utilities Commission
Dobbs Building
430 North Salisbury Street
Raleigh, North Carolina 27603

Re: Duke Energy Carolinas, LLC and Duke Energy Progress, LLC's Comments and Filings Regarding Risks Posed by Inverter-Based Resources
Docket No. E-100, Sub 101

Dear Ms. Dunston:

Enclosed for filing in the above-referenced proceeding on behalf of Duke Energy Carolinas, LLC ("DEC") and Duke Energy Progress, LLC ("DEP" and together with DEC, "Duke Energy") is their *Comments and Filings Regarding Risks Posed by Inverter-Based Resources* pursuant to the Commission's November 22, 2021 *Order Requiring Comments and Filings Regarding Risks Posed by Inverter-Based Resources*. Included as Attachment A to this filing is Duke Energy's Distributed Energy Resource ("DER") Functional Settings for DER Interconnected to Duke Energy Distribution System.

Please do not hesitate to contact me should you have any questions. Thank you for your assistance with this matter.

Very truly yours,

/s/E. Brett Breitschwerdt

EBB:sbc

Enclosure

STATE OF NORTH CAROLINA
UTILITIES COMMISSION
RALEIGH

DOCKET NO. E-100, SUB 101

BEFORE THE NORTH CAROLINA UTILITIES COMMISSION

In the Matter of	)	**DUKE ENERGY CAROLINAS, LLC**
Petition for Approval of Revisions to	)	**AND DUKE ENERGY PROGRESS,**
Generator Interconnection Standards	)	**LLC'S COMMENTS AND FILINGS**
	)	**REGARDING RISKS POSED BY**
	)	**INVERTER-BASED RESOURCES**

NOW COME Duke Energy Carolinas, LLC ("DEC") and Duke Energy Progress, LLC ("DEP") (collectively the "Companies" or "Duke Energy") pursuant to the North Carolina Utilities Commission's ("Commission") November 22, 2021 *Order Requiring Comments and Filings Regarding Risks Posed by Inverter-Based Resources* (the "Order") and hereby file the instant Comments in response to the questions regarding inverter-based resources ("IBR") posed by the Commission. In response to the directive in Ordering Paragraph 2, the Companies are also filing as Attachment A to these Comments the Functional Settings for Distributed Energy Resources ("DER") Interconnected to Duke Energy Distribution System.

I. INTRODUCTION

In its Order, the Commission indicated that the questions it posed were in response to a number of issues identified in a Joint Staff Report[1] (the "Joint Report") prepared by the North American Electric Reliability Corporation ("NERC") and the Texas Reliability Entity ("Texas RE"), analyzing two disturbances that occurred on the bulk power system in Texas during the summer of 2021. The Commission noted that its questions were targeted to "determine whether these issues exist in North Carolina and, if so, address them in the interest of maintaining reliability of the electric system."[2]

The Companies view the risks identified by NERC and referenced in the Order to be increasingly present on the Companies' utility systems, and the Companies believe evolving Good Utility Practice[3] in both the interconnection study process as well as during parallel operation of IBR Generating Facilities is critical to maintaining adequate reliability of the Duke Energy electric systems in North Carolina. The aggregate capacity of IBR Generating Facilities connected to the DEC/DEP systems will exceed 6 gigawatts by 2024,

---

[1] Odessa Disturbance Texas Events: May 9, 2021 and June 26, 2021 Joint NERC and Texas RE Staff Report (September 2021), *available at* https://www.nerc.com/pa/rrm/ea/Documents/Odessa_Disturbance_Report.pdf.
[2] Order, at 2.
[3] Capitalized terms not otherwise defined in these Comments shall have the meaning set forth in Appendix 1 to the North Carolina Interconnection Procedures ("NCIP").

representing roughly twenty percent of peak summer demand. Most of these sites were designed, studied, and constructed before the performance and interconnection guidelines discussed in the Order were well known and accepted in the industry. The Companies are committed to working with inverter manufacturers, IBR developers, other Utilities in the region, the Commission, and other stakeholders to address the reliability risks and interconnection-related issues identified in the Joint Report.

The Joint Report addresses impacts to the Bulk Electric System[4] from IBR facilities subject to NERC guidelines. The Companies' responses to the Commission's questions in ordering paragraph 1 are similarly focused on state-jurisdictional transmission-connected Generating Facilities connecting to the Bulk Power System ("BPS")[5] and does not address Distribution System-connected facilities. While many of the findings in the Joint Report can also be ascribed to state-jurisdictional Generating Facilities connecting to the Distribution System, the IEEE 1547-2018 implementation process should appropriately address these related but ultimately distinct set of issues.

Aside from a few NERC-regulated Generating Facilities,[6] state-jurisdictional Interconnection Customers have not been required to comply with an evolving set of interconnection standards after they have achieved parallel operation. In the responses below, the Companies assert that Appendix 5 and Articles 2.2 and 1.6 of the North Carolina Interconnection Agreement ("NCIA") give the Utility significant latitude in adopting new standards consistent with Good Utility Practice and subject to Commission oversight to ensure safe and reliable parallel operation of state-jurisdictional IBR facilities with the BPS.

The findings in the Joint Report indicate the need for robust protections and control review, modeling, and monitoring of transmission-connected Generating Facilities that have already achieved parallel operation. The Companies intend to develop the scope and timing of this activity through the Interconnection Technical Standards Review Group ("TSRG"). Additionally, the Companies are enhancing NCIA Appendix 5 templates to directly reference each Utility's FAC-001[7] Facility Interconnection Requirements ("FIR"),

---

[4] NERC standards only apply to elements of the Bulk Electric System (BES), which in the case of IBRs are those connecting at a voltage of 100kV or above and having gross aggregate nameplate rating greater than 75MVA.

[5] Bulk-Power System: (A) facilities and control systems necessary for operating an interconnected electric energy transmission network (or any portion thereof); and (B) electric energy from generation facilities needed to maintain Transmission System reliability. The term does not include facilities used in the local distribution of electric energy. NERC Glossary of Terms, *available at* https://www.nerc.com/files/glossary_of_terms.pdf.

[6] In DEC and DEP, only 6 of 34 IBR Generating Facilities interconnected to the Transmission System are considered BES.

[7] NERC Standard FAC-001 requires "Each Transmission Owner shall document Facility interconnection requirements, update them as needed, and make them available upon request." *accessible at* https://www.oasis.oati.com/woa/docs/DUK/DUKdocs/Duke_Energy_Carolinas_Facilities_Connection_Requirements_Rev_11.pdf; https://www.oasis.oati.com/woa/docs/CPL/CPLdocs/Duke_Energy_Progress_Facility_Interconnection_Requirements_R1.pdf.

beginning with those tendered to transmission-connected sites proceeding through the NCIP Section 1.10.1 Transitional Serial process. Finally, the Companies are planning to implement EPRI openXDA software to monitor individual inverter-based resource site performance.

II. DUKE ENERGY'S RESPONSES TO COMMISSION QUESTIONS

1. **Do North Carolina's state-jurisdictional generation interconnection standards and agreements adequately address the issue of generator ride-through, electromagnetic transient ("EMT") modeling, and the on-going monitoring of inverter-based resources?**

Response: As the Commission recently recognized in its October 8, 2021 *Order Clarifying Interconnection Standards, Requesting Comments, and Requiring Filing of Remediation Information*, a primary purpose of the NCIP and NCIA are to protect system reliability and ensure safe parallel operations of generating facilities and to ensure the integrity of utility systems in North Carolina. As described below, the NCIP and/or the NCIA adequately address the issues of generator ride-through, EMT modeling, and the ongoing monitoring of inverter-based resources at this time.

Generator Ride-Through

The Companies require compliance with NERC reliability standard PRC-024 for transmission-connected sites through Appendix 5 of the NCIA, *Additional Operating Requirements for the Utility's System and Affected Systems Needed to Support the Interconnection Customer's Needs*. For reference, Appendix 5 to the DEP NCIA template includes the following operating requirement:

> *6. The solar Generating Facility inverter control equipment shall be set such that the voltage and frequency ride-through capability is in accordance with NERC Reliability Standard PRC-024 Attachment 1 (for frequency) and Attachment 2 (for voltage).*

NERC concludes that PRC-024 voltage and frequency curves are not sufficient to mitigate the risks detailed in the investigation of the disturbances. In light of these findings, the Companies have recently undertaken efforts to coordinate plant protections and controls for new transmission-connected Generating Facilities. This includes PRC-024 compliance review of both high and medium voltage protection schemes and inverter control settings. As a result of the Joint Report, the Companies are in the process of updating NCIA Appendix 5 and Article 2.2.1 templates to formalize a more detailed coordination process for new state-jurisdictional Generating Facilities connecting to the Transmission System.

At this time, the Companies have not attempted to implement increased coordination of protection and controls with IBR Generating Facilities that have already executed NCIAs and achieved parallel operations. Importantly, all NERC-regulated

Generating Facilities are required to comply with new standards as they are implemented. While many North Carolina IBR resources are not subject to the NERC standards,[8] Section 1.6 of the NCIA requires Interconnection Customers to abide by all rules and procedures pertaining to the parallel operation of the Generating Facility in the applicable control area. Accordingly, even if a specific operating requirement did not exist at the time the NCIA Appendix 5 was executed, the Interconnection Customer is required to comply with the FIR[9] that establish the minimum operating requirements for all facilities connecting to the Utility's system.[10]

EMT Modeling

The recent NCIP revisions implementing queue reform include a 150-day Phase 2 study that includes, among other things, building and verifying a positive sequence dynamic model for each interconnection request that proceeds to Phase 2. In most cases, these types of studies are sufficient for determining transient stability issues created by the new interconnection request. However, as pointed out in Table 1.2 of the NERC Reliability Guideline *Improvements to Interconnection Requirements for BPS-Connected Inverter-Based Resources, September 2019* ("Interconnection Guideline"),[11] more complex EMT modeling may be required in certain scenarios:

> *EMT simulations may be needed in certain situations or scenarios involving inverter-based resources. These include, but are not limited to, subsynchronous control interactions near series compensation or interaction with other neighboring inverter-based resources, low short circuit strength pockets, or other sub-synchronous or super-synchronous controls issues. [Transmission Operators] should specify requirements for inverter-based resources to provide EMT models in situations where an EMT-type study may be needed now or in the foreseeable future.*

---

[8] *See supra* notes 4, 7.
[9] Facility Interconnection Requirements are required to be posted on OASIS per NERC Standard FAC-001.
[10] If determined necessary in the future, Duke Energy could seek clarification from the Commission to ensure that the provisions of NCIA Section 1.6 and Appendix 5 provide the Companies all necessary and appropriate authority to update minimum operating requirements over time to ensure safe and reliable parallel operation of Generating Facilities with Duke Energy's systems in North Carolina.
[11] Reliability Guideline Improvements to Interconnection Requirements for BPS-Connected Inverter-Based Resources, September 2019, *available at* https://www.nerc.com/comm/PC_Reliability_Guidelines_DL/Reliability_Guideline_IBR_Interconnection_Requirements_Improvements.pdf.

In the case of a Phase 2 cluster study where EMT studies are required, it is likely that these studies would require additional time, as the EMT requires specialized resources to complete.[12]

The Companies historically have not required the EMT model during the interconnection process. However, as EMT studies become more prevalent, it may be more practical to collect the models up front than to collect EMT models from all affected Generating Facilities when the Utility determines an EMT study is necessary.

In its Interconnection Guideline, NERC observed that the value of these studies only extends as far as the accuracy of the models and proposes that the models should be validated, once the site achieves parallel operation, in the same manner as synchronous generators.[13] This involves using a phasor measurement unit ("PMU") to measure event data, from a disturbance or a staged test, to validate dynamic models for inverter-based resources. This is not a common practice for inverter-based resources, but is required for synchronous generators with individual units or plants with gross nameplate greater than 100 MVA by NERC standard MOD-026 and MOD-027.

The Companies have not yet made a determination as to whether collecting EMT models for all sites and requiring verification testing is needed at this time to be consistent with Good Utility Practice. However, the Companies assert that the current NCIP/NCIA provide the Utility sufficient latitude (subject to Commission oversight) to implement these standards—both during the study process for proposed Generating Facilities as well as for interconnected Generating Facilities now operating in parallel with Duke Energy's systems should adverse operating effects be identified on the System. In the event the Companies determine that EMT modeling and verification testing is needed for all sites, the implementation process would be addressed through the TSRG and formalized in the FIR posted on OASIS. Additionally, if a DISIS Cluster was deemed to require an EMT model as part of a Phase 2 study, this need would be identified in the Phase 1 Report Meeting prior to Interconnection Customers committing to proceed to Phase 2.

On-Going Monitoring

The standard supervisory control and data acquisition ("SCADA"), metering and telecommunications packages provide adequate access to many of the extensive data requirements outlined in NERC's Reliability Guideline *BPS-Connected Inverter-Based Resource Performance, September 2018*[14] ("Performance Guideline"). Duke Energy is implementing EPRI openXDA software to monitor individual inverter-based resource site performance, in accordance with the Utility FIR. As discussed previously, the Companies

---

[12] *See* NCIP 4.4.7.3 requires Utilities to use Reasonable Efforts to complete the Phase 2 analysis within 150 calendar days.

[13] Interconnection Guideline, p. 33.

[14] BPS-Connected Inverter-Based Resource Performance, September 2018, *available at* https://www.nerc.com/comm/PC_Reliability_Guidelines_DL/Inverter-Based_Resource_Performance_Guideline.pdf.

submit that the FIR apply to all transmission-connected facilities connecting under the NCIP, as applied through Appendix 5 of the NCIA.

The excerpt below is from DEC FIR Section 4 General Operating Requirements:

> *Inverter-based generation resources will require power quality monitoring instrumentation installed by Duke Energy Carolinas to provide monitoring of harmonics and other power quality issues. The power quality metering will include communications infrastructure for remote data acquisition.*
>
> ***4.4.4 Disturbance Monitoring*** *Unique and unanticipated protection problems can result from the changed system configuration resulting from connection of the Project to the Duke Energy Carolinas Transmission System. Duke Energy Carolinas may, at its discretion, install or request the installation of monitoring equipment to identify possible protection scheme problems and to provide power quality measurements of the new configuration. If relay performance indicates inadequate protection of the Duke Energy Carolinas Transmission System, the owner of the Project will be notified of additional protection requirements. The monitoring equipment will provide information similar to that of an oscillograph or fault recorder. The availability of current and voltage measurements will determine the number of channels for the device. Monitoring equipment may also be installed to aid in the understanding of electrical phenomena, such as overvoltages and ferroresonance that can be associated with the Project.*
>
> *Inverter-based generation resources will require power quality monitoring instrumentation installed by Duke Energy Carolinas to provide monitoring of harmonics and other power quality issues. The power quality metering will include communications infrastructure for remote data acquisition.*
>
> ***4.4.5 Protective System Fault Analysis*** *All operations of protective devices within the Project shall be reviewed and documented. This information shall then be made available to Duke Energy Carolinas on request to assist in analyzing fault operations on the Duke Energy Carolinas Transmission System. To facilitate the analysis of system*

> *disturbances and the evaluation of system operation, fault recorders may be required on certain types of complex substations and at all major generating stations connected to the Duke Energy Carolinas Transmission System. Fault recording functions in microprocessor relays may provide the detail data needed to perform the analysis.*

With the increasing penetration of transmission-connected IBR, additional coordination between the plant owner and utility to designate resources and acquire expertise will be required in order to improve on-going monitoring. These efforts can be addressed through the TSRG and further formalized in the FIR posted on OASIS.

2. Are generators providing accurate EMT models of their inverters during the interconnection process so that the subsequent utility interconnection studies are accurate predictors of the inverters' behavior after interconnection?

Response: Generators are not currently providing EMT models during the interconnection study process. In the Companies' view, it will take some time for inverter, power plant controllers, and plant designs specifications to mature to the same level as synchronous generators before the collection and verification of the models can be streamlined. The development of EMT models and obtaining them will introduce an additional level of complexity beyond what is currently performed for positive sequence dynamic models. As discussed above, performance testing and benchmarking are the only way to confirm the accuracy of EMT models.

3. Should electric utilities be required to adopt the NERC guidelines that were cited earlier in this Order, and should the Commission make them part of the NC Interconnection Procedures?

Response: The Companies have actively participated in the development of the NERC guidelines for inverter-based resources. Duke Energy was a primary contributor to the Performance Guideline and is active in many NERC working groups, notably including the NERC Inverter-Based Resource Performance Task Force ("IRPTF") and the System Planning Impacts of Distributed Energy Resources Working Group ("SPIDERWG"). This includes a member of the DEP transmission planning organization serving as vice-chair of SPIDERWG while the NERC Reliability Guideline, *Bulk Power System Reliability Perspectives on the Adoption of IEEE 1547-2018* was developed.

The Companies believe adoption of the guidelines will lead to greater reliability on the BPS. However, there also will be impacts to the cost and timing of interconnections. For that reason, requiring electric utilities to adopt the NERC guidelines, as a whole, may not be consistent with Good Utility Practice until the cost and expedition of these practices become more understood and accepted.

Florida Power & Light ("FPL") has taken a similar approach, adopting the IEEE P2800 standard for Interconnection and Interoperability of Inverter-Based Resources

Interconnecting with Associated Transmission Systems in its FIR.[15] FPL excludes specific sections which it is not implementing and replace them with an FPL-specific section. For example, FPL excludes Chapter 11: Measurement data for performance monitoring and validation:

> *In place of the IEEE P2800 requirements, FPL requires alarms for the following quantities to be provided via communication to the FPL control center as applicable limits are approached:*
>
> *1. Individual harmonic current distortion*
>
> *2. Total demand distortion*
>
> *3. Individual harmonic voltage distortion*
>
> *4. Total harmonic voltage distortion*
>
> *5. Short-term flicker*
>
> *6. Long-term flicker*

Recognizing that IBRs seek interconnection to the Utility's system not only through the NCIP, but also through the FERC LGIP, and South Carolina GIP, alignment of these procedures is critical to avoiding the unintended consequences that were resolved in the recent queue reform alignment efforts.

As an initial step towards ensuring the Companies have the ability to integrate NERC Performance Guidelines and operational requirements for state-jurisdictional Interconnection Customers interconnecting to the BPS in North Carolina, the Companies would support action by the Commission to clarify that the FIR, discussed above, constitutes NCIA Section 1.6 "rules and procedures pertaining to the parallel operation of the Generating Facility in the applicable control area" for all NCIP Generating Facilities connecting to the Transmission System. This clarification would allow the Companies to work collaboratively with IBR Generating Facility owners to detail these minimum requirements and work to align requirements for transmission-connected projects regardless of NERC registration or jurisdiction.

4. Should electric utilities be required to monitor for the impacts of system faults on inverter-based resources?

Response: In order to maintain required control performance metrics, each Utility is required to monitor the impacts of system faults on all resources. NERC is advising that Generating Facilities be evaluated for their performance during parallel operation and assessed for IBR response to fault events in proximity to their site. These events include relatively minor events that would be indicative of performance during larger system

[15] https://www.oasis.oati.com/woa/docs/FPL/FPLdocs/Facility_Interconnection_Requirements.pdf.

events. For example, a normally cleared fault in the proximity of an IBR would be expected to invoke some level of change in real and reactive output from the site to support local system conditions. A periodic review of Generating Facility performance under these conditions gives a good indication of the response during a larger more system wide event and its capability to support overall grid reliability. An important part of the protections and control coordination review, discussed above, is verifying that the plant data required to perform the event analysis can be provided from the site.

III. DUKE ENERGY'S RESPONSES TO ORDERING PARAGRAPH #2

Ordering Paragraph#2: DEC and DEP shall file a copy of the functional settings compliance document . . . along with their analysis of whether the functional settings document is consistent with the recommendations in the Joint Report, and whether it is sufficient to ensure appropriate performance by generators.

Response: See Attachment A. Since the Joint Report is primarily concerned with the response of resources connected to the BPS and the functional settings document applies to inverters connecting to the Distribution System, the recommendations of the Joint Report are only directionally related. The functional settings document is intended to set and verify the maintenance of DER functional settings. The current version of the functional settings document considers that all distribution connected inverters and facilities were designed prior to the current 2018 version of the IEEE 1547 Standard. Therefore, the topics addressed in the document are the functions and requirements applicable to inverters and facilities designed under earlier versions of IEEE 1547. As Duke Energy continues to implement IEEE 1547-2018, revisions to the functional settings document will be incorporated to support new and revised requirements. Those changes will also take into consideration the NERC recommendations consistent with IEEE 1547-2018 and applicable to DER. The functional settings document supports more consistent and appropriate performance by DER.

Respectfully submitted this, the 22nd day of December, 2021.

E. Brett Breitschwerdt

Jack E. Jirak
Deputy General Counsel
Duke Energy Corporation
PO Box 1551/NCRH 20
Raleigh, North Carolina 27602
Telephone: (919) 546-3257
Jack.jirak@duke-energy.com

E. Brett Breitschwerdt
Tracy S. DeMarco
McGuireWoods LLP
501 Fayetteville Street, Suite 500
PO Box 27507 (27611)
Raleigh, North Carolina 27601
Tel. (919) 755-6563
Email: bbreitschwerdt@mcguirewoods.com
Email: tdemarco@mcguirewoods.com

Counsel for Duke Energy Carolinas, LLC and Duke Energy Progress, LLC

Distributed Energy Resource (DER) Functional Settings for DER Interconnected to Duke Energy Distribution System

1. Introduction

1.1 Purpose

To initially set and verify the maintenance of DER Functional settings specified in the Interconnection Agreement, required by Duke Energy, and in compliance with the applicable version of IEEE Std 1547[1]. The purpose of these requirements is to ensure that medium and large-scale DERs interconnected to the Duke Energy Distribution Systems support reliability and safety. The requirements herein govern DER facilities for maintenance of proper settings, reporting of setting changes, and retention of data or evidence of compliance.

Note: As of the date of the initial version of this document, Duke has not adopted IEEE Std 1547 – 2018 to its DER interconnection requirements. The operational DER facilities should comply with IEEE Std 1547 – 2003. However, when Duke implements IEEE 1547 Std – 2018 requirements, it is intended this document would apply.

1.2 Definition

Appendix A contains a Glossary of Terms applicable to this document.

1.3 Applicability

This document applies to DER facilities interconnected to Duke Energy Distribution System that are 250kW and greater.

- **DER functional settings are applied to the following:**
  (1) Protection and control functions internal[2] to inverter-based generating resources
  (2) Other protective relays or control systems present between the Point of Interconnection (POI) and generator or inverter terminals which is able to control the facility's generating resource(s).
  (3) Protective relays and control systems for synchronous and induction generating resource(s)
- **Exemptions:** Protection and control on all auxiliary equipment within the DER Facility unless the tripping or operation of the auxiliary equipment will consequently cause the loss of the DER (e.g., loss of cooling results in a DER trip).

[1] The applicable version of IEEE Std 1547 to each DER should be designated by DER's interconnection date.
[2] This refers to protection functions internal to inverters, such as under/over frequency, under/over voltage, anti-islanding enabled/disabled, etc.

2. Requirements and Measures

2.1 DER Functional Settings Requirements and Measures

2.1.1 Documentation of DER Functional Settings

Duke Energy will create and maintain a "*DER Functional Settings Sheet*" (DFSS) that contains the latest Specified Settings and Applied Settings of each DER facility.

The DFSS will list the setting requirements as directed by Duke in the Specified Settings and store the latest DER reported settings in the Applied Settings. An example of the format of the DFSS is provided in Appendix B.

2.1.2 Frequency Protection Requirements

Each DER shall set its applicable frequency protection in accordance with the guidance provided in this clause, with the intent that:

(1) the DER shall disconnect for system abnormal frequency conditions exceeding mandatory tripping limits, and
(2) also remain connected during defined frequency excursions in support of the Electric Power System (EPS)[3].

Frequency protection shall be set in accordance with the Specified Settings in the DFSS.

2.1.3 Voltage Protection Requirements

Each DER shall set its applicable voltage protection in accordance with the guidance provided in this clause, with the intent that:

(1) the DER shall disconnect for system abnormal voltage conditions exceeding mandatory tripping limits, and
(2) also remain connected during defined voltage excursions in support of the EPS[4].

Voltage protection shall be set in accordance with the Specified Settings in the DFSS.

2.1.4 Anti-islanding Protection Requirements

Each DER shall set its applicable anti-islanding protection in accordance with the IEEE Std 1547 requirement that "…*the DER shall detect the island, cease to energize the Area EPS, and trip within 2 s of the formation of an island*…"

[3] As of the date of the initial version of this document, Duke does not have frequency ride-through requirements. However, when Duke implements a frequency ride-through capability requirement, it is intended this document would apply.
[4] As of the date of the initial version of this document, Duke does not have voltage ride-through requirements. However, when Duke implements a voltage ride-through capability requirement, it is intended this document would apply.

(1) For inverter based DER without Direct Transfer Trip (DTT), the inverter on-board anti-islanding protection must be enabled.
(2) For inverter based DER with DTT, the inverter on-board anti-islanding protection shall be enabled by default, unless it is specified differently in the Interconnection Agreement or as directed by Duke.
(3) Non-inverter based DER may implement specific non-islanding means referenced in IEEE Std 1547 – 2003 to meet this requirement. However, DER shall maintain the non-islanding mean as implemented at the time of DER commissioning.

Each DER shall include an adjustable delay that delays the reconnection after the EPS steady-state voltage and frequency are restored to the normal ranges.

2.1.5 Power Factor and Reactive Power Requirements

Each DER shall be operated in the way to meet the power factor and reactive power requirements, as specified in the DFSS, at the POI (where utility-owned metering is located).

2.1.6 Maximum Export Capacity Requirements

Each DER shall set its applicable settings in a way such the maximum continuous electrical output of the Generating Facility at any time as measured at the POI and the maximum kW delivered to the Utility during any metering period would not exceed the Maximum Generating Capacity approved in the IA.

The applicable settings include, but are not limited to, the maximum active power output limits (Pmax) in the inverters or the plant controller.

The DER operator may set the active power limit slightly exceeding the Maximum Generating Capacity to compensate for losses or auxiliary load inside the DER facility. And the settings may be adjusted when it is deemed necessary by the DER operator to ensure the active power measured at POI would not exceed the Maximum Generating Capacity.

2.1.7 Measures for Compliance with DER Functional Settings Requirements

Each DER shall have evidence that the applicable DER functional settings have been set in accordance with the above requirements, such as dated setting sheets or similar documentation.

2.2 DER Functional Settings Variances and Measures

Each DER shall document any settings variances that prevent an applicable generating resource from meeting functional setting criteria in Section 2.1, including (but not limited to) the discovery of a settings variance, a planned need for a settings variance, or removal thereof.

Each DER shall communicate the discovered settings variance, planned settings variance, or removal of settings variance, to Duke Energy, within 30 calendar days. Such documentation shall include a full explanation for the variance, or removal thereof.

Each DER shall have evidence that it has documented and communicated any setting variances with Requirements 2.1 in accordance with Requirements 2.2, such as a dated email or letter that contains such documentation and the revised DFSS.

2.3 Settings Reporting Requirements and Measures

Each DER shall provide its applicable functional settings associated with Requirements 2.1 to Duke Energy upon receipt of a written request for the data, as soon as is practical but within ten (10) business days of such request, subject to the provisions in section 3.2. Duke and DER Operator may, in writing, mutually agree to an alternative time limit based on the nature of the request.

Each DER shall have evidence that it communicated applicable functional settings in accordance with Requirements 2.3, such as dated emails, correspondence or other evidence and copies of any requests it has received for that information.

3. Compliance

3.1 Compliance Data Retention

Compliance with these requirements includes evidence retention.

3.1.1 Each DER shall continuously maintain records of all DER Functional Settings (as referenced in section 2.1).

3.1.2 Each DER shall retain all evidence of DER Functional Settings Variances (as referenced in section 2.2) for a minimum of five years from the occurrence.

3.1.3 Each DER shall retain all evidence of DER Functional Settings reporting (as referenced in section 2.3) for a minimum of five years from the occurrence.

3.2 Compliance Monitoring Process

3.2.1 Duke may request proof of compliance through the following means:

- 3.2.1.1 Field verification of DER Functional Settings, no more frequent than once every 5 years per facility
- 3.2.1.2 Request for electronic records, no more frequent than once annually

3.2.2 Duke may request, in writing and together with a description of its operational need, DER functional settings and proof of compliance not subject to the frequency limitation in 3.2.1 in the following cases:

- 3.2.2.1 Suspected incompliance suggested by metering records
- 3.2.2.2 System operational needs, including but are not limited to, routine maintenance, construction, and repair
- 3.2.2.3 Investigation of adverse operating effects or emergency conditions
- 3.2.2.4 Modification of the DER Facility

3.3 Remedies and Penalties

In violation of Requirements 2.1 – 2.3, the remedies and penalties shall follow the terms and conditions of the Interconnection Agreement.

Effective Date

September 13th, 2021

Version History

<u>Revision 0 (6/16/2021)</u>

- Initial Draft

<u>Revision 1 (9/13/2021)</u>

- Initial release of this document

<u>Revision 1.1 (10/5/2021)</u>

- Formatting and grammatical changes throughout

Appendix A – Glossary of Terms

Applied Settings (AS): This is a term introduced in IEEE Std 1547.1 – 2020 to indicate the setting applied in the DER. Typically reported at time of commissioning, or following subsequent parameter changes.

Cease to Energize: Cessation of active power delivery under steady-state and transient conditions and limitation of reactive power exchange.

Distributed Energy Resource (DER): A source of electric power that is not directly connected to a bulk power system. DER includes both inverter based resources (IBR) and non-inverter based resources.

DER Facility (or Facilities): The Customer owned DER equipment and all associated or ancillary equipment, including interconnection equipment, on the Customer's side of the Point of Common Coupling

DER Operator: The entity responsible for operating and maintaining the distributed energy resource. The term, as is used in this document, places requirements upon the owner of the DER facility.

Electric Power System (EPS): Facilities that deliver electric power to a load or interconnect generation and load devices for the purpose of energy delivery.

- **Area electric power system (Area EPS):** An EPS that serves Local EPSs. Typically, this is the utility power system.
- **Local electric power system (Local EPS):** An EPS contained entirely within a single premises or group of premises. Typically, this is the DER facility.

Island: A condition in which a portion of an Area EPS is energized solely by one or more Local EPSs through the associated PCCs while that portion of the Area EPS is electrically separated from the rest of the Area EPS on all phases to which the DER is connected. When an island exists, the DER energizing the island may be said to be "islanding".

Point of Common Coupling (PCC): The point of connection between the Area EPS and the Local EPS.

Point of Interconnection (POI): Point where the customer system interconnects with the utility grid. It is the demarcation point between customer owned equipment and utility owned equipment. Typically, POI is the same as the PCC for medium and large-scale DERs.

Ride-through: Ability to withstand voltage or frequency disturbances inside defined limits and to continue operating as specified.

Settings Variance: The DER functional setting mode or value that is different, divergent, or inconsistent from the specified mode or value in theDFSS. It does not include applicable settings to DER performance requirements for which Duke does not specify a specific value (for example, each inverter's "Pmax" setting).

Specified Settings (SS): This is a term introduced in IEEE Std 1547.1 – 2020 to indicate the settings specified by the area EPS operator, which is Duke Energy in this document.

Supplemental DER Device: Any equipment that is used to obtain compliance with some or all of the interconnection requirements. NOTE—Examples include capacitor banks, STATCOMs, harmonic filters that are not part of a DER unit, protection devices, plant controllers, etc.

Trip: Inhibition of immediate return to service, which may involve disconnection.

Unintentional Island: An unplanned island.

Appendix B – Example of DER Functional Settings Sheet (DFSS)

The table below represents the format of site-specific DFSS applicable for each DER facility. Each DER shall utilize the DFSS specific to their facility, which is intended to supersede such requirements listed in the original Interconnection Agreement.

Parameter Description	Specified Settings (SS)		
	DEC	DEP	Units
OV2, overvoltage must trip magnitude per unit value	1.20	1.10	V p.u.
OV2, overvoltage must trip duration	0.167	0.167	s
OV1, overvoltage must trip magnitude per unit value	1.10	1.10	V p.u.
OV1, overvoltage must trip duration	1	0.167	s
UV1, undervoltage must trip magnitude per unit value	0.88	0.90	V p.u.
UV1, undervoltage must trip duration	2	0.167	s
UV2, undervoltage must trip magnitude per unit value	0.50	0.90	V p.u.
UV2, undervoltage must trip duration	0.167	0.167	s
OF2, over-frequency must trip magnitude	Disabled	Disabled	Hz
OF2 , over-frequency must trip Duration	Disabled	Disabled	s
OF1, over-frequency must trip magnitude	60.5	60.5	Hz
OF1 , over-frequency must trip Duration	0.167	0.167	s
UF1, under-frequency must trip magnitude	59.3	57	Hz
UF1, under-frequency must trip Duration	0.167	0.167	s
UF2, under-frequency must trip magnitude	Disabled	Disabled	Hz
UF2, under-frequency must trip Duration	Disabled	Disabled	s
Constant power factor setpoint (1.0 is unity power factor)	1.00	1.00	
Constant power factor excitation setting (injecting or absorbing)	Unity	Unity	Text
Configured maximum active power output (Pmax)	Reference to IA	Reference to IA	kW
Minimum intentional restart delay	300.00	300.00	s

CERTIFICATE OF SERVICE

I hereby certify that a copy of the foregoing *Duke Energy Carolinas, LLC and Duke Energy Progress, LLC's Comments and Filings Regarding Risks Posed by Inverter-Based Resources* as filed in Docket No. E-100, Sub 101, was served via electronic delivery or mailed, first-class, postage prepaid, upon all parties of record.

This, the 22nd day of December 2021.

s/E. Brett Breitschwerdt
E. Brett Breitschwerdt
McGuireWoods LLP
501 Fayetteville Street, Suite 500
PO Box 27507 (27611)
Raleigh, North Carolina 27601
Telephone: (919) 755-6563
bbreitschwerdt@mcguirewoods.com

Attorney for Duke Energy Carolinas, LLC and Duke Energy Progress, LLC