

171 FERC ¶ 61,152
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

Before Commissioners: Neil Chatterjee, Chairman;
Richard Glick, Bernard L. McNamee,
and James P. Danly.

Cube Yadkin Generation, L.L.C.

Docket No. EL19-51-000

v.

PJM Interconnection, L.L.C.

ORDER DENYING COMPLAINT IN PART AND GRANTING IN PART

(Issued May 20, 2020)

1. On March 1, 2019, Cube Yadkin Generation, L.L.C. (Cube Yadkin) filed, pursuant to sections 206 and 306 of the Federal Power Act (FPA)¹ and Rule 206 of the Commission's Rules of Practice and Procedure,² a complaint (Complaint) against PJM Interconnection, L.L.C. (PJM) alleging that PJM violated its Tariff in determining that Cube Yadkin's four hydroelectric generating resources (the Cube Yadkin Resources) failed PJM's Electrical Distance requirement, which PJM applies to external generating resources seeking to pseudo-tie into PJM to deliver capacity. Cube Yadkin further argues that PJM's Electrical Distance requirement, as applied by PJM, is unjust and unreasonable, because it fails to correctly measure Thévenin equivalent impedance and instead uses a proprietary algorithm, the results of which are not verifiable, and because it produces results that are electrically impossible.

2. In this order, we deny the Complaint with respect to Cube Yadkin's argument that PJM applied the Electrical Distance requirement to the Cube Yadkin Resources in a manner that was unjust and unreasonable and inconsistent with its Tariff. We grant the Complaint in part with respect to Cube Yadkin's concern that PJM's administration of the Electrical Distance requirement lacks sufficient notice and transparency.

¹ 16 U.S.C. §§ 824e, 825e (2012).

² 18 C.F.R. § 385.206 (2018).

I. Background

3. In order for new, external generation resources to participate in PJM's capacity auctions, they must be pseudo-tied from their native Balancing Authority Area (BAA) into PJM.³ In order to be eligible for a pseudo-tie into PJM, an external resource must meet a set of threshold requirements that the Commission approved in November 2017 in the Pseudo-Tie Enhancement Order.⁴ In that order, the Commission also approved a five-year transition period for resources that had an existing pseudo-tie, had cleared in a capacity market auction prior to May 9, 2017, and met certain other operational and deliverability requirements.⁵

4. In the Pseudo-Tie Enhancement Order, the Commission found that PJM had demonstrated: (1) the new pseudo-tie requirements are needed to help ensure that external resources are treated comparably to internal resources and (2) external resources have operational and deliverability concerns that differ from internal resources.⁶ The Commission also found that the pseudo-tie requirements addressed the operational and deliverability concerns of external resources, and in doing so, do not create unreasonable barriers to entry.⁷

5. In order to be eligible for a pseudo-tie, one of the threshold requirements an external generator must meet is the Electrical Distance requirement, which requires that:

³ See *PJM Interconnection, L.L.C.*, 151 FERC ¶ 61,208, at PP 96-97 (2015), *order on reh'g*, 155 FERC ¶ 61,157 (2016). A Balancing Authority Area is “[t]he collection of generation, transmission, and loads within the metered boundaries of the Balancing Authority. The Balancing Authority maintains load-resource balance within this area.” Further, a Balancing Authority is “[t]he responsible entity that integrates resource plans ahead of time, maintains load-interchange-generation balance within a Balancing Authority Area, and supports Interconnection frequency in real time.” See North American Electric Reliability Corporation, *Glossary of Terms Used in NERC Reliability Standards*, (NERC Glossary), https://www.nerc.com/pa/Stand/Glossary%20of%20Terms/Glossary_of_Terms.pdf.

⁴ *PJM Interconnection, L.L.C.*, 161 FERC ¶ 61,197 (2017) (Pseudo-Tie Enhancement Order), *order on reh'g.*, 170 FERC ¶ 61,217 (2020).

⁵ Pseudo-Tie Enhancement Order, 161 FERC ¶ 61,197 at PP 119, 134-138.

⁶ *Id.* P 27.

⁷ *Id.*

the external Generation Capacity Resource must have a minimum Electrical Distance impedance equal to or less than 0.065 p.u.; or is within one station of a transmission bus that has a minimum Electrical Distance impedance equal to or less than 0.065 p.u.⁸

6. PJM's Tariff defines "Electrical Distance" as "for a Generation Capacity Resource geographically located outside the metered bounds of the PJM Region the measure of distance, based on impedance and in accordance with the PJM Manuals, from the Generation Capacity Resource to the PJM Region."⁹

7. In the Pseudo-Tie Enhancement proceeding, PJM characterized the Electrical Distance requirement as helping to resolve modeling challenges and limit expansion of its Energy Management System (EMS) model.¹⁰ PJM stated that if a resource met the Electrical Distance requirement, that resource and its affected area could be included in the EMS or market model without raising undue risk of model performance solution problems.¹¹ In the Pseudo-Tie Enhancement Order, the Commission found the Electrical Distance requirement to be just and reasonable because it struck an appropriate balance between allowing external resources to participate in PJM's capacity market while providing PJM with a level of reliability assurance.¹² The Commission also found that the Electrical Distance requirement establishes a bright-line test, with clear values for determining eligibility of pseudo-ties from BAAs outside of PJM.¹³ The Commission accepted PJM's representation that the further the State Estimator model extends beyond its own borders, the less resilient the PJM system becomes to data loss and inaccuracy of data and models.¹⁴

⁸ PJM, Tariff, Attachment DD.5.5A Capacity Resource Types, § 5A(b)(1)(A) (2.0.2).

⁹ PJM, Tariff, § 1, OATT Definitions – E – F, (12.0.0).

¹⁰ Pseudo-Tie Enhancement Order, 161 FERC ¶ 61,197 at P 48 (referring to PJM, Transmittal, Docket No. ER17-1138-000, at 14 (filed Mar. 9, 2017) (PJM Transmittal)).

¹¹ PJM Transmittal, Docket No. ER17-1138-000 at 14 (filed Mar. 9, 2017).

¹² Pseudo-Tie Enhancement Order, 161 FERC ¶ 61,197 at P 60.

¹³ *Id.*

¹⁴ *Id.* P 54.

8. PJM explained in the Pseudo-Tie Enhancements proceeding that the calculation of the 0.065 threshold is an equivalent per-unit impedance of parallel paths between the facility and the PJM border.¹⁵ The Commission directed PJM to include the 0.065 p.u. impedance value in its Tariff, but acknowledged that the methodology that PJM will use to conduct the Electrical Distance requirement can remain in the PJM Manuals.¹⁶

9. PJM Manual 12 states:

PJM staff will evaluate the feasibility of upgrading the PJM Energy Management System (EMS) model to explicitly model the pseudo-tied resource by performing an electrical distance test, from the highest connected voltage at the station the unit is inter-connected, to determine the Thévenin equivalent impedance into PJM. If determined to be feasible, meaning the resulting equivalent impedance is determined to be less than or equal to .065 plus one adjacent bus, the cost of the model upgrade will be borne by the Market Participant requesting to Pseudo-Tie.¹⁷

II. Overview of Cube Yadkin Complaint

10. Cube Yadkin states that in May 2018, it applied to have the Cube Yadkin Resources¹⁸ pseudo-tied into PJM, but that on June 21, 2018, PJM informed Cube Yadkin that it had failed the Electrical Distance requirement.¹⁹ Cube Yadkin contends that PJM acted inconsistently with its Tariff and Manuals in determining that the Cube Yadkin Resources failed the Electrical Distance requirement and are ineligible to pseudo-tie into PJM and that PJM's application of its Electrical Distance requirement is unjust and unreasonable.²⁰

¹⁵ PJM, Deficiency Response, Docket No. ER17-1138-001 at 11 (filed Sept. 18, 2017).

¹⁶ Pseudo-Tie Enhancements Order, 161 FERC ¶ 61,197 at P 62.

¹⁷ PJM Manual 12, Attachment F at 96.

¹⁸ Cube Yadkin owns and operates the Yadkin Project, a hydroelectric project consisting of four sites – Tuckertown, High Rock, Falls and Narrows with an aggregate nameplate generation capacity of 220 MW. Complaint at 5.

¹⁹ Complaint at 2.

²⁰ *Id.* at 2-3.

11. Cube Yadkin states that contrary to PJM's statements in the Pseudo-Tie Enhancement proceeding and the Commission's findings in the Pseudo-Tie Enhancement Order, the Electrical Distance requirement (1) is not a bright-line test with clear values; (2) is not a consistent, objective, nondiscriminatory process that is repeatable; (3) produces results that are not electrically possible; (4) produces results that are a moving target; and (5) reflects flaws that are endemic to the new pseudo-tie requirements generally.²¹

12. Cube Yadkin argues that as applied by PJM, the Electrical Distance requirement is not a "bright line" test with clear values because PJM used a significantly truncated version of the Electrical Distance requirement for the Cube Yadkin Resources that fails to actually measure their Thévenin equivalent impedance into PJM.²² Cube Yadkin further argues that the results of the Electrical Distance requirement are unverifiable and subjective because relies upon proprietary modeling that is unavailable to customers like Cube Yadkin.²³ Cube Yadkin also argues that PJM's application of the Electrical Distance requirement produces results that are electrically impossible because it selected three "closest buses" to the PJM grid when, under graph theory, the Cube Yadkin Resources can only have two bus paths to the grid.²⁴

13. Cube Yadkin requests that the Commission find, as applied to the Cube Yadkin Resources, PJM's Tariff and Manual setting out the Electrical Distance requirement fail to comply with the Pseudo-Tie Enhancement Order. Cube Yadkin asks the Commission to require PJM to amend its Tariff and Manual to include an industry-wide definition of Thévenin equivalent impedance as the appropriate test for measuring impedance between the pseudo-tied resource and the PJM border.²⁵

III. Notice of Filing, Responsive Pleadings and Paper Hearing

14. Notice of the Complaint was published in the *Federal Register*, 84 Fed. Reg. 8523-01 (2019), with answers, interventions and protests due on or before March 21, 2019. The following parties filed timely motions to intervene: Monitoring Analytics, LLC, in its capacity as the Independent Market Monitor for PJM (PJM IMM); Tilton Energy, LLC; Exelon Corporation; Dominion Energy Services, Inc.; Calpine

²¹ *Id.* at 16.

²² *Id.* at 18-21.

²³ *Id.* at 21-22.

²⁴ *Id.* at 23-25.

²⁵ *Id.* at 32.

Corporation; NRG Power Marketing LLC; American Municipal Power, Inc.; and North Carolina Electric Membership Corporation. Also on March 21, 2019, Brookfield Energy Marketing LP (Brookfield) filed a motion to intervene and comments (Brookfield Comments).

15. On March 21, 2019, PJM filed its answer (PJM Answer). On April 11, 2019, the PJM IMM filed a motion for leave to answer and answer (PJM IMM Answer). On April 26, 2019, Cube Yadkin filed a motion for leave to answer and answer (Cube Yadkin Answer).

16. On August 26, 2019 the Commission issued an order instituting paper hearing proceedings and directing PJM to further explain how it administers its Electrical Distance requirement.²⁶ On September 25, 2019, PJM filed its response to the Cube Yadkin Paper Hearing Order (PJM Paper Hearing Response). On October 10, 2019, Cube Yadkin filed a reply to the PJM Paper Hearing Response (Cube Yadkin Paper Hearing Reply). On October 30, 2019, PJM filed an answer to the Cube Yadkin Paper Hearing Reply (PJM Paper Hearing Answer). On November 27, 2019, Cube Yadkin filed an answer to the PJM Paper Hearing Answer (Cube Yadkin Second Paper Hearing Answer).

IV. Discussion

A. Procedural Matters

17. Pursuant to Rule 214 of the Commission's Rules of Practice and Procedure, 18 C.F.R. § 385.214 (2019), the timely, unopposed motions to intervene serve to make the entities that filed them parties to this proceeding.

18. Rule 213(a)(2) of the Commission's Rules of Practice and Procedure, 18 C.F.R. § 385.213(a)(2) (2019), prohibits an answer to an answer unless otherwise ordered by the decisional authority. We accept the answers of the IMM, PJM, and Cube Yadkin because they have provided information that assisted us in our decision-making process.

B. Substantive Matters

19. As discussed further below, we find that Cube Yadkin failed to meet its burden to show that the Electrical Distance requirement, as applied by PJM, is unjust and unreasonable and that PJM applied the Electrical Distance requirement in a manner that is inconsistent with its Tariff, and we deny the Complaint on that issue. However, we

²⁶ *Cube Yadkin Generation, L.L.C. v. PJM Interconnection, L.L.C.*, 168 FERC ¶ 61,113 (2019) (Paper Hearing Order).

grant the Complaint, in part, and direct PJM to amend its Tariff to provide greater notice and transparency in its administration of the Electrical Distance requirement.

1. PJM's Use of a Proprietary Algorithm

a. Complaint and Responsive Pleadings

20. Cube Yadkin asserts that PJM's application of the Electrical Distance requirement is unjust and unreasonable and inconsistent with the tariff because of PJM's use of a proprietary algorithm and its use of a modified version of the Thévenin equivalent impedance test. Cube Yadkin states that it requested access to PJM's model to verify the results of the Electrical Distance requirement, but that PJM declined to provide its model on the grounds that the model is proprietary.²⁷ In the absence of the model, Cube Yadkin states that it hired GE Power to use the Transmission Adequacy & Reliability Assessment (TARA) power flow software tool to calculate the Thévenin equivalent impedance from the Cube Yadkin Resources to PJM and to estimate the paths of lowest impedance between the Cube Yadkin Resources and nodes specified by PJM.²⁸ According to Cube Yadkin, GE Power's TARA results determined that three of the four resources satisfied the 0.065 equivalent impedance threshold.²⁹

21. According to Cube Yadkin, PJM responded that the results differed because TARA calculates equivalent impedances for the full Eastern Interconnection model while PJM's model identifies the shortest path to multiple PJM border buses and uses "a subset of adjacent parallel paths from the generator to each PJM border bus to calculate impedance."³⁰ According to Cube Yadkin, PJM did not describe the methodology it uses to select the subset of adjacent parallel paths it uses in its algorithm.³¹ According to Cube Yadkin, PJM defended its use of the proprietary algorithm on the grounds that it is designed to ensure that PJM effectively manages the reliability risks involved with

²⁷ Complaint at 12.

²⁸ *Id.*

²⁹ *Id.* at 13. Falls/Narrows (Badin) and Tuckertown satisfied the 0.065 equivalent threshold on a bus-to-bus basis using TARA's "Equiv Path Reactance X" methods. High Rock did not satisfy the 0.065 equivalent impedance threshold on a bus-to-bus basis. *Id.* (citing Simmons Aff. at 9).

³⁰ *Id.* at 13 and Ex. J.

³¹ *Id.*

expanding PJM's EMS modeling to accommodate external capacity resources under the Pseudo-Tie concept.³²

22. Cube Yadkin states that on August 30, 2018, PJM sent a Withdrawal Letter to Cube Hydro Partners, LLC indicating that pseudo-ties for the Cube Yadkin Resources could not be established.³³ Cube Yadkin states that in a subsequent communication, PJM indicated that its algorithm "finds the most direct path to each [PJM] border bus using the Dijkstra algorithm, and then iteratively finds adjacent paths by opening the edges of the identified path. . . the algorithm may select a different subset of edges for each unique direct path."³⁴

23. Cube Yadkin further notes the fact that PJM "evaluated" TARA but ultimately elected to use its own methodology to calculate Electrical Distance does not render the results of the TARA analysis invalid or render PJM's results valid.³⁵ According to Cube Yadkin affiant Simmons, "[i]f PJM's Electrical Distance requirement did measure Thevenin-equivalent impedance, or even roughly approximate it, one would expect the pattern of highest to lowest impedance to be consistent with, or at least similar to, the results of the TARA analysis."³⁶

24. Cube Yadkin adds that it does not advocate for PJM's adoption of the TARA analysis in lieu of the Electrical Distance requirement, but rather that it ran the TARA analysis in order to attempt to replicate the results of the Electrical Distance requirement. Its purpose was to demonstrate that the two tests arrive at vastly different results in their measurement of Thévenin equivalent impedance.³⁷

³² *Id.*

³³ *Id.* at 13-14 and Ex. H.

³⁴ *Id.* at Ex. K.

³⁵ *Id.* at 21.

³⁶ Simmons Aff. at 10. According to Mr. Simmons, PJM's border node with the lowest impedance value under PJM's test has the highest impedance under the TARA analysis: Under the PJM Electrical Distance, the PJM border node with the lowest measurement of electrical impedance is East Danville, followed by Halifax, Jackson Ferry, and Carson. Under the TARA analysis, the PJM border node with the lowest measurement of electrical impedance is Jackson Ferry, followed by Carson, Halifax, and, finally, East Danville. *Id.*

³⁷ Cube Yadkin Answer at 8-9.

25. PJM affiant John Richard Baranowski contends (1) that the Electrical Distance requirement appropriately focuses on the external resources affected by a proposed pseudo-tie as the entire purpose of the test is to limit PJM's obligations to add new external facilities to its EMS; (2) that it is illogical to depart from PJM's algorithm because the same approach was used to calculate the Commission-approved impedance threshold of 0.065 p.u.; and (3) PJM has consistently used the same algorithm since 2016 for identifying facilities and paths impacted by a pseudo-tie.³⁸

26. PJM argues that while it considered utilizing the TARA model, it specifically rejected the TARA model because TARA calculates impedance of the facilities in all possible paths in the entire network model and therefore is not well suited to PJM's objective of assessing to what extent PJM would need to expand its EMS to monitor the external paths impacted by the flow of electricity from any specific external resource to the PJM border.³⁹ Rather, PJM's approach identifies the electrically-shortest paths from the external generator to multiple PJM border buses.⁴⁰ According to PJM, the result of applying this algorithm is the set of transmission paths that may be impacted by the dispatch of the generator into PJM "generally approximating the facilities PJM might need to add to its EMS if the external generator became pseudo-tied to PJM." It then calculates the Thévenin equivalent impedance for that set of alternative paths to the PJM border bus.⁴¹

27. Mr. Baranowski explains that PJM developed a custom application using Dijkstra's algorithm, which "identifies the (electrically) shortest paths from the external generator to multiple PJM border buses,"⁴² to address which particular paths PJM uses for the Electrical Distance requirement. According to Mr. Baranowski, this application suits PJM's goal of focusing on impacted facilities PJM would need to model if it agreed to a pseudo-tie.⁴³ Mr. Baranowski further notes that Exhibit 1 to his Affidavit, an electrical distance map, which was attached to PJM's filing in the Pseudo-Tie Enhancements Proceeding, was produced using the same methodology PJM used to

³⁸ PJM Answer at 9-10.

³⁹ *Id.*

⁴⁰ *Id.* at 11-12.

⁴¹ *Id.*

⁴² Baranowski Aff. ¶ 10.

⁴³ *Id.*

produce the results presented to PJM stakeholders in August 2016.⁴⁴ Mr. Baranowski adds that the analysis reflected in Exhibit 1 to his affidavit was the foundation for PJM's recommendation of the 0.065 impedance threshold.⁴⁵

28. Further, PJM asserts that it rejected use of the TARA model in part because its use of TARA would have created a "fundamental inconsistency."⁴⁶ Mr. Baranowski explains "if PJM used the TARA method Cube now advocates, PJM would not have proposed in 2017 an impedance threshold of 0.065 p.u., and would instead have proposed a lower threshold."⁴⁷ PJM explains, because the Electrical Distance impedance standard sets a maximum level, a party seeking a pseudo-tie is advantaged by a higher value for the standard, and a lower value for the result calculated for its plants.⁴⁸ Cube Yadkin's approach, according to Mr. Baranowski, results in lower impedances for Cube Yadkin's pseudo-ties compared against a threshold using PJM's analysis that results in relatively higher impedances for the standard.⁴⁹

29. Mr. Baranowski describes the process he led in 2016 that resulted in the 0.065 p.u. standard adopted in PJM's Tariff. Mr. Baranowski explains PJM applied its custom algorithm to calculate results for dozens of external plants and other significant nodes outside the PJM region, and then grouped together external locations "that appeared to not require PJM to add external facilities to its EMS at a level that would cause a reliability concern," classifying those locations as "electrically close."⁵⁰ PJM asserts that adopting a different method of calculating impedance for purposes of determining

⁴⁴ *Id.* Dijkstra's Algorithm, developed by computer scientist Edsger W. Dijkstra, is an algorithm for finding the shortest paths between nodes in a graph. Baranowski Aff. at 4 n.6.

⁴⁵ *Id.* P 12.

⁴⁶ PJM Answer at 12.

⁴⁷ Baranowski Aff. ¶ 13.

⁴⁸ PJM Answer at 13.

⁴⁹ Baranowski Aff. ¶ 14.

⁵⁰ Baranowski Aff. ¶ 12. According to Mr. Baranowski, those locations had an impedance value at or below 0.065 p.u. *Id.*

whether the Cube Yadkin Resources fall below that threshold would be discriminatory in Cube Yadkin's favor.⁵¹

30. In response to Cube Yadkin's assertion that PJM applies the Electrical Distance requirement inconsistently, PJM states that the Electrical Distance requirement is not subjectively applied—"it is an iterative model used to identify paths that may be affected by the flow of electricity from external resources to the PJM border."⁵² According to PJM, it "uses one consistent algorithm, applies it consistently to each external resource, and compares the results to the 0.065 impedance level that was set using the same algorithm."⁵³

31. Cube Yadkin also contends that PJM failed to use a "bright-line test, with clear values," as required in the Pseudo-Tie Enhancement Order⁵⁴ and does not measure the Thévenin equivalent impedance as that test normally is defined. According to Cube Yadkin affiant Walter N. Simmons, the Thévenin theorem states that any linear complex circuit or network containing multiple voltage sources and resistances (impedances in alternating current "AC" systems) can be simplified into a single voltage source and a single resistance (impedance in AC). Mr. Simmons further states that the Thévenin equivalent impedance between two points is the single impedance between two points calculated using the Thévenin theorem that represents all the impedances between those two points.⁵⁵

32. Cube Yadkin states that it submitted a Notice of Dispute to PJM on October 17, 2018 in which it argued that Thévenin equivalence "is a well-known and well-defined concept used throughout the electrical industry" which "allows for a complex network of voltages or impedances to be simplified into a single voltage or impedance."⁵⁶ Cube Yadkin states that PJM's determination of the Thévenin equivalent impedance value

⁵¹ PJM Answer at 14.

⁵² *Id.* at 16 (citing Baranowski Aff. ¶ 15)

⁵³ *Id.*

⁵⁴ *Id.*

⁵⁵ Complaint, Ex. A (Affidavit of Walter Neal Simmons) at 5 (Simmons Aff.)

⁵⁶ Complaint, Attachment L. Cube Yadkin further argued that by the theorem's definition, the Thévenin equivalent impedance between two points must account for *all impedances in the network* and results in a single equivalent impedance. *Id.*

appears to deviate from the established approach, but that Cube Yadkin was unable to replicate or verify PJM's results due to PJM's refusal to share its model.⁵⁷

33. Cube Yadkin states that it expressed its concern to PJM engineers that "there are additional parallel paths between the units and the PJM border that have not been properly accounted for in PJM's determination" and that PJM's approach "does not provide an accurate Thévenin equivalent impedance but rather analyzes only a reduced network of parallel/series impedances."⁵⁸

34. According to Cube Yadkin, PJM responded to the Notice of Dispute by reiterating that the Cube Yadkin Resources are ineligible to pseudo-tie into PJM; that PJM conducted the Electrical Distance requirement in accordance with its Tariff, Manuals and Commission orders; and that the Thévenin Theorem does not require that the Electrical Distance requirement use the entire Eastern Interconnection, as the TARA model does, because "that would defeat the purpose of the test."⁵⁹

35. Cube Yadkin argues that rather than conduct the Electrical Distance requirement in a manner set forth in PJM's Tariff, Manual 12, and the Pseudo-Tie Enhancement Order, PJM conducted a significantly truncated version of the Electrical Distance requirement that fails to actually measure the Cube Yadkin Resources' Thévenin equivalent impedance into PJM. Cube Yadkin argues that PJM did not calculate Thévenin equivalent impedance of the path from the Cube Yadkin Resources to PJM and instead, arbitrarily determined Thévenin equivalent impedance using a subset of paths in contravention of the well-established, objective methodology.⁶⁰ According to Cube Yadkin, instead of measuring all paths within the system to calculate the Thévenin equivalent impedance, PJM measured impedance using a narrow subset of the total available paths that are impacted by the flow of electricity from the Cube Yadkin Resources to the PJM BAA, necessarily impacting the resulting impedance calculation.⁶¹

36. Cube Yadkin further states that PJM argued to keep the methodology it uses to calculate Electrical Distance out of its Tariff and in its manuals, and that "Manual 12 is the *only* PJM document that provides any definitive guidance as to the methodology that

⁵⁷ Complaint at 14.

⁵⁸ *Id.* at 15 and Ex. L.

⁵⁹ *Id.* at Ex. M.

⁶⁰ *Id.* at 19.

⁶¹ *Id.* at 19-20.

PJM *must* use in conducting its Electrical Distance Test.”⁶² Cube Yadkin argues that the definition found in PJM Manual 12 requires PJM to determine Thévenin equivalent impedance and PJM failed to do so.⁶³ Cube Yadkin adds however, that “[t]he path-selecting algorithm is not referenced – either generally, in describing the Electrical Distance, or as justification for establishing the test’s 0.065 p.u. threshold.”⁶⁴

37. Cube Yadkin states that contrary to PJM’s assertion that the inclusion of all of the paths in the Eastern Interconnection would be so “extreme” as to result in PJM never accepting any pseudo-tie,⁶⁵ the very purpose of the Thévenin theorem is to reduce a complex system to a “simple source-resistance equivalent.”⁶⁶

38. Cube Yadkin states that it does not disagree with PJM that it is possible to analyze a sub-circuit of paths using the Thévenin theorem, but that is not the same thing as calculating the Thévenin equivalent impedance between two points.⁶⁷ Cube Yadkin states that as a matter of physics, electricity has the potential to flow over any and all paths in a circuit, and thus, analyzing Thévenin equivalent impedance of a generation resource necessarily requires analyzing all paths over which the electricity may conceivably flow (i.e., the entire network/circuit).⁶⁸

39. PJM disagrees with Cube Yadkin’s assertion that PJM must calculate impedance for the Electrical Distance requirement based on all possible paths in the Eastern Interconnection.⁶⁹ PJM contends that nothing in the Pseudo-Tie Enhancement Order, PJM’s Tariff, nor PJM Manual 12 states that PJM must calculate impedance of all possible paths in the Eastern Interconnection for the transfer from the plant into PJM.⁷⁰

⁶² Cube Yadkin Answer at 2.

⁶³ *Id.* at 3-4.

⁶⁴ *Id.*

⁶⁵ Cube Yadkin Answer at 7 (citing Affidavit of Stefano Curtarolo at 3 (Curtarolo Aff.)) (referencing PJM Answer at 2).

⁶⁶ *Id.*

⁶⁷ *Id.*

⁶⁸ *Id.*

⁶⁹ *Id.* at 8.

⁷⁰ *Id.* at 8-9.

40. In response to Cube Yadkin's argument that use of the phrase "the Thévenin equivalent impedance" in Manual 12 requires PJM to calculate Electrical Distance on all possible paths in the Eastern Interconnection, PJM affiant John Richard Baranowski states that the Electrical Distance requirement appropriately focuses on the external facilities affected by a proposed pseudo-tie.⁷¹ According to Mr. Baranowski, the specific purpose of the test is to limit PJM's obligation to add new external facilities to its EMS.⁷²

41. Finally, PJM dismisses Cube Yadkin's reference to a textbook⁷³ purportedly setting out the application of Thévenin equivalent impedance stating that it performed the Thévenin equivalent exactly as the Cube Yadkin referenced textbook prescribes, i.e., focus on the part of the network that PJM would have to include in its EMS if it accepted a pseudo-tie.⁷⁴

b. Commission Determination

42. As set forth below, we find that Cube Yadkin did not meet its burden to show that PJM's application of the Electrical Distance requirement to the Cube Yadkin Resources was contrary to its Tariff and unjust and unreasonable. Specifically, we find that PJM did not violate its Tariff by using its proprietary algorithm to conduct the Electrical Distance requirement or by choosing, consistent with its Manual, to use a modified version of the Thévenin Equivalent Impedance test to conduct the studies.

43. PJM's Tariff requires only that a pseudo-tied resource have an impedance value of 0.065 p.u., and does not require the use of any particular methodology to develop that value.⁷⁵ We agree with PJM affiant Baranowski that: (1) the Electrical Distance requirement appropriately focuses on the external resources affected by a proposed pseudo-tie as the entire purpose of the test is to limit PJM's obligations to add new

⁷¹ *Id.* at 10.

⁷² PJM Answer, Attachment A (Affidavit of John Richard Baranowski) at P 9 (Baranowski Aff.)

⁷³ Complaint, Ex. L (Letter from Neal Simmons, Vice President, Cube Yadkin, to Patty Cory, PJM Senior Representative, PJM (Oct. 17, 2018)).

⁷⁴ PJM Answer at 14; *see also* Baranowski Aff. ¶ 16. (citing Anant Agarwal and Jeffrey Lang, *Foundations of Analog & Digital Electronic Circuits* at 157 (2005), [https://neurophysics.ucsd.edu/courses/physics_120/Agarwal%20and%20Lang%20\(2005\)%20Foundations%20of%20Analog%20and%20Digital.pdf](https://neurophysics.ucsd.edu/courses/physics_120/Agarwal%20and%20Lang%20(2005)%20Foundations%20of%20Analog%20and%20Digital.pdf)).

⁷⁵ PJM, OATT Attachment DD.5.5A Capacity Resource Types, § 5A(b)(1)(A) (2.0.2).

external facilities to its EMS; (2) it is appropriate to apply PJM's custom algorithm because the same approach was used to calculate the Tariff-specific impedance threshold of 0.065 p.u.; and (3) PJM has consistently used the same algorithm since 2016 for identifying facilities and paths impacted by a pseudo-tie.

44. Contrary to Cube Yadkin's arguments, we find that the fact that the results of the TARA analysis differ from the results of the analysis using PJM's proprietary algorithm does not render PJM's approach unjust and unreasonable. Rather, we find that PJM's approach to approximate the facilities it might need to add to its EMS as a result of pseudo-tie resources is reasonable. Cube Yadkin's TARA model determines the Thévenin equivalent impedance using all possible paths in the entire Eastern Interconnection, while PJM's approach identifies the electrically shortest paths from an external generator to multiple PJM border buses, consistent with PJM's original determination of 0.065 p.u. as the impedance threshold for the Electrical Distance requirement; therefore, the results of these approaches are expected to differ.

45. With regard to Cube Yadkin's argument that PJM failed to use a "bright-line" test consistent with the Pseudo-Tie Enhancement Order, we disagree. PJM does use a bright-line test with clear values. PJM's use of the term "the Thévenin equivalent impedance" in PJM Manual 12's description of the Electrical Distance requirement does not implicitly require PJM to use all possible paths in the Eastern Interconnection in conducting the Electrical Distance requirement, as Cube Yadkin suggests.⁷⁶

46. We note that in the Pseudo-Tie Enhancement proceeding, PJM explained that the Electrical Distance threshold is an analytical measurement used as a bright-line screen to communicate the amount of operational and compliance risk that PJM is willing to take on when expanding the State Estimator model to incorporate pseudo-ties. To the extent that PJM relies on data feeds from external Balancing Authorities, data might be aggregated, causing a single point of failure for the PJM State Estimator and that the farther the State Estimator model extends beyond the PJM borders, the less resilient the PJM system becomes to data loss or inaccurate models.⁷⁷ In the Pseudo-Tie Enhancement Order, the Commission found that the Electrical Distance requirement, as proposed by PJM, was just and reasonable because establishing a bright-line test for external participation strikes an appropriate balance between allowing external resources to participate in PJM's capacity auctions, while providing PJM with a level of reliability

⁷⁶ PJM argues, and the Commission agrees, that there is no provision of the Pseudo-Tie Enhancements Order, the Tariff or PJM Manual 12 that commands that PJM calculate impedance of all possible paths in the Eastern Interconnection.

⁷⁷ PJM, Response to Deficiency Letter at 10, Docket No. ER17-1138-001 (filed Sept. 18, 2017).

assurances.⁷⁸ Therefore, we affirm our finding in the Pseudo-Tie Enhancement Order that PJM's Electrical Distance Requirement is just and reasonable.

47. We also find that PJM has not acted unjustly and unreasonably by incorrectly referencing Thévenin equivalent impedance in PJM Manual 12. We find that, as explained in the PJM Whitepaper, PJM has accurately implemented the mathematical principles utilized to calculate the Thévenin equivalent impedance between two nodes of a admittance matrix representing a power system.⁷⁹ The fact that the admittance matrix in this instance is populated using only the subset of facilities identified by PJM's proprietary algorithm rather than all facilities in the Eastern Interconnection does not render it inappropriate to refer to this analysis as either "a" or "the" Thévenin equivalent impedance.

48. We find that PJM permissibly limits its calculation of impedance to a subset of paths impacted by dispatch of the external generation resource, because they reflect the facilities that PJM would need to add to its EMS model. We further find that PJM has conducted the Electrical Distance requirement consistently, and we expect that PJM will continue to conduct the test consistent with its explanations in this proceeding.

49. We reiterate that the Commission does not review and approve PJM's manuals, which are not filed with the Commission. The Commission did not require in the Pseudo-Tie Enhancement Order that PJM include in its Tariff the detailed methodology used to calculate Electrical Distance. Pursuant to the Federal Power Act, all practices that significantly affect rates, terms, and conditions of service must be on file with the Commission.⁸⁰ Thus, the 0.065 p.u threshold is the rate, term, and condition of service itself because, should a generating resource exceed this 0.065 p.u. threshold, it would not be eligible to pseudo-tie into PJM. The methodology by which PJM computes the Electrical Distance requirement is not a rate, term, or condition of service, and therefore, it need not be included in PJM's Tariff, and is appropriately set forth in PJM's manuals. Consistent with Commission precedent, not all rules or guidance governing a generating

⁷⁸ Pseudo-Tie Enhancement Order, 161 FERC ¶ 61,197 at P 60.

⁷⁹ PJM Interconnection, L.L.C., *Dynamic Transfers: Electrical Distance Test*, at 4-5 (January 2, 2019) (PJM Whitepaper), <https://pjm.com/-/media/about-pjm/member-services/dynamic-transfers-electrical-distance-test.ashx?la=en>.

⁸⁰ See *Wis. Power & Light Co.*, 123 FERC ¶ 61,307, at P 6 (2008) (explaining that pursuant to 18 C.F.R. §§ 35.1-35.2, rate schedules must be set forth in writing, clearly and specifically, all rates, terms, and conditions for sales of electric energy subject to the Commission's jurisdiction); see generally *Prior Notice & Filing Requirements under Part II of the Fed. Power Act*, 64 FERC ¶ 61,139, at 61,986-89, *order on reh 'g*, 65 FERC ¶ 61,081 (1993).

resource's participation in PJM's markets must be included in PJM's tariff. Including all such rules and guidance in the Tariff could limit PJM's ability to respond to changes in operational characteristics.⁸¹

2. Selection of Closest Buses

a. Complaint and Responsive Pleadings

50. In its Complaint, Cube Yadkin asserts that PJM's selection of buses in applying the Electrical Distance requirement to the Cube Yadkin Resources was not just and reasonable and was inconsistent with the Tariff.⁸² The four Cube Yadkin Resources are: Narrows, Falls, High Rock, and Badin. Cube Yadkin explains that these Cube Yadkin Resources are connected to the transmission grid in series with two resources – Narrows and Falls – connected at a single node – Badin.⁸³ Cube Yadkin further explains that of the four resources, Tuckertown lies directly between High Rock and Badin.⁸⁴ Cube Yadkin further explains that because the four resources are modeled as three nodes in a series (High Rock – Tuckertown – Badin), all power flowing out of them and onto the transmission system would have to flow out of either High Rock or Badin, and as such, there are only two possible connections through which all power must flow from these resources to reach the PJM system.⁸⁵

51. Cube Yadkin uses a graph theory diagram to illustrate that there can be only, and at most, two closest buses from which PJM would analyze impedance.⁸⁶ Cube Yadkin states that from both a Thévenin equivalence and graph theory perspective, it is not possible to have three closest buses from four generators modeled and connected in series as three nodes – the number of closest nodes cannot exceed the number of connections to

⁸¹ See *Big Sandy Peaker Plant, LLC v. PJM Interconnection, L.L.C.*, 154 FERC ¶ 61,216, at P 50 (2016) (“ In addition, requiring PJM to set forth in the PJM Tariff an exclusive list of all specific, reliability-related reasons that could result in the deselection of a generating resource...would necessarily limit PJM to those tariff criteria, and could compromise PJM's ability to respond to changes in operations or characteristics of the PJM system”).

⁸² Complaint at 23-25; Cube Yadkin Paper Hearing Reply at 9-10.

⁸³ Complaint at 23.

⁸⁴ *Id.*

⁸⁵ *Id.*

⁸⁶ *Id.* at 24.

the grid.⁸⁷ As such, Cube Yadkin deems PJM's Electrical Distance requirement results to not be electrically possible.⁸⁸

52. To further illustrate the point, Cube Yadkin argues that given the unique geographical locations of its four resources, power flows sourced from Cube Yadkin's BAA must flow out of only two buses into PJM.⁸⁹ Therefore, Cube Yadkin asserts, it is not possible for PJM's analysis to identify the three "closest" buses, a result Cube Yadkin asserts is "electrically impossible." Accordingly, Cube Yadkin contends PJM improperly conducted the Electrical Distance requirement and that PJM should be required to perform the Electrical Distance requirement correctly and accept Cube Yadkin's pseudo-tie.

53. PJM responds that finding slightly different "closest" PJM border buses for the different Cube Yadkin generator buses does not mean that PJM's approach is unjust and unreasonable. PJM argues that the graph used by Cube Yadkin to make its argument is oversimplified because it shows three Cube Yadkin generators in a line connected to the bulk electric system at only one end, whereas in the Eastern Interconnection model used for the analysis, that line is connected to the grid at both ends. PJM explains that each of the three plant locations has a unique set of paths through and out of the Yadkin area to the PJM border and, given these unique paths, finding differences between each location is not an unexpected result. According to PJM, this is the case because PJM's algorithm identifies and selects a set of adjacent paths from each generator bus to the PJM border, so there is no guarantee that the same set of parallel paths will be selected for adjacent generator buses to be included in the Electrical Distance calculation.⁹⁰

54. In response to the Paper Hearing Order,⁹¹ PJM states that the algorithm does not select a particular bus for each generator but rather "uses a long list of PJM boundary

⁸⁷ *Id.*, Simmons Aff. at 10-11.

⁸⁸ *Id.*

⁸⁹ Simmons Aff. at 15-17.

⁹⁰ *Id.* at 21-22.

⁹¹ In the Paper Hearing Order, the Commission found that Cube Yadkin has raised questions of material fact about the manner in which PJM administered its Electrical Distance requirement to the Cube Yadkin Resources that could not be resolved based on the current record in this proceedings. The Commission raised questions regarding: how PJM's algorithm selects particular buses for each generator for purposes of its Electrical Distance requirement; how the algorithm determines the specific path from each generator to these buses; how PJM's selection of three closest buses is consistent with PJM's Tariff and electrically feasible; and whether PJM's algorithm's selection of three

busses.”⁹² PJM states it assessed 166 PJM boundary buses in order to calculate the Electrical Distance from the PJM Region to Badin, High Rock and Tuckerton stations, using a system model, and incidence matrix and Dijkstra’s algorithm to identify the path with the lowest total impedance between the generator source station and each of the 166 PJM boundary buses. PJM states it then created 100 alternate paths to each boundary bus by varying the initial path to that bus, and repeated this process 166 times, - one for each boundary bus. Only then PJM states did it calculate the Electrical Distance from the generator to each of the 166 boundary buses. In its final step, PJM states the generator passed the Electrical Distance requirement so long as the smallest of the 166 results had an impedance of 0.065 p.u. or less.⁹³

55. Explaining how its algorithm determines the specific paths from each generator to each boundary bus, PJM states that (1) the algorithm begins with an initial path calculated as having the lowest impedance from the generator to the boundary bus; and (2) next removes “edges” – segments of paths between two nodes - from the initial path.⁹⁴ According to PJM, “removing an edge is roughly comparable to closing a highway bridge and forcing traffic to find an alternate route; closing different bridges compels different alternate routes. Forcing traffic onto a more circuitous route would be roughly comparable to forcing energy from a generator to follow a higher-impedance path to the PJM border.”⁹⁵

56. PJM states that its algorithm follows three rules for removing edges: (1) Removing edges of the shortest path, one at a time; (2) Removing all edges of the shortest path; and (3) Removing all edges after/before the first/last edge.⁹⁶ Mr. Baranowski attached the PJM Whitepaper to his Second Affidavit, Exhibit A to PJM’s

closest buses, if erroneous, could cause an external generator to fail the Electrical Distance requirement when it would have otherwise passed. Paper Hearing Order, 168 FERC ¶ 61,113 at P 19.

⁹² PJM Paper Hearing Response at 2-3.

⁹³ *Id.*

⁹⁴ *Id.* at 3.

⁹⁵ *Id.*

⁹⁶ *Id.*, Ex. A, Second Affidavit of John R. Baranowski at ¶ 10 (Second Baranowski Aff.).

Paper Hearing Response, setting forth additional technical detail including governing formulae for this path selection and Electrical Distance calculation process.⁹⁷

57. PJM states that its process next calculates Electrical Distance using Thévenin theorem for a system composed of any node that was part of the initial path or any of the numerous alternate paths. PJM affiant Mr. Baranowski, states PJM's approach focuses the Electrical Distance calculation on the facilities most likely to be affected by the Pseudo-Tie "and thus is a good indication of the level of facilities that would need to be added to PJM's EMS to model and operate a new Pseudo-Tie."⁹⁸

58. PJM further states the algorithm selects a different initial path for each generator and the alternate shortest paths selected for each generator are also unique. Mr. Baranowski explains the algorithm "does not guarantee it will select an identical set of alternate paths for *adjacent* busses . . . because, for example, . . . even adjacent generators will have different 'first edges' so the algorithm will produce different sets of alternative paths for the different generators."⁹⁹ Mr. Baranowski also asserts that the Electrical Distance requirement does not assess the electrical feasibility or the deliverability of the external generator and rather "only provides an assessment of the complexity of the external modeling required."¹⁰⁰

59. Mr. Baranowski further explains (1) PJM described the derivation and validation of results in its response to Question 2 of the Commission Deficiency Letter in Docket No. ER17-1138-000;¹⁰¹ (2) PJM conducted initial testing of software to confirm its approach successfully calculated per-unit impedance of parallel paths between the facility and the PJM border; (3) PJM confirmed that at least 130 GW of external resources successfully passed the Electrical Distance requirement 0.065 p.u. threshold using the same algorithm applied to Cubs Yadkin's resources; and (4) the PJM Whitepaper "memorializes part of PJM's development and validation efforts, including comparisons with other electrical distance methods investigated during the Electrical Distance requirement's development."¹⁰²

⁹⁷ PJM Paper Hearing Response at 3-4 (citing PJM Whitepaper).

⁹⁸ *Id.* (citing Second Baranowski Aff. ¶ 13).

⁹⁹ *Id.* (citing Second Baranowski Aff. ¶ 15).

¹⁰⁰ *Id.* (citing Second Baranowski Aff. ¶ 16).

¹⁰¹ *Id.* at 5 (citing Second Baranowski Aff. ¶ 18).

¹⁰² *Id.* at 5-6 (citing Second Baranowski Aff. ¶ 21).

60. Mr. Baranowski states if PJM selected the two closest buses for the Cube Yadkin resources, the Electrical Distance would have been slightly higher than that previously calculated when Cube Yadkin failed the Electrical Distance requirement. This is because the lowest Electrical Distance value for the Cube Yadkin Resources already exceeded the 0.065 p.u. threshold, and the use of a higher Electrical Distance value would not have changed the outcome.¹⁰³

61. Finally, PJM states that its algorithm selects paths based on the impedance between buses, so bus numbers are applicable but other transmission elements are not. PJM refers to tables set forth in Mr. Baranowski's Affidavit listing bus-to-bus details for the initial paths and each of the three alternate (i.e., next closest) buses identified in PJM's analysis for the Cube Yadkin Resources.¹⁰⁴

62. Cube Yadkin maintains that PJM fails to validate its methodology, coding or results of the algorithm and fails to address technical defects in its algorithm in general and as applied to the Cube Yadkin Resources.¹⁰⁵ Cube Yadkin further maintains that PJM does not justify its analysis of only a subset of the system buses in the algorithm and fails to explain any criteria or detail in its selection of the subset of 166 boundary buses and paths used as the starting point for its algorithm.¹⁰⁶

63. Cube Yadkin rejects Mr. Baranowski's explanation that PJM's algorithm focuses on those paths across which electricity is likely to flow as failing to explain why it is necessary to analyze only a subset of potential paths in the network.¹⁰⁷ Cube Yadkin argues that if PJM had wished to use an iterative k-shortest algorithm as described in the Second Baranowski Affidavit and the PJM Whitepaper, it could have done so by filing the algorithm with FERC for its review and comment. Cube Yadkin argues that the PJM Tariff is replete with examples of complicated formulae and methodologies used to calculate everything from rates of return to Cost of New Entry into the PJM market and

¹⁰³ *Id.* at 6 (citing Second Baranowski Aff. ¶¶ 22-24).

¹⁰⁴ Second Baranowski Aff. ¶ 26.

¹⁰⁵ Cube Yadkin Paper Hearing Reply at 1-2.

¹⁰⁶ Cube Yadkin notes that the PJM Whitepaper characterizes Thévenin equivalent impedance as considering "all paths. Cube Yadkin Paper Hearing Reply at 6 (citing PJM Whitepaper at 5).

¹⁰⁷ Cube Yadkin reiterates that under TARA, the Cube Yadkin resources met the 0.065 p.u. threshold.

provides as an example, PJM Tariff Attachment DD, Section 5.10, a methodology to establish the Variable Resource Requirement Curve.¹⁰⁸

64. Cube Yadkin maintains that PJM failed to explain the algorithm's selection of three closest buses and whether such a result is electrically feasible. Cube Yadkin asserts that PJM's discussion of "edges" and the selection of "different sets of alternative paths for different generators" does not address how the algorithm selected three closest buses for the Cube Yadkin Resources nor whether the result is electrically feasible.¹⁰⁹

65. Cube Yadkin criticizes PJM's statement that selecting two closest buses would have resulted in slightly higher Electrical Distance measurements, as flawed because the test is based upon compounded problems such as the selection of only a subset of buses and associated paths.¹¹⁰

66. Cube Yadkin also responds that Mr. Baranowski only provides initial paths analyzed by PJM but fails to provide a list of buses in all parallel affected paths identified through the application of the PJM algorithm. More generally, Cube Yadkin argues that rather than applying Thévenin equivalent impedance as the Tariff and Manual 12 proscribe, PJM is unable to provide the information that forms the basic assumptions underlying its methodology; it is hence neither transparent nor reproducible.¹¹¹

67. PJM clarifies that the starting-point list of 166 boundary buses comprises all PJM bulk electric system boundary buses, i.e., those on AC tie lines or transformers with voltage at or above 100 kV and does not include buses on DC ties.¹¹²

68. PJM adds that its algorithm arrived at the selection of three closest buses after starting with all 166 boundary buses. PJM refers to Mr. Baranowski's Second Affidavit to explain why the algorithm selected three buses instead of two, in which Mr. Baranowski explains, "[s]ince the network topology is unique for each generator, the algorithm selects a different initial path for each generator [and] [a]s a result, the alternate shortest paths selected for each generator are also unique."¹¹³ In other words, according to PJM, the algorithm found a different closest boundary bus for each of the three Cube

¹⁰⁸ Cube Yadkin Paper Hearing Reply at 7 n.24.

¹⁰⁹ *Id.* at 9-10.

¹¹⁰ *Id.* at 12.

¹¹¹ *Id.* at 13.

¹¹² PJM Paper Hearing Answer at 9.

¹¹³ Second Baranowski Aff. ¶ 15.

Yadkin generators, so there were three closest boundary buses. Each generator had a different closest boundary bus because each generator had slightly different initial paths and thus different alternate paths. With different alternate paths, the boundary bus found at the conclusion of all the iterations to be closest to one generator may not be the closest boundary bus for a different generator.¹¹⁴ PJM asserts this result is not only consistent with PJM's algorithm, but "*the result of the algorithm.*"¹¹⁵ PJM further asserts that this result is electrically feasible because even adjacent generators will have a different electric topography and thus different "starting edges" leading to different iterations and different results.¹¹⁶

69. With respect to Cube Yadkin's generators, PJM asserts the three generators¹¹⁷ have different "starting edges" which impacts the outcome of step (c) as described in PJM's Paper Hearing Response, i.e., "removing all edges after/before the first/last edge." PJM demonstrates this result in a series of illustrations and figures which demonstrates each generator has a different shortest initial path, and each generator has a different set of edges removed after the first edge.¹¹⁸ PJM notes in addition that while, for example, Tuckertown and High Rock have different closest PJM boundary buses, the difference in the calculations that produce that result is quite narrow as demonstrated in a series of tables provided in Mr. Baranowski's Second Affidavit. PJM asserts that Mr. Baranowski's tables show that Tuckertown and High Rock have *almost* the same PJM boundary bus.¹¹⁹

70. PJM states that the Commission has not held that RTO planning models, formulae or algorithms are only valid if submitted to a peer-reviewed journal or are subject to other prerequisites. PJM reiterates that the results show that PJM's methodology meets the need of limiting expansion of PJM's EMS and argues that the same methodology produced the 0.065 p.u. Electrical Distance standard now in the Tariff.¹²⁰

¹¹⁴ PJM Paper Hearing Answer at 10.

¹¹⁵ *Id.*

¹¹⁶ *Id.* at 10-11.

¹¹⁷ PJM refers to the Cube Yadkin resources located at High Rock, Tuckertown and Badin (Narrows/Falls).

¹¹⁸ PJM Paper Hearing Answer at 11.

¹¹⁹ *Id.* at 14.

¹²⁰ PJM Paper Hearing Answer at 15.

71. Finally, PJM reiterates that paths are selected based on the impedance between buses and therefore no specific circuit information is applicable. PJM notes that it provided a series of tables showing the bus-to-bus details for the initial path to the electrically closest boundary bus for each of Cube Yadkin's generators and the same detail for the next three closest boundary buses.¹²¹

72. PJM states that Cube Yadkin's criticism that PJM has not provided the buses in all parallel paths identified by the algorithm would require roughly one thousand lines of bus-to-bus pairs and was not requested in the Commission's Paper Hearing Order.¹²²

73. Cube Yadkin maintains, however, that PJM's refusal to provide details on every alternate path leaves only details of how a portion of PJM's algorithm works and does not establish validity for purposes of measuring electrical distance.¹²³

b. Commission Determination

74. The Commission finds that Cube Yadkin did not meet its burden to establish that PJM's selection and modeling of buses in performing the Electrical Distance requirement for the Cube Yadkin Resources was unjust and unreasonable or inconsistent with the Tariff. We find that PJM addressed Cube Yadkin's concerns regarding PJM's examination of 166 buses by explaining that those 166 buses constituted all of the PJM boundary buses. We also find that PJM addressed the feasibility of its algorithm's selecting three rather than two closest buses by stating "this result is electrically feasible because even adjacent generators will have a different electric topography and thus different 'starting edges' leading to different iterations and different results."¹²⁴ We are not persuaded by Cube Yadkin's claim that PJM must include the entire Eastern Interconnection as required by Thévenin equivalent impedance, because the Tariff does not require PJM to measure Electrical Distance pursuant to any particular standard and, here, PJM has adequately supported its approach.

3. Transparency of the Electrical Distance Requirement Process

a. Complaint and Responsive Pleadings

75. In its pleadings, Cube Yadkin raises concerns with the notice and transparency PJM provides to pseudo-tie applicants regarding the Electrical Distance requirement.

¹²¹ *Id* at 17. (citing Second Baranowski Aff. ¶ 26).

¹²² *Id.*

¹²³ Cube Yadkin Second Paper Hearing Answer at 11.

¹²⁴ PJM Paper Hearing Answer at 11.

Cube Yadkin argues that PJM's refusal to share aspects of its modeling ensures that Cube Yadkin cannot verify the objectivity, consistency or repeatability or the Electrical Distance requirement.¹²⁵ Cube Yadkin states that PJM ultimately provided the numerical results of the Electrical Distance requirement and identified the four closest PJM border buses identified through the test.¹²⁶ But according to Cube Yadkin, PJM refused to provide details about the number of paths it measured from the Cube Yadkin Resources, nor did it provide an explanation regarding the number of paths PJM chose or the specific paths PJM analyzed.¹²⁷ Cube Yadkin asserts that it offered to execute an NDA specifically with respect to PJM's algorithm but PJM continues to refuse to share it.¹²⁸

76. Cube Yadkin further asserts that the fact that PJM provided figures, illustrations and tables to support subsequent responses to the Paper Hearing Order, which, as a general matter, are not allowed by the Commission reveals a lack of transparency in PJM's processes. Cube Yadkin further alleges that PJM's "eleventh hour disclosures" of the process of removing edges is another indication that PJM "continually adapts its responses to inquiries . . . to defend the use of its algorithm."¹²⁹

77. According to Cube Yadkin, nothing demonstrates this lack of transparency and inconsistency more than the example of the Maine generator that passed the Electrical Distance requirement. Cube Yadkin relies on PJM's statement that the Maine generator would no longer meet the Electrical Distance requirement because PJM now treats the PJM-to-New York phase angle regulators (PARs) as open circuits. Cube Yadkin then argues that "it would be inconceivable that this explanation would be unique to this particular generator in Maine and would not consistently apply to other nearby generators."¹³⁰ Cube Yadkin asserts the explanation is in direct conflict with Exhibit A of the September 24, 2019 Baranowski Affidavit because PJM submitted that exhibit to set forth additional technical detail "for this path selection and Electrical Distance calculation process."¹³¹ In addition, Cube Yadkin argues that PJM's explanation further demonstrates how PJM changes the rules of the game and its explanations of how the

¹²⁵ Complaint at 18.

¹²⁶ *Id.* at 22 (citing Simmons Aff. at 7).

¹²⁷ *Id.* (citing Simmons Aff. at 12).

¹²⁸ Cube Yadkin Answer at 10.

¹²⁹ Cube Yadkin Second Paper Hearing Answer at 9.

¹³⁰ *Id.* at 10.

¹³¹ *Id.*

rules apply. Cube Yadkin asserts “there is no way for Cube Yadkin (or any other pseudo-tie applicant) to know what procedures were applied to measure electrical distance.”¹³²

78. In response to Cube Yadkin’s arguments that PJM’s Electrical Distance requirement lacks transparency, PJM states that its consistent use, for all pseudo-tie requests, of the same algorithm to determine which paths and facilities each pseudo-tie affects, “removes subjectivity from the process.”¹³³ Mr. Baranowski adds “[o]ther than identifying a starting location (i.e., the Pseudo-tied generator, and a target set of PJM border busses as the ending location), the algorithm does not require analyst intervention or discretion.”¹³⁴ PJM adds that while it has been open with Cube Yadkin by sharing results, explaining methodology and reviewing and explaining differences in results, PJM has “reasonably declined” to share the intellectual property embedded in its custom-coded algorithm.¹³⁵

79. PJM also takes issue with Cube Yadkin’s reference to a generator located in Maine which passed the Electrical Distance requirement. PJM explains that generator’s lowest impedance path went through a PAR and that the PAR impedance was identified in the algorithm as an internal PJM path, which reduced the path’s impedance. PJM further explains that discussions with New York ISO led to treating PJM-New York PARs as open circuit because the devices are used to control actual flow to prescribed target values. PJM states that while it has used this process for all pseudo-tie requests regarding the Electrical Distance requirement, it had not adopted that step in 2016 when it prepared the map Cube Yadkin refers to.¹³⁶

b. Commission Determination

80. We find Cube Yadkin’s Complaint and pleadings raise a concern regarding the lack of a sufficient level of notice and transparency with respect to the Electrical Distance requirement. Thus, we find PJM’s Tariff is unjust and unreasonable in not providing an

¹³² *Id.*

¹³³ PJM Answer at 19.

¹³⁴ Baranowski Aff. ¶ 21.

¹³⁵ PJM Answer at 20.

¹³⁶ PJM Paper Hearing Answer at 16.

open and transparent process for pseudo-tie applicants to determine the reasons why PJM has determined their resource fails this test.¹³⁷

81. The Commission has recognized that the complexity of electrical system modeling means that RTO customers themselves cannot run tests, like the ones at issue here, to validate an RTO's conclusions; for this reason, the Commission relies on notice and transparency to ensure RTO customers understand the application of tariff provisions to their projects.¹³⁸ In this case, PJM's initial inability to sufficiently describe its process of selecting buses, without which it could remain unclear why one resource passes the Electrical Distance requirement and another does not, demonstrates the need to require PJM to provide for enhanced transparency in its Tariff.

82. In responding to the Commission's Paper Hearing question of how its algorithm selects particular buses for each generator and the determination of specific paths from each generator to the buses, PJM referred to the PJM Whitepaper, which it posted on its website in January 2019. This Whitepaper was only made part of the record as an attachment to Mr. Baranowski's 2nd Affidavit in response to the Commission's Paper Hearing Order. The Whitepaper discusses a process by which its algorithm removes "edges" from paths. It states that its algorithm does not determine electrical feasibility. We find that much of the explanation contained in PJM's Whitepaper and noted in PJM's response to the Paper Hearing Order is not contained in its Tariff nor in its manuals and thus interested parties may have had insufficient notice of how the Electrical Distance requirement works, or how and when it may be amended.

83. To remedy the unjustness and unreasonableness of the Tariff, we require PJM to include in the Electrical Distance requirement section of its tariff, PJM Tariff Attachment DD.5.5A (Capacity Resource Types),¹³⁹ provisions similar to those we require for the

¹³⁷ See *Transource, LLC*, 168 FERC ¶ 61,119, at PP 82-85 (2019) (finding PJM's tariff unjust and unreasonable for not providing sufficient transparency).

¹³⁸ See *id.* (requiring PJM to include information in its tariff to ensure its interconnection process is transparent); *PJM Interconnection, L.L.C.*, 165 FERC ¶ 61,078 at P 23 (2018) (finding the "complexity" of the calculations does not preclude PJM from relying on its tariff methodology as long as it provides sufficient transparency).

¹³⁹ OATT Attachment DD.5.5A Capacity Resource Types, § 5A(b)(i)(A) and (B) (2.0.2).

Market to Market Flowgate Test in a contemporaneous order.¹⁴⁰ Specifically, PJM must amend its tariff to require that:

- (1) PJM provide a copy of the results of the Electrical Distance requirement to the pseudo-tie applicant as well as related work papers, if requested;
- (2) PJM post on its website the material assumptions that are used in its modeling software in the conduct of the Electrical Distance requirement and that are applicable to all tested generators, *e.g.*, the general process used to define the facilities included in the Electrical Distance requirement for each pseudo-tie applicant; and
- (3) Upon request, PJM meet with each pseudo-tie applicant to discuss specific modeling assumptions and the results of the Electrical Distance requirement for that individual pseudo-tie applicant.

4. Other Arguments

a. Moving Target

84. Cube Yadkin argues that PJM’s Electrical Distance requirement has been a moving target for external generating resources.¹⁴¹ Cube Yadkin explains that in stakeholder presentations and in PJM’s Transmittal filed in the Pseudo-Tie Enhancement proceeding, PJM represented to stakeholders and the Commission that the Electrical Distance requirement would be applicable to resources throughout the entire Eastern Interconnect.¹⁴² Cube Yadkin asserts that on April 2, 2018, notably after the Commission issued the Pseudo-Tie Enhancement Order, PJM presented an updated model which “shrank precipitously” the footprint for tier 1 resources.¹⁴³ Cube Yadkin argues that PJM’s April 2, 2018, presentation to stakeholders demonstrates a 50% decline in resources qualified to pseudo-tie with PJM post-Pseudo-Tie Enhancement Order.¹⁴⁴

¹⁴⁰ *Brookfield Energy Marketing, LP v. PJM Interconnection, L.L.C.*, 171 FERC ¶ 61,151 (2020).

¹⁴¹ Complaint at 25.

¹⁴² *Id.* at 26-27. (citing PJM Transmittal, Docket No. ER17-1138-000 at Attachment E (filed Mar. 9, 2017)).

¹⁴³ *Id.* at 28.

¹⁴⁴ *Id.*

85. In response to Cube Yadkin’s assertion that PJM changed its analysis after the issuance of the Pseudo-Tie Enhancement Order and is a “moving target,” PJM states that the diagrams Cube Yadkin offers in its Complaint ignore subsequent diagrams presented at the same stakeholder meeting. PJM further explains that the first diagram presented in Cube Yadkin’s complaint show the Geographic Tier approach which PJM explained was abandoned in favor of the Electrical Distance approach.¹⁴⁵ Mr. Baranowski states “[t]he geographic tier approach reflected on the slide cited by Cube therefore reflects an approach developed earlier in the stakeholder process that was explicitly discarded, and replaced with the method presented to and approved by FERC.”¹⁴⁶

86. As discussed above, we grant the complaint insofar as we are requiring PJM to revise its tariff to provide greater notice and transparency and to provide pseudo-tie applicants with the ability to, upon request, meet with PJM to discuss specific modeling assumptions and results. We find that this remedy will also address transparency-related concerns with how the Electrical Distance requirement is performed.

b. Related Proceedings

87. Cube Yadkin states that the instant Complaint is only one of four then-pending complaints before the Commission and argues that taken together, the four complaints against PJM’s new pseudo-tie rules raise genuine issues of material fact with respect to the various new pseudo-tie tests adopted by PJM.¹⁴⁷ Cube Yadkin concludes “because an external resource must satisfy *all* of the New Pseudo-Tie Requirements, if one requirement is unjust and unreasonable, then the entire regime necessarily cannot stand.”¹⁴⁸

88. Brookfield Energy Marketing LP argues that Cube Yadkin’s complaint echoes the arguments raised by Tilton Energy LLC and Brookfield Energy Marketing LP regarding the Market to Market Flowgate Test, which argue that the test requirement is

¹⁴⁵ PJM Answer at 17.

¹⁴⁶ Baranowski Aff. ¶ 19.

¹⁴⁷ Complaint at 31-32. Cube Yadkin refers here to Potomac Economics., Ltd. v. PJM Interconnection, L.L.C., Docket No. EL17-62-000 (filed Apr. 6, 2017, Tilton Energy LLC v. PJM Interconnection, L.L.C., Docket No. EL18-145-000 (filed May 11, 2018), and Brookfield Energy Mktg. LP v. PJM Interconnection, L.L.C., Docket No. EL19-34-000 (filed Jan. 18, 2019). *See also Potomac Economics, Ltd. v. PJM Interconnection, L.L.C.*, 171 FERC ¶ 61,039 (2020).

¹⁴⁸ *Id.* at 32.

(1) inconsistent with its own governing documents and explanations to the Commission; and (2) is opaque and not repeatable.¹⁴⁹

89. We reject Cube Yadkin's argument that other arguments made in pending complaints before the Commission should be considered along with Cube Yadkin's arguments. The arguments made in those complaints are addressed in orders particular to those dockets.

c. **Participation of Pseudo-Tied Resources in PJM's Capacity Market**

90. The PJM IMM states that PJM correctly applied the Electrical Distance requirement because the test was consistent with PJM's explanation in the stakeholder process prior to filing as well as the approach that the Commission approved in the Pseudo-Tie Enhancement Order.¹⁵⁰ However, the PJM IMM believes that PJM's approach is too lenient and allows participation of resources that are not comparable to internal resources in the PJM capacity markets. The PJM IMM argues that PJM's market rules should more clearly define a substitute capacity resource in order to protect the efficiency and competitiveness of the PJM capacity market.¹⁵¹ In addition, the PJM IMM argues that the Complaint amounts to a collateral attack on PJM's filed rules and should be denied.¹⁵²

91. PJM IMM's arguments about pseudo-tied resources' participation in PJM's capacity market are outside the scope of this complaint proceeding.

The Commission orders:

(A) The Complaint is hereby denied in part, and granted, in part, as discussed in the body of this order.

¹⁴⁹ Brookfield Comments at 2-3.

¹⁵⁰ PJM IMM Answer at 2.

¹⁵¹ *Id.* at 1-2.

¹⁵² *Id.*

(B) PJM is hereby directed to make a compliance filing within 45 days of the issuance of this order with proposed notice and transparency amendments to its Tariff, as discussed in the body of this order.

By the Commission.

(S E A L)

Nathaniel J. Davis, Sr.,
Deputy Secretary.