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STATE CORPORATION COMMISSION CASE NO. PUR-2024-00144

Ex Parte: Electric Utilities and Data Center Load Growth

POST CONFERENCE COMMENTS OF THOMAS DONAHUE

Chair Hudson, Judge Bagot, and Judge Towell

The Virginia State Corporation Commission (SCC) technical conference[1] on large-use electricity customers held on 16 December 2024 failed to consider the concerns of a significant stakeholder group, namely the owners of land that will be taken to build regional transmission lines in support of the data center industry, even while under-utilized, practical solutions exist that would mitigate such concerns and provide greater capacity and reliability for Virginia's transmission grid.

Unprecedented Data Center Needs Override Land Owners

While the local jurisdictions benefit from taxes, the land owners lose their land, are paid a nominal price for just the easement, and are not compensated for loss of the use of the land that often occurs or for diminished property value caused by hosting transmission lines.

- An adjacent land owner, whose property is affected by proximity to a line, gets nothing.
- Instead, land owners are subsidizing the wealth generation of the data center industry.

Regulatory decisions for the routing of transmission lines override local efforts to preserve land such as conservation easements, sensitive environmental areas, and historic districts.

- The land taken also can come from national and state parks.

This application of eminent domain for the benefit of the "greater good" is well established under US law; however, eminent domain on a large scale spanning multiple states for the benefit of one category of retail electric power customers is a new phenomenon. Furthermore, this is not a matter of a major infrastructure investment made just once in a generation.

- The expected unprecedented growth of data centers will require *repeated* buildouts of transmission and power generation infrastructure, ultimately eclipsing all other uses of electric infrastructure in Virginia, particularly in rural areas served by electric cooperatives.

[1] Virginia SCC, Data Center Load Technical Conference, Case No. PUR-2024-00144, Richmond, 16 December 2024, https://scc.virginia.gov/DocketSearch#caseDocs/145480.

- NOVEC,[2] in its comments at the SCC conference, noted that data centers by 2032 will make up 95 percent of its load.
- This is *not* business as usual.

PJM has made clear that most of the 230 kV, 500 kV, and 765 kV transmission lines and the related substation upgrades included in 2022-RTEP-Window 3[3] and 2024-RTEP-Window 1[4] are the result of the accelerating load growth of Virginia's data centers. Of the total of more than $10 billion that PJM estimates for these two regional transmission expansion plans, more than $8.5 billion will be spent to meet the expected load demand from Virginia's data centers.

- While it is clear that, as stated by several speakers at the conference, one cannot link the *incremental* load of *one* data center to a specific *regional* transmission line, the two PJM plans link most of their new regional transmission lines *collectively* to the growing load demand from data centers in Virginia.
- The *regional* transmission lines that will be built because of the increased demand from data centers will be paid for by *all* ratepayers in the PJM region.
- The data centers are thus *not* paying their way.

Higher-Capacity Conductors Provide a Path Forward

While land owners were ignored entirely at the conference, the data center industry speakers did at least note that the cost of this infrastructure should be contained (after all, the data centers are ratepayers too). The Data Center Coalition (DCC) and Google each made reference to advanced transmission technologies that could be used to reduce the need for new rights of way.

- The DCC[5] stated, "grid enhancing technologies (GETs)—such as dynamic line ratings, advanced reconductoring, and other capacity enhancing solutions—can help maximize future and existing transmission capacity to unlock significant cost savings."
- Google[6] stated, "the Commission, transmission owners, and large customers need to explore every opportunity to reduce new transmission investments through Grid Enhancing Technologies (GETs), advanced reconductoring, and other non-wires alternatives."

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[2] Gilbert Jaramillo, Virginia SCC, Data Center Load Technical Conference, Case No. PUR-2024-00144, Richmond, 16 December 2024, NOVEC Opening Comments, p. 3, https://www.scc.virginia.gov/docketsearch/DOCS/82vs01!.PDF.

[3] PJM, "Reliability Analysis Report, 2022-RTEP-Window 3," 8 December 2023, p. 4, https://www.pjm.com/-/media/DotCom/committees-groups/committees/teac/2023/20231205/20231205-2022-rtep-window-3-reliability-analysis-report.pdf.

[4] PJM, "Reliability Analysis Report (Draft), 2024-RTEP-Window 1," 27 November 2024, pp. 1, 5, and 13; https://www.pjm.com/-/media/DotCom/committees-groups/committees/teac/2024/20241203/20241203-2024-rtep-window-1-reliability-analysis-report---draft.pdf.

[5] Aaron Tinjum, Virginia SCC, Data Center Load Technical Conference, Case No. PUR-2024-00144, Richmond, 16 December 2024, DCC Opening Comments, p. 9, https://www.scc.virginia.gov/docketsearch/DOCS/82w%2401!.PDF.

[6] Brian George, Virginia SCC, Data Center Load Technical Conference, Case No. PUR-2024-00144, Richmond, 16 December 2024, Google Opening Comments, p. 4, https://www.scc.virginia.gov/docketsearch/DOCS/82w%2301!.PDF.

New rules under Order 1920 from the Federal Energy Regulatory Commission[7] (FERC) require "transmission providers to consider the following alternative transmission technologies: dynamic line ratings, advanced power flow control devices, advanced conductors, and transmission switching. The aim is to identify efficient and cost-effective solutions to meet transmission needs and optimize the transmission system without the need to build additional transmission facilities."

- The Virginia Academy of Science, Engineering, and Medicine in a September 2024 report[8] prepared for Virginia General Assembly Delegate David Reid also notes the ability of advanced conductors to reduce the need for new rights of way.

Regulators in Virginia, West Virginia, Maryland, and Pennsylvania have the opportunity to reduce the impact of data centers on ratepayers and adjacent communities—while also ensuring adequate capacity and reliability—by requiring higher-capacity conductors on existing or already planned 500 kV lines to be used as a complement to 765 kV lines proposed as part of 2024-RTEP-Window 1.

- In addition to using existing 500 kV lines for this purpose, regulators could also consider additional proposed 500 kV lines that run in parallel with the existing lines, which PJM's Board approved in December 2023 and August 2024[9] as part of 2022-RTEP-Window 3.
- Because of the rapid pace of data center growth, these additional 500 kV lines planned for growth through 2027 are still going through engineering design and thus are still subject to regulatory approval, even as PJM has moved on to consider even more transmission lines for load growth in 2028–2029 as part of 2024-RTEP-Window 1.
- Figure 1 provides an example of how higher-capacity conductors could be used in Virginia to reduce cost and impact, increase reliability, and provide greater power capacity.

Technical Approaches to Reconductoring

Older 500 kV lines are typically upgraded with conventional, but larger-diameter Aluminum Conductor Steel Reinforced (ACSR) lines (early 20th Century technology), and the number of conductors per phase is typically increased from two to three.

- For example, Dominion Energy in 2015 increased the transmission capacity of the Mt. Storm–Doubs 500 kV line by 66 percent in this manner.[10]
- Extending this approach to even higher capacity, however, would require much larger and heavier ACSR conductors, which could not be supported by existing towers and hardware.

[7] FERC, "Explainer on the Transmission Planning and Cost Allocation Final Rule, Building for the Future Through Electric Regional Transmission Planning and Cost Allocation," Docket No. RM21-17-000, Order No. 1920, Effective 12 August 2024, https://www.ferc.gov/explainer-transmission-planning-and-cost-allocation-final-rule.

[8] Virginia Academy of Science, Engineering, and Medicine; "Technologies for Powering Virginia's Data Centers," September 2024, pp. 13-18, https://vasem.org/wp-content/uploads/2024/10/White-Paper-Technologies-for-Powering-Virginias-Data-Centers.pdf.

[9] *PJM Inside Lines*, "PJM Board Approves Updates to Regional Transmission Plan," 8 August 2024, https://insidelines.pjm.com/pjm-board-approves-updates-to-regional-transmission-expansion-plan-2/.

[10] W. Briggs and S. Harrington, *T&D World*, "Dominion Takes Historic Project by Storm," 24 November 2015, https://www.tdworld.com/grid-innovations/transmission/article/20966072/dominion-takes-historic-project-by-storm.

The next most common approach in the United States for further increases in transmission line capacity is Aluminum Conductor Steel Supported (ACSS)[11] technology, including lines up to 375 miles long at 345 kV, according to an Idaho National Lab survey.[12] This technology from the 1970s uses aluminum pre-treated for higher-temperature operations (and thus a higher current rating). Dominion Energy has a standard for using ACSS at 230 kV (e.g., in Loudoun County[13]).

- For higher-temperature operations, ACSS can provide up to twice the power of ACSR conductors with similar weight[14] but sags more, possibly forcing towers to be taller.

Composite-core technology,[15] which has been available since the early 2000s, has been deployed on more than 120,000 miles of lines globally,[16] including several operational lines at 500 kV in Indonesia.[17, 18] The global experience across all voltages is relevant even to a discussion of increasing 500 kV capacity, given that conductors are rated by current capacity, not by voltage.

- The inner cores of these conductors use stronger, lighter composite materials instead of the steel used in ACSR and ACSS, allowing composite-core conductors to be used either for longer spans, at lower temperatures at the same power level to reduce fire risks, or at high temperatures (similar to ACSS) to allow for higher power capacity.
- Like ACSS, composite-core conductors can provide up to twice the power of ACSR conductors with similar weight[19] but sag less than ACSR and ACSS conductors.

Why US Industry Adoption of Advanced Conductors Has Been Slow

As the relative "new comer," composite-core technology in the United States continues to be viewed with uncertainty about long-term reliability by the energy industry and is thus mostly used for field tests at voltages below 500 kV or for niche applications (such as wide river crossings).

- According to Idaho National Lab, Dominion has only deployed a composite-core line once, at 230 kV in 2009,[20] increasing that line's capacity by 90 percent (Loudoun–Brambleton).

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[11] Dennis Doss, *Power Grid International*, "Primer on ACSS/TW overhead conductor," 1 August 2002, https://www.power-grid.com/td/primer-on-acss-tw-overhead-conductor/.

[12] Idaho National Lab, "Advanced Conductor Use Case Studies," INL/RPT-23-75874, December 2023, p. 5, 7, 33, 34, and 53; p. 18 for Dominion standard, https://inl.gov/content/uploads/2024/02/23-50856_R4a_-Use-Case-Studies.pdf.

[13] SCC, Final Order, Case No. PUR-2021-00100, 8 February 2022, p. 1, https://www.dominionenergy.com/-/media/pdfs/global/projects-and-facilities/electric-projects/power-line-projects/line-227/final-order.pdf.

[14] American Wire Group, Product Catalog, accessed 31 December 2024, https://www.buyawg.com/viewitems/bare-aluminum-acss-tw/trapezoidal-shaped-aluminum-strands.

[15] Emilia Chojkiewicz et. al., Grid Lab and UC Berkeley, "2035 and Beyond: Reconductoring With Advanced Conductors Can Accelerate the Rapid Transmission Expansion Required For a Clean Grid," April 2024, https://www.2035report.com/wp-content/uploads/2024/06/GridLab_2035-Reconductoring-Technical-Report.pdf.

[16] Dave Bryant, CTC Global, 11 December 2024, (120,000 miles in 67 countries), https://ctcglobal.com/why-transmission-engineers-and-utilities-are-choosing-ctc-global-as-their-advanced-conductor-supplier/.

[17] Epsilon Cable, accessed 27 December 2024, (62 miles, double-circuit 500 kV line installed in Jakarta, Indonesia in 2017), https://www.epsilon-cable.com/case-studies/500kv-line-in-jakarta-indonesia.

[18] CTC Global, "PLN Completes 500 kV ACCC Upgrade in Indonesia," (38 miles, single circuit), 11 December 2018, https://ctcglobal.com/pln-completes-500-kv-accc-conductor-upgrade-in-indonesia/; (other lines in 2019 and 2023).

[19] CTC Global, ACCC Specification Sheet, accessed 27 December 2024, https://ctcglobal.com/wp-content/uploads/2023/05/ACCC-CONDUCTOR-US-CUSTOMARY-SIZES-US-Units-new.pdf.

[20] Idaho National Lab, "Advanced Conductor Use Case Studies," p. 18.

- American Electric Power (AEP) used composite-core technology[21] for a 120-mile-long, double-circuit 345 kV line in 2015 in Texas after concluding that no other means existed to deliver the needed power within the available space and time.
- Composite-core conductors have been used at 500 kV in the United States three times, according to Idaho National Lab: a mile-long pilot by the Tennessee Valley Authority in 2013,[22] a 3-mile "load relief" line by Southern California Edison in 2018, and a 26.4-mile line by Exelon to replace an old line between two utilities in northern Maryland in 2018.[23]

Industry concerns with any new conductors include endurance, failures under extreme conditions, unfamiliar installation procedures that vary by manufacturer,[24] and the resulting increased risk of damaging the conductor during installation (see industry concerns with composite-core lines in another Idaho National Lab report[25]). Utilities prefer to see field test data from within their own systems and prefer consistent product and installation standards, according to this report.

While higher-capacity conductors must be able to withstand icing conditions, they also can take advantage of their higher temperatures to clear icing to get ahead of structural failures.[26] Composite-core conductors have been deployed in areas with heavy icing,[27, 28] and manufacturers offer products[29, 30] designed to deal with particularly heavy icing conditions and other hazards.

A critical consideration for high-temperature conductors is that the distance between substations should be less than 50 miles[31] when the maximum power capacity available with the higher thermal limits of these conductors is required.

- Multiple segments can be strung together, but at the cost of adding voltage support at intervening substations.

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[21] Quanta Energized Services, "American Electric Company—Energized Reconductor, Lower Rio Grande Valley," accessed 27 December 2024, https://www.quantaenergized.com/project/574/.

[22] Jeffery Phillips, *T&D World*, "TVA Pushes More Power Down the Corridor," 10 February 2014, https://www.tdworld.com/grid-innovations/transmission/article/20963979/tva-pushes-more-power-down-the-corridor. This line was still operating without problems as of 2024, according to the author.

[23] Idaho National Lab, "Advanced Conductor Use Case Studies," pp. 26, 48, and 50.

[24] TSConductor, accessed 28 December 2024, (advertises that the company's aluminum-encapsulated composite cores are fully compatible with ACSR installation methods and tools), https://tsconductor.com/product-details/.

[25] Idaho National Lab, "Advanced Conductor Scan Report," INL/RPT 23-75873 Revision 2, December 2023 (revision 2, September 2024), pp. 28-31, https://inl.gov/content/uploads/2024/10/23-50856_R12a_-AdvConductorsScanProjectReportCompressed.pdf.

[26] *Moorefield Examiner*, 17 December 2024, (collapse of 11 towers caused by ACSR conductor icing along the 500 kV Hatfield–Doubs line), https://hardylive.com/2024/12/17/the-worst-in-memory-e-still-assessing-damage-of-big-storm/.

[27] 3M, accessed 28 December 2024, (advanced conductors operating since 2002 at 230 kV in North Dakota), https://www.3m.com/3M/en_US/power-transmission-us/resources/accr-customer-installations/harsh-environments/.

[28] TSConductor, accessed 28 December 2024, (aluminum-encapsulated composite-core conductors energized at 230 kV in North Dakota), https://tsconductor.com/projects/basin-electric-neset-northshore/.

[29] CTC Global, 4 January 2019, (website advertises composite-core variant designed for heavy icing), https://ctcglobal.com/introducing-accc-azr-conductor-designed-to-mitigate-heavy-ice-loads/.

[30] TSConductor, accessed 28 December 2024, (website advertises how the entire product line with aluminum-encapsulated composite cores handles icing), https://tsconductor.com/product-details/.

[31] Emilia Chojkiewicz et. al., Grid Lab and UC Berkeley, "2035 and Beyond," p. 27.

Further contingency planning is necessary for mitigating outages on transmission lines carrying power well above typical levels, whether they involve 765 kV or higher-capacity conductors. A similar challenge was faced when 500 kV transmission lines were first introduced in the 1960s.

- Focusing initial installation on corridors with two or more parallel lines would provide the most direct contingency mitigation, but using higher-capacity conductors in other corridors as well would enable a broader, long-term resiliency strategy.

New Architectural Approach Using Complementary Technologies

This combination—of the superior long-distance capabilities of 765 kV[32] with the higher-capacity capabilities across shorter distances of ACSS or composite-core conductors—has the potential to provide more power capacity for data centers in Virginia with:

- Less cost by not building as many towers (even when advanced conductors cost more, given that they are a small fraction of the overall transmission line cost),
- Greater reliability by taking advantage of existing parallel lines and loops (as opposed to isolated 765 kV lines), and
- Less impact on adjacent communities by reducing the need for future new or expanded 500 kV rights of way and reducing the need to extend new 200-foot-wide rights of way for 765 kV lines further into Virginia.

The relatively short distances between 500 kV substations near the data centers of northern and central Virginia make this area an ideal candidate for using higher-capacity conductors. This approach would be consistent with FERC's requirement for "right sizing" existing rights of way in Order 1920[33] and with PJM's new effort to expand its planning considerations beyond five years (currently, out to 2032).[34]

- The current system for managing the grid is struggling to keep up with the rapid pace of data center development and, as a result, is bringing solutions to the regulators piecemeal. This approach not only creates additional costs, it does not consider the lost opportunities for greater efficiency or make use of all available technologies.
- Higher-capacity conductors could overcome challenges in some existing transmission corridors, where further expansion would conflict with adjacent housing developments, parks, historic districts, or land conservation efforts.
- Composite-core conductors, with less sagging than ACSS conductors, might be more suitable for double-circuit and monopole towers, which have lines stacked vertically.
- Reconductoring could be implemented more quickly than building new transmission lines and would buy time for Virginia to build its own additional power generation capacity.

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[32] MISO Planning Advisory Committee, 8 March 2023, p. 17, https://cdn.misoenergy.org/20230308%20PAC%20Item%2007%20Discussion%20of%20765%20kV%20and%20HVDC628088.pdf.

[33] FERC, "Explainer on the Transmission Planning and Cost Allocation Final Rule."

[34] PJM, "Reliability Analysis Report (Draft), 2024-RTEP-Window 1," 27 November 2024, p. 1.

A more strategic approach could be implemented in phases to give power companies time to gain experience and adjust to different technologies and procedures.

- This would also provide time for a more phased approach to upgrading substations to handle higher power levels (some substations upgrades are already included in 2022-RTEP-Window 3 and 2024-RTEP-Window 1).
- A longer-term architectural plan could help reduce the impact of data centers and help adjust work in relation to how much of the anticipated load growth actually occurs.

The US Department of Energy[35] has identified higher-capacity conductors as an essential part of the national strategy to meet 2050 electricity objectives and identified state regulators as critical to moving industry past "early adopter" reluctance toward these solutions. Toward that end, the combination of PJM's 2022-RTEP-Window 3 and 2024-RTEP-Window 1 creates an opportunity for Virginia to move forward and gain more experience with higher-capacity conductors.

- It is essential that regulatory considerations incentivize rather than discourage the use of the best technology.
- For example, the Wall Street Journal in August 2024[36] highlighted a challenge for some utilities that are forced to account for reconductoring under operational expenses rather than capital expenses and, thus, are unable to make a profit.

Virginia must lead in electric power technology, not just in power consumption by data centers. Building just conventional transmission lines in the long run will not be enough to meet the unprecedented load demand of data centers, and we should not sacrifice irreplaceable land, the environment, and our historical legacy to expedient solutions.

- Virginia cannot wait decades for someone else to figure this out for us or expect other states to sacrifice on our behalf.
- We need to learn from those who have been successful adopting new technologies and apply that knowledge to solving the problem of delivering power to the unprecedented loads expected for future data centers.
- We need the region's state regulators to drive the industry forward, consistent with FERC's approach, because the regional "competitive" process has little incentive to do so.

For the record, I have no financial interests in these matters other than as a homeowner, an electricity ratepayer, and a taxpayer.

Thomas Donahue,
Retired electrical engineer in western Loudoun County

[35] US Department of Energy, "Pathways to Commercial Liftoff: Innovative Grid Deployment," April 2024, p. 49, https://liftoff.energy.gov/innovative-grid-deployment/ (for a summary) and https://liftoff.energy.gov/wp-content/uploads/2024/05/Liftoff_Innovative-Grid-Deployment_Final_5.2-1.pdf (for the full report).

[36] Ed Ballard, *Wall Street Journal*, Climate and Energy Highlights, "A Grid Revamp Could Save Everybody Money, But There's a Catch," August 2024, https://climate.cmail20.com/t/d-e-ehlhtkl-iiklluhyg-r/.

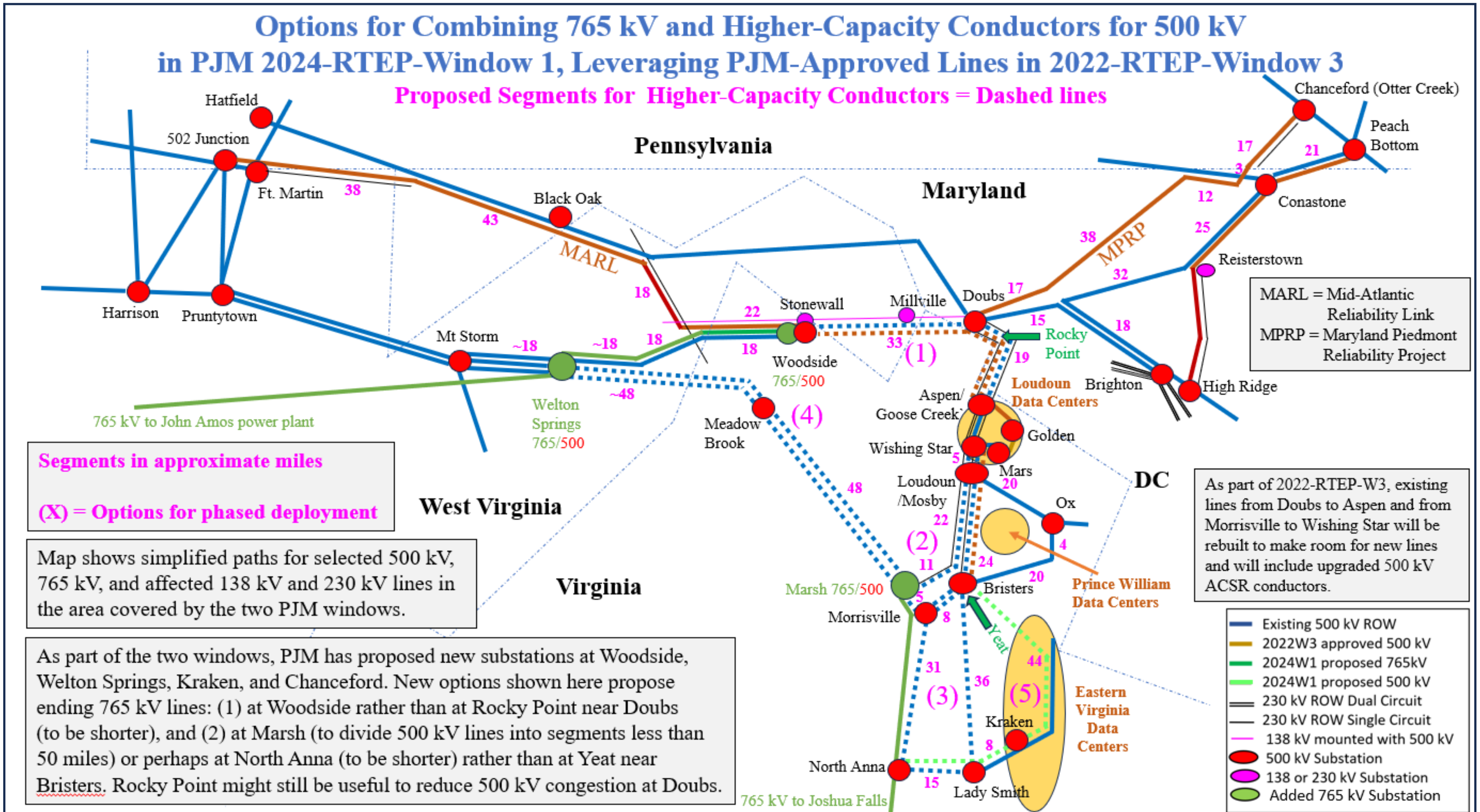

FIGURE 1: A notional electric power architecture, drawn roughly to scale, illustrating how higher-capacity conductors (dashed lines) on existing 500 kV lines (blue) or those planned under 2022-RTEP-Window 3 (brown)—in combination with parts of 765 kV transmission lines proposed under 2024-RTEP-Window 1 (green)—could bring more power to data centers across Virginia in four phases, with greater reliability and reduced impact on adjacent communities than the current incremental approach. A fifth option could be to use higher-capacity conductors for a new 500 kV line proposed under 2024-RTEP-Window 1 (light green), running east from North Anna and then up through the eastern data center concentration up to Bristers, creating a second loop. Higher-capacity conductors also could help reinforce the grid during the work for other planned line upgrades.