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Climate Resilience Planning and TVA

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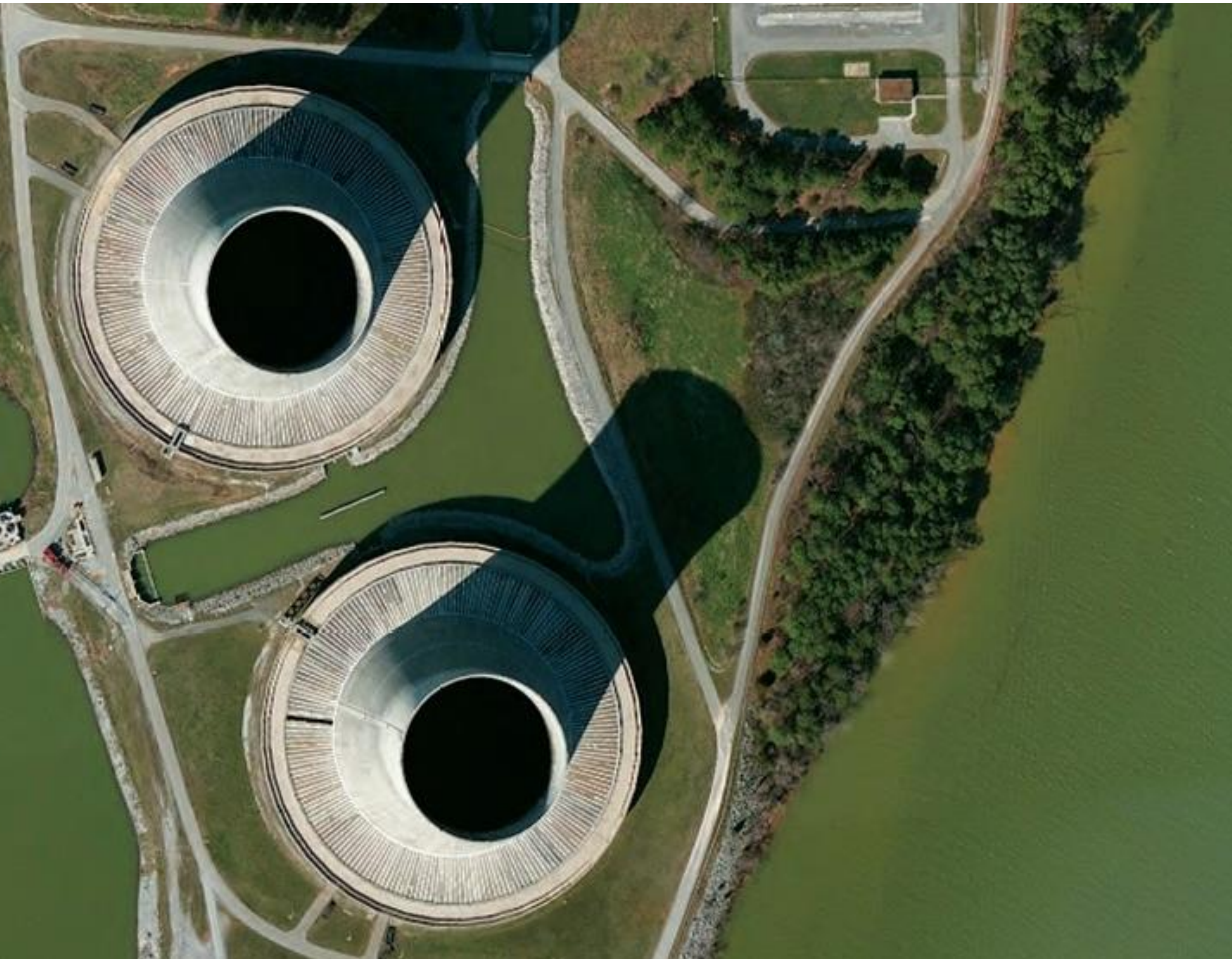

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Introduction

On December 23 and 24, 2022, Winter Storm Elliot led to rolling blackouts across Tennessee, darkening businesses and homes for fifteen-minute intervals to lower electricity demand.[1] Although grid operators had advanced notice of Winter Storm Elliott, the sustained single-digit temperatures exceeded expectations and caught the electric grid off guard.[2] Not all equipment could withstand the extreme conditions. The frigid temperatures undermined production capabilities of 38 of the Tennessee Valley Authority's (TVA) 232 generating units, just as electricity demand peaked across the region.[3] This combination of high demand and lower generating capacity pushed TVA to instruct the region's local power companies to curtail their electricity demand by 5% on December 23 and by 10% for more than five hours on Christmas Eve, effectively requiring most utilities to use rolling blackouts.[4]

Severe weather events like Winter Storm Elliott make the need for a resilient electricity system apparent.[5] A resilient system is one capable of withstanding and recovering from extreme conditions, and utilities and regulators are increasingly focused on how to improve electricity resilience planning given the realities of climate change.[6] Scientists expect more extreme and frequent severe weather events that may, like Winter Storm Elliott, create power disruptions.[7] In TVA territory, Chattanooga's experience during Elliott is a concrete example of the value of resilience measures to the electric system. The city's local power company avoided rolling blackouts on December 23—although not those on December 24—through its earlier investment in resilience measures like battery storage.[8]

This paper delves into the governance of electric-system climate resilience planning in the TVA region, using TVA as a case study to highlight the challenges of preparing the electric grid effectively for climate change. This exploration of resilience planning and governance in the

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1 *See, e.g.*, Kelly Broderick, *TVA Reports Impact of Winter Storm Elliott Totaled Around $170 Million*, NEWSCHANNEL 5 NASHVILLE (May 5, 2023, 7:09 p.m. CT), https://perma.cc/RX97-6PQG (noting the presence of rolling blackouts); Hope McAlee, *TVA Ends Rolling Blackouts Across East Tennessee*, WATE 6 (Dec. 24, 2022, 12:21 p.m. ET), https://perma.cc/4BKM-6FHF (noting the fifteen minute interval for several impacted local power companies). This was the first time TVA had required local power companies to reduce their demand to maintain system stability. TENN. VALLEY AUTH., WINTER STORM ELLIOTT AFTER-ACTION REPORT 11 (2023) [hereinafter AFTER-ACTION REPORT], https://perma.cc/4UC3-YUWJ.

2 AFTER-ACTION REPORT, *supra* note 1, at 8, 10.

3 *Id.* at 10.

4 *Id.* at 12–13; *TVA Accepts Responsibility, Starts Full Review*, TENN. VALLEY AUTH. (Dec. 28, 2022), https://perma.cc/9B3F-YNFK.

5 *See, e.g.*, AFTER-ACTION REPORT, *supra* note 1, at 20–21 (listing potential improvements in the wake of Winter Storm Elliott, including several efforts to promote "site resiliency").

6 *See, e.g.*, Sara R. Gosman, *Framing Energy Resilience*, 35 J. LAND USE & ENV'T L. 1, 5–6, 18 (2019).

7 *See* Craig D. Zamuda et al., *Energy Supply, Delivery, and Demand*, *in* U.S. GLOB. CHANGE RSCH. PROGRAM, FIFTH NATIONAL CLIMATE ASSESSMENT 5-4–5-5 (2023).

8 *See* CAROLINE COX & VICTORIA SCHMIT, MICROGRIDS: LEGAL OPPORTUNITIES & BARRIERS IN TENNESSEE at 2 & n.14.

region begins with an overview of resilience and its role in the electric grid. The paper then delves into the regulatory environment, best practices, and case studies from other electric utilities. The focus then shifts to TVA, detailing its resilience planning processes and comparing them against best practices and those of other utilities. Finally, the paper offers recommendations for policies that TVA and relevant regulators could implement to improve climate resilience planning processes and grid resilience.

I. Resilience and the Electric System

In recent years, scholars and regulators alike have emphasized the importance of resilience to the proper functioning of the electric grid.[9] But "resilience" is a slippery term.[10] At its most basic, resilience describes a system's ability to absorb change while maintaining continuity.[11] Professor Robert L. Fischman has explained resilience in systems like the electric grid through an analogy to riding a bicycle.[12] Two steady states exist for a person on a bicycle in this scenario: moving forward or stationary on the ground. Picture the person in the moving forward steady state. If the rider hits a bump and the rider is able to continue moving forward, the human-bike system was resilient. But if the bump leads the rider and bike to fall, then the system was not sufficiently resilient.[13]

Given resilience's broad applications and its particular relevance to climate change, it is no surprise that resilience is a major concern for the electric grid.[14] Like the human-bike system, the electric grid has two states: providing a consistent flow of electricity (akin to the bicycle's forward motion), or not providing electricity (akin to the bicycle falling over). Resilience, in the electric grid context, gauges the electricity system's ability to absorb disruptions—like winter storms, fires, and tornados—and continue providing electricity.[15]

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9 *See, e.g.*, NAT'L ACADS. OF SCIS., ENG'G & MED., ENHANCING THE RESILIENCE OF THE NATION'S ELECTRICITY SYSTEM 1 (2017) [hereinafter NAT'L ACADS. OF SCIS.]; Jim Rossi & Michael Panfil, *Climate Resilience and Private Law's Duty to Adapt*, 100 N.C. L. REV. 1135, 1156 (2022); Romany M. Webb et. al., *Climate Risk in the Electricity Sector: Legal Obligations to Advance Climate Resilience Planning by Electric Utilities*, 51 ENV'T L. 577, 581 (2021).

10 *See* Stephanie Phillips, Note, *Federal Regulation for a "Resilient" Electricity Grid*, 46 ECOLOGY L.Q. 415, 421 (2019).

11 *See, e.g.*, HENRY H. WILLIS & KATHLEEN LOA, RAND CORP., MEASURING THE RESILIENCE OF ENERGY DISTRIBUTION SYSTEMS 3–4 (2015); Jonathan Schneider & Jonathan Trotta, *What We Talk About When We Talk About Resilience*, 39 ENERGY L.J. 353, 359–60 (2018).

12 *See* Robert L. Fischman, *Letting Go of Stability: Resilience and Environmental Law*, 94 IND. L.J 689, 691 (2019) (citing Kerry Krutilla & Rafael Reuveny, *The Systems Dynamics of Endogenous Population Growth in a Renewable Resource-Based Growth Model*, 56 ECOLOGICAL ECON. 256 (2006); Kerry Krutilla & Rafael Reuveny, *The Quality of Life in the Dynamics of Economic Development*, 7 ENV'T & DEV. ECON. 23 (2002)).

13 *Id.*

14 *See e.g.,* NAT'L ACADS. OF SCIS., *supra* note 9, at 45.

15 *See* Schneider & Trotta, *supra* note 11, at 359; *see also* Webb et. al., *supra* note 9, at 581 (arguing that utilities must plan for climate risks, a process the article terms "climate resilience planning").

A. The Need for Electric System Resilience

The growing frequency of extreme weather and disasters threatening the electricity system has elevated resilience as a critical concern for electric utilities, regulators, and customers alike. The economic implications for utilities are significant, with the aftermath of climate change disasters making utilities responsible for ever-rising costs. [16] For instance, a Vermont utility reported in 2023 that it had seen a drastic rise in costs related to extreme weather responses in recent years,[17] and an electric utility in Maine spent more than twelve times its budget for storm response in 2022.[18] Similarly, electric utilities in Florida, Texas, and California—just to name a few prominent examples—have faced substantial and costly damage from climate-change related events over the past few years.[19]

Winter Storm Elliott was a potent illustration of the need for electric-system resilience in the TVA region. Following the storm, TVA released a report outlining its preparations for the storm, what caused the energy shortfalls, and a series of recommendations for future improvement.[20] The report revealed several contributing factors to the strained electric system. TVA's forecasted demand was inaccurate, as the predicted demand was far lower than actual demand.[21] Additionally, about 20% of TVA's generation capacity was inoperable during the storm, largely due

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16 *See, e.g.*, Zamuda et al., *supra* note 7, at 5-6 (noting that extreme weather exacerbated by climate change is likely to cause higher annual infrastructure expenditures and that "[a]dditional costs for power interruptions could reach $4.7 to $8.3 billion per year by 2090 (in 2022 dollars)"). The economic benefits of enhancing grid resilience in the face of a changing climate is not a new phenomenon for grid planners. *See* EXEC. OFF. OF THE PRESIDENT, ECONOMIC BENEFITS OF INCREASING ELECTRIC GRID RESILIENCE TO WEATHER OUTAGES 3 (2013), https://perma.cc/N2BX-ANQ5.

17 *See* Ivan Penn, *Vermont Utility Plans to End Outages by Giving Customers Batteries*, N.Y. TIMES (Oct. 9, 2023), https://perma.cc/FDY3-R7M4 ("[The utility] spent about $55 million on storm recovery this year. It spent an average of less than $10 million a year after storms between 2015 and 2022."); Order Granting in Part the Petition of Green Mountain Power Corporation for Approval of the Zero Outages Initiative, Vt. Pub. Util. Comm'n, Case No. 23-3501-PET (Oct. 18, 2024), at 6–8.

18 *See* Raquel Ciampi & Norah Hogan, *CMP Calls Public Advocate's Claims on Excessive Spending to Restore Power During Storms 'Outrageous*,*'* WMTW 8 (Sept. 6, 2023, 10:33 p.m. ET), https://perma.cc/MEN9-TGEL.

19 *See, e.g.*, *2023-2024 Wildfire Related Cost Increases of California's Three Major Investor-Owned Electric Utilities* CAL. PUB. ADVOCS. OFF. (June 14, 2024), https://perma.cc/TPJ3-P4EM; Jason Fargo, *After String of Hurricanes, Duke Seeks to Bill Florida Customers $1.1 Billion for Recovery,* S&P GLOB. (Dec. 30, 2024), https://perma.cc/JRF4-C5HJ; Adam Zuvanich, *Houston-Area Customers Will Cover CenterPoint's $100 Million-Plus Power Restoration Costs After Deadly Storm*, HOUS. PUB. MEDIA (May 24, 2024, 4:43 p.m. ET), https://perma.cc/N9AH-EN2A; Jennifer Hiller, *Utility Bills Rise as Americans Pay Off Storm-Recovery Costs for Decades to Come*, WALL ST. J. (Dec. 11, 2022, 8:00 a.m. ET), https://perma.cc/384B-GV8Z.

20 AFTER ACTION REPORT, *supra* note 1, at 10–11, 18–19.

21 *Id.* at 12.

to the extreme temperatures.[22] Shortcomings in TVA's system for communicating with its customers and the public further exacerbated these problems.[23]

In addition to the impact of severe weather on individuals and utilities, a resilient grid is necessary to combat more far-reaching threats. The Department of Homeland Security, for example, recognizes sixteen critical sectors of infrastructure within the United States that are so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof."[24] Central to each sector is a functioning energy system.[25] Therefore, a resilient grid is necessary to protect national interests as well.

Taken together, these observations make clear that there is a need for, and room for improvement in, electric grid resilience, particularly within TVA's service territory. Electric utilities can improve the grid's ability to withstand and bounce back from severe events, as well as the resilience of interrelated critical sectors, in part by improving the resilience planning processes to accurately assess risks and adopt targeted risk reduction measures. The efficacy of those planning processes is, in turn, dependent on governance.

B. Resilience and Reliability

Regardless of current recognition of its importance, resilience has traditionally taken a back seat to another concept for electricity providers: reliability.[26] Reliability is about maintaining consistent service or "keeping the lights on" such that that when customers flip their light switches, a light turns on.[27] Reliability includes the ability to deliver this consistent power "even in the face of instability, uncontrolled events, cascading failures, or unanticipated loss of system components."[28] Regulators measure reliability with two metrics: the System Average Interruption

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22 *Id.* at 12. TVA reported that "38 of TVA's 232 generating units were negatively impacted, mostly due to instrumentation that froze." *Id.* at 10.

23 *Id.* at 18.

24 *Critical Infrastructure Sectors*, U.S. DEP'T OF HOMELAND SEC., CYBERSECURITY & INFRASTRUCTURE SEC. AGENCY, https://perma.cc/Z2S7-E49D (last visited Feb. 5, 2025) (listing the sixteen critical infrastructure sectors); *see also* TENN. VALLEY AUTH., CLIMATE CHANGE ADAPTATION AND RESILIENCY PLAN 2020 UPDATE 7 (2020), https://perma.cc/TS24-34WM [hereinafter TVA 2020 ADAPTATION PLAN] (noting the "interdependencies between the grid and [many] infrastructures" that are "highly dependent upon electricity").

25 *Energy Sector*, U.S. DEP'T OF HOMELAND SEC., CYBERSECURITY & INFRASTRUCTURE SEC. AGENCY, https://perma.cc/533F-AJLK (last visited Feb. 11, 2025).

26 *See* ROGER J. CAMPBELL, CONG. RSCH. SERV., IN10895, ELECTRIC RELIABILITY AND POWER SYSTEM RESILIENCE 1–2 (May 2, 2018) [hereinafter CRS Report] (discussing FERC's federal authority to regulate reliability but noting that federal low does not require resilience measures).

27 *Keeping the Lights On: Essential Reliability Services*, DEP'T OF ENERGY, OFF. OF ENERGY EFFICIENCY & RENEWABLE ENERGY (Sept. 13, 2018), https://perma.cc/P5MD-ZGAV.

28 *Energy Reliability & Resilience*, U.S. DEP'T OF ENERGY, https://perma.cc/28X5-LZ8B (last visited Feb. 12, 2025).

Duration Index (SAIDI) and the System Average Interruption Frequency Index (SAIFI).[29] As the difference in their names suggests, SAIDI measures *how long* customers are left without power, while SAIFI measures *how often* customers are left without power.[30]

Resilience and reliability share many of the same characteristics, but resilience is not wholly contained within reliability.[31] Resilience focuses more on "high-impact, low probability disruptions," whereas reliability measures the ability of the electric system to deal with "high probability, low-impact disruptions."[32] Utilities also evaluate climate resilience on a longer timescale.[33] The high-impact low-frequency events of concern for resiliency have a longer duration, broader geographic reach, and the potential for broader, cascading economic consequences.[34] Most importantly, there is no analogue for the widely used reliability metrics, at least at present, "there are no commonly used metrics for measuring grid resilience."[35]

C. Regulation of Resilience in the Electric System

The lack of agreed upon metrics for resilience mirrors the uncertainty about where regulatory authority over resilience lies. At the national level, both the Federal Energy Regulatory Commission (FERC) and the North American Electric Reliability Corporation (NERC) regulate electric *reliability* in the United States,[36] albeit differently. FERC's authority is primarily over generation and transmission systems.[37] Among its duties, the federal agency approves and enforces reliability standards, giving the public opportunities for public comment and issuing final rules on grid reliability.[38] NERC, on the other hand, is not a federal agency but an international, nonprofit corporation that serves most of the United States, Canada, and a small portion of northern Mexico.[39] NERC drafts reliability standards, which FERC then "reviews, approves, and

29 *U.S. Power Customers Experienced an Average of Nearly Five Hours of Interruptions in 2019*, U.S. ENERGY INFO. ADMIN.: TODAY IN ENERGY (Nov. 6, 2020), https://perma.cc/T27K-GGDB.

30 *Id.*

31 NAT'L ACADS. OF SCIS., *supra* note 9, at 9–10; CRS Report, *supra* note 26, at 1 ("While electric system reliability and system resiliency are related, they differ both in scope and regulatory requirement.").

32 TENN. VALLEY AUTH., CLIMATE ACTION ADAPTATION AND RESILIENCY PLAN 8 (Aug. 16, 2021), https://perma.cc/Q335-XENQ.

33 *Id.* at 9.

34 CAITLIN MURPHY ET AL., NAT'L RENEWABLE ENERGY LAB., ADAPTING EXISTING ENERGY PLANNING, SIMULATION, AND OPERATIONAL MODELS FOR RESILIENCE ANALYSIS 2 (Feb. 2020) [hereinafter NREL, ADAPTING EXISTING ENERGY PLANNING], https://perma.cc/3V2G-ZKFZ.

35 CRS Report, *supra* note 26, at 2.

36 ALISON SILVERSTEIN ET AL., GRID STRATEGIES LLC, A CUSTOMER-FOCUSED FRAMEWORK FOR ELECTRIC SYSTEM RESILIENCE (2018), https://perma.cc/8PVS-B572 (noting that "FERC and NERC have been regulating both reliability and resilience under that same [reliability] umbrella.").

37 *Reliability Explainer*, FED. ENERGY REG. COMM'N (Aug. 16, 2023), https://perma.cc/NM95-X5T6.

38 *Id.*

39 *About NERC*, N. AM. ELEC. RELIABILITY CORP., https://perma.cc/CCT7-Q6BH (last visited Feb. 4, 2025).

enforces," subject to FERC's oversight within the continental United States.[40] But while FERC and NERC have clear authority with respect to reliability, there is no corresponding regulatory body with a similar directive for resilience.[41] FERC and NERC may regulate some aspects of resilience through the overlap between resilience and reliability,[42] but neither has taken definitive steps to set standards for resilience.

In 2021, FERC terminated a rulemaking that would have further prioritized resilience as part of its reliability requirements for Regional Transmission Organizations and Independent Service Operators.[43] Although FERC recognized the importance of resilience, the termination order explained that FERC determined that resilience is best addressed at the regional level, rather than by national standards.[44] Some stakeholders involved in the proceedings articulated a similar view, arguing that a regional and cross-regional approach is valuable because it allows engagement of local stakeholders and tailoring to region-specific hazards.[45] Despite this decision, FERC later adopted a rule instructing electric transmission providers to conduct and file one-time reports on their vulnerabilities to extreme weather.[46]

FERC's authority to regulate electric system resilience is also subject to two important limitations. First, FERC lacks the legal authority to require direct reliability investment in the grid.[47] By statute, FERC is instructed that reliability standards may not include enlarging or constructing additional generation or transmission capacity.[48] Therefore, to the extent resilience efforts will require a significant investment in grid infrastructure—such as undergrounding existing transmission lines or investing in microgrids or other distributed generation capacity—FERC is not the appropriate regulator.

Second, neither FERC nor NERC have authority to prioritize resilience of distribution utilities' infrastructure.[49] Many resilience measures, such as microgrids and distributed generation, will

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40 *Id.*; *Reliability Explainer*, supra note 37.

41 *See* Schneider & Trotta, *supra* note 11, at 359–60.

42 *See* Order Terminating Rulemaking Proceeding, Initiating New Proceeding, and Establishing Additional Procedures, Grid Reliability and Resilience Pricing, 162 FERC ¶ 61,012, at P 12 (Jan. 8, 2018) ("The Commission has taken action to address reliability and other issues with regard to the bulk power system that have helped with the bulk power system's resilience, even though we may not have used that particular term.").

43 Order Terminating Proceeding, Grid Resilience in Regional Transmission Organizations and Independent System Operators, 174 FERC ¶ 61,111, at PP 1, 3 (Feb. 18, 2021).

44 *Id.* at P 5. FERC also hinted at its jurisdictional limitations, finding a regional resilience approach will be "both effective—for the grid and the region—consistent with [FERC's] statutory authority . . . ." *Id.*

45 Comments of Public Interest Organizations, Grid Resilience in Regional Transmission Organizations and Independent System Operators, FERC Docket No. AD18-7-000, at 3 (May 9, 2018), https://perma.cc/B42J-B57T (discussing the importance of policies that enhance "the work already being done at the regional level").

46 One-Time Informational Reports on Extreme Weather Vulnerability Assessments, Climate Change, Extreme Weather, and Electric System Reliability, 88 Fed. Reg. 41,477 (June 27, 2023) (codified at 18 C.F.R. pt. 141).

47 *See* Schneider & Trotta, *supra* note 11, at 364.

48 *Id.* (citing 16 U.S.C. § 824o(a)(3), (i)(2)).

49 *See id.* at 359–60, 364.

require infrastructure construction at the distribution level, which falls outside of FERC's jurisdiction over interstate transmission and bulk generation.[50] Even if FERC focused on resilience within its jurisdictional bounds, the resulting regulation would not address the greatest threats to the electricity system. For example, the now-terminated FERC rulemaking centered on resilience of electricity generation, but nearly all failures of electric service are due to transmission or distribution.[51]

State regulation of resilience has, to date, been uneven across the United States. A Berkeley National Laboratory report found that as of June 2024, fourteen states had mandated some form of resilience planning for regulated utilities.[52] For example, the California Public Utilities Commission (CPUC) and California Energy Commission created a working group in 2015 to support utility efforts to develop climate vulnerability plans, and in 2020 the CPUC announced that investor-owned utilities must submit climate vulnerability assessments in their regular rate case filings.[53] In 2022, New York State enacted a law requiring electric corporations operating in the state to assess their climate vulnerability and develop resilience plans.[54] Even where state regulators have not expressly required resilience planning, state public utilities laws may oblige regulated utilities to plan for climate risks.[55] Some scholars have, for instance, argued that advocates could advance resilience through intervention in public utilities' ratemaking proceedings.[56] Changes to state law and state regulator-led initiatives have, however, been the primary vehicle for public utilities to consider and plan for climate change impacts.[57]

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50 *Id.* at 364.

51 *See* Comments of Americans for a Clean Energy Grid, FERC Docket No. AD18-7-000, at 4 (May 1, 2018), https://perma.cc/J859-LSSQ ("From 2012 to 2016, disruptions to the electrical grid caused 96 percent of electrical outages in the U.S., whereas generation inadequacy caused only 0.865 percent of grid disruptions . . . ." (citing Trevor Houser et al., *The Real Electricity Reliability Crisis*, RHODIUM GRP. (Oct. 3, 2017), https://perma.cc/7J92-ARZE; NAT'L ACADS. OF SCIS., *supra* note 9, at 1)).

52 JOSH SCHELLENBERG & LISA SCHWARTZ, BERKELEY NAT'L LAB., GRID RESILIENCE PLANS: STATE REQUIREMENTS, UTILITY PRACTICES, AND UTILITY PLAN TEMPLATE 1 (July 2024), https://perma.cc/5EMX-NXA2 [hereinafter GRID RESILIENCE PLANS].

53 Webb et. al., *supra* note 9, at 599, 601; *see also* GRID RESILIENCE PLANS, *supra* note 52, at 9 (listing state-level resilience planning requirements for regulated utilities as of June 2024).

54 N.Y. PUB. SERV. LAW § 66(29) (McKinney 2022).

55 *See* Webb et. al., *supra* note 9, at 581.

56 *See id.* at 608.

57 *See* GRID RESILIENCE PLANS, *supra* note 52, at 9; *see also* Webb, *supra* note 9, at 596 (explaining why the uncertainty about whether electric utilities can recover costs for climate resilience planning and investment may discourage some electric utilities from engaging in such planning).

D. Measuring Electric System Resilience

Despite the uncertainty about regulatory authority over electric system resilience, both researchers[58] and utilities[59] widely recognize its importance. Scholars,[60] policymakers,[61] and regulators[62] have coalesced around a broad definition that recognizes a resilient electric system as one capable of bouncing back after external disruptions. As the North American Transmission Forum has put it, resilience refers to "[t]he ability of the system and its components (both equipment and human) to prepare for, anticipate, absorb, adapt to, and recover from non-routine disruptions, including high impact-low frequency (HILF) events, in a reasonable amount of time."[63] But there are few widely accepted metrics for resilience.[64] In the absence of such metrics, utilities and regulators often find it difficult to operationalize the existing broad resilience definitions. This section discusses some of the major approaches to measuring resilience that have emerged in the last decade.

One approach to measuring resilience is to focus on the electric system's critical functions, systems, hazards, and failure points. The CPUC used this approach in its microgrid rulemaking,

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58 *See, e.g.*, J.D. TAFT, PAC. N.W. NAT'L LAB., PNNL-26623, ELECTRIC GRID RESILIENCE AND RELIABILITY FOR GRID ARCHITECTURE 1, 7 (Mar. 2018) https://perma.cc/HW3C-9TWZ (defining "grid resilience as an intrinsic grid characteristic comprised of stress resistance and strain compensation elements" and explaining that resilience is recognized as "a key electric power grid characteristic" in a report prepared for the U.S. Department of Energy); NAT'L ACAD. OF SCIS., *supra* note 9, at 9.

59 Many of the largest American utilities tout the importance of resilience on their websites. *See e.g., Reliability, Resilience, and Affordability*, SOUTHERN CO., https://perma.cc/SXE5-58DK (last visited Feb. 6, 2025); *Working to Bring Exelon Customers the Benefits of Latest Federal Investments in Tomorrow's Cleaner, More Resilient Grid*, EXELON (Oct. 19, 2023), https://perma.cc/QU38-BMXR.

60 *See, e.g.*, Rossi & Panfil, *supra* note 9, at 1156; James M. Van Nostrand, *Keeping the Lights on During Superstorm Sandy: Climate Change Adaptation and the Resiliency Benefits of Distributed Generation*, 23 N.Y.U. ENV'T L.J. 92, 112 (2015).

61 *See, e.g.*, FED. EMERGENCY MGMT. AGENCY, U.S. DEP'T OF HOMELAND SEC., CLIMATE ADAPTATION PLANNING: GUIDANCE FOR EMERGENCY MANAGERS 2 (2024), https://perma.cc/3GQM-44YY; *see also* WILSON RICKERSON ET AL., NAT'L ASS'N OF REGUL. UTIL. COMM'RS & NAT'L ASS'N OF STATE ENERGY OFFICIALS, VALUING RESILIENCE FOR MICROGRIDS: CHALLENGES, INNOVATIVE APPROACHES, AND STATE NEEDS 4 (Feb. 2022) (asserting that "resilience encapsulates the system's ability to anticipate, absorb, adapt to, and recover from all threats, including high-impact, low frequency (HILF) disruptions . . . .").

62 Grid Resilience in Regional Transmission Organizations and Independent System Operators, Order Terminating Rulemaking Proceeding, Initiating New Proceeding, and Establishing Additional Procedures, 162 FERC ¶ 61,012 at P 23 (January 8, 2018) (defining resilience as, "[t]he ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event").

63 N. AM. TRANSMISSION F., TRANSMISSION RESILIENCE OVERVIEW (2024), https://perma.cc/KAN5-GWYG (cleaned up); *see also* CLAYTON CLEM, TENN. VALLEY AUTH., APPROACHES TO RESILIENCY AT TVA 3, https://perma.cc/FLC5-UUKS (last visited Feb. 7, 2025) (using the North American Transmission Forum's definition).

64 *See, e.g.*, SANDIA NAT'L LABS., PERFORMANCE METRICS TO EVALUATE UTILITY RESILIENCE INVESTMENTS, SAND2021-5919, at 8 (May 2021), https://perma.cc/EN9E-P9XJ; CRS Report, *supra* note 26, at 2.

which sought to support, among other goals, "protecting the health, safety, and lives of California residents during catastrophic events."[65] As part of this effort, the CPUC's Resiliency and Microgrids Working Group has sought to bolster the definition of resilience by tying it to the grid's critical functions, systems, hazards,[66] and failure points.[67] By focusing on *who* needs power (critical functions), *how* that power arrives (system), *what* threats are present (hazards), and *when* those threats are most likely to negatively impact the system (failure points), CPUC's approach adds content to the concept of resilience beyond its definition.[68]

Additionally, even if national standardization of resilience metrics has not yet been achieved, regulators are finding other ways to consider resilience throughout the United States. At the state level, both New York and California have taken steps to standardize resilience measurements.[69] TVA has also indicated, despite emphasizing the lack of standardized resilience metrics, that it "may be possible to organize the metric identification and development process around a consistent framework."[70]

And although a general, measurable standard for resilience may not yet exist, scholars have proposed various frameworks and metrics for resilience.[71] Some researchers have argued that utilities could measure resilience by breaking the concept into features like "resistance, brittleness, and dependency."[72] Other researchers have pointed out that metrics already exist for particular subsets of electric system resilience.[73] For example, monitoring "asset health" to maintain assets and prevent failures during extreme events can be achieved through traditional

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[65] Order Instituting Rulemaking Regarding Microgrids Pursuant to Senate Bill 1339, Cal. Pub. Utils. Comm'n, Case No. 19-09-009 at 2 (Sept. 19, 2019); *see also Resiliency and Microgrids*, CAL. PUB. UTILS. COMM'N, https://perma.cc/ST94-W5WX (last visited Feb. 7, 2025) (discussing the rulemaking proceeding). For background on microgrids, *see generally* COX & SCHMIT, *supra* note 8, at 4–10.

[66] There may be value to leaving hazards openly defined. *See* ALISON SILVERSTEIN ET AL., GRID STRATEGIES LLC, A CUSTOMER-FOCUSED FRAMEWORK FOR ELECTRIC SYSTEM RESILIENCE 12 (2018), https://perma.cc/672X-HTZN (emphasizing the value of resilience measures being "threat-agnostic.") Such decisions, however, should be made explicit and designed to guard against a range of hazards. *Id.*

[67] *See* CAL. PUB. UTILS. COMM'N, MICROGRIDS PROCEEDING R.19-09-009, VALUE OF RESILIENCY, RESILIENCY STANDARDS: DEFINITIONS AND METRICS at 29–31, 35 (Mar. 21, 2023), https://perma.cc/6WDV-T56P (presentation by Lumen Energy Strategy on climate resilience definitions).

[68] *Id.*; *see also* CAL. PUB. UTILS. COMM'N, RESILIENCY STANDARDS: METRICS at 20 (Sept. 5, 2023), https://perma.cc/63FX-8433 (presentation by Lumen Energy Strategy on resilience metrics).

[69] *See Resilience Metrics and Valuation*, NAT'L RENEWABLE ENERGY LAB. (Jan. 22, 2025), https://perma.cc/R5YV-T7PV (summarizing New York State Energy Research and Development and Authority's work with NREL to identify standards for resilience and common resilience practices); CAL. PUB. UTILS. COMM'N, RESILIENCY STANDARDS: METRICS, *supra* note 68, at 18.

[70] TVA 2020 ADAPTATION PLAN, *supra* note 24, at 29.

[71] *See, e.g.*, NAT'L ACADS. OF SCIS., *supra* note 9, at 32.

[72] *Id.*

[73] TAFT, *supra* note 58, at 7 (finding "well known metrics" for "asset health" and a strong metric for "capacity," but noting metrics are not yet developed for measuring "hardness" or "efficacy").

measures used in the industry.[74] Further, some utilities have benefited from incorporating their own resilience measures tailored to their purposes, even without adoption of that method by utilities more broadly.[75]

California has also taken steps to provide more concrete standards for resilience. In a public information session in September 2023, CPUC provided an updated presentation on resilience standards and metrics.[76] Because CPUC requires utilities to consider resilience in integrated resource planning (IRP),[77] utilities need metrics to analyze their system's resilience.[78] The presentation by Lumen Energy Strategy to the CPUC workgroup asserted that utilities can pair existing metrics such as value of lost load, as well as CPUC's defined resilience criteria, to begin accounting for resilience and the cost-effectiveness of new resilience investments.[79] Utilities should also evaluate characteristics of customers and of likely outages to measure resilience improvements.[80] Relevant customer characteristics include whether they are in a high burden community, a residential or commercial customer, and if their reliance on power is critical.[81] Relevant characteristics of outages include duration, frequency, and geographic reach.[82] Once all these statistics are compiled, based on utilities' internal or publicly accessible information, utilities can make educated decisions on which resilience measures they should prioritize.[83]

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74 *See id.* at 5, 7. Some companies provide risk management services and assess asset health with predictive analytics. *See e.g., Asset Health Index — Driving Asset Maintenance Strategy for Electric Utilities — Cascade Foresight*, DNV, https://perma.cc/SXT8-VGGX (last visited Feb. 7, 2025) (discussing services DNV provides to utilities for assessing the health of assets).

75 NAT'L ACADS. OF SCIS., *supra* note 9, at 32–33 (providing an example of Chicago's utility using customized resilience metrics for their microgrid project). This source also outlines the "immature" metrics proposed prior to 2017 but notes utilities are "arguably more advanced in considering and evaluating resilience than other critical infrastructure sectors." *Id.* at 32.

76 *See* CAL. PUB. UTILS. COMM'N, RESILIENCY STANDARDS: METRICS, *supra* note 68, at 20; *see also Resiliency and Microgrids Events and Materials*, CAL. PUB. UTILS. COMM'N, https://perma.cc/J7CW-QZHS (last visited Feb. 10, 2025) (listing CPUC workshops and information sessions on resiliency and providing links to presentations, recordings, and agendas from those events).

77 The IRP process allows utilities to plan their operations to ensure they are investing in infrastructure and assets that will meet necessary demand while reducing risk of outages. For more on TVA's IRP process, see *infra* Part III.C.

78 CAL. PUB. UTILS. COMM'N, RESILIENCY STANDARDS: METRICS, *supra* note 68, at 13 (citing CAL. PUB. UTILS. CODE § 454.52(a)(1)(G)).

79 *Id.* at 17 (describing existing metrics including the cost of new entry (CONE) and risk spend efficiency (RSE)); *id.* at 18 (providing an equation to measure the net cost of resilience investment); *id.* at 20 (recapping an earlier workshop's discussion of the key elements of resilience, including the critical function or service involved, the systems involved, the key hazards, and known failure points).

80 *Id.* at 32.

81 *Id.* at 31–32.

82 *Id.*

83 *Cf. id.* at 32–41, 49 (using Sonora, California, and Twain Harte, California as case studies in how to evaluate resilience planning options).

The National Renewable Energy Laboratory (NREL)—a Department of Energy sponsored research and development center—has conducted research on quantifying resilience how to incorporate its findings into energy planning models.[84] In a 2023 report funded by the New York State Energy Research and Development Authority, NREL proposes a five-step process to quantifying the cost of disruptions, which is a necessary step in cost-benefit analysis of resilience measures:

1. Identify *hazards*
2. Determine relevant *scenarios*
3. Determine occurrence *frequency* of each scenario
4. Calculate the *impact* of each scenario
5. Quantify the *consequence* of impacts[85]

The report details each step, including examples and sources useful in identifying hazards, scenarios, frequencies, impacts, and consequences.[86] Then, once a utility has completed these steps and compiled the relevant inputs, a series of equations are available to quantify a particular project's resilience value.[87] However, few utilities appear to have expressly put this method into practice.[88]

II. Electric System Climate Resilience Planning Best Practices

Utilities have had resilience on their radar for several years, but in developing planning processes, the electric industry initially experienced growing pains. Fortunately, a rich body of research has since developed which provides a sound framework for grid resilience planning. This section begins by outlining the resilience planning framework and best practices. It then provides an example of effective resilience planning by a utility in New York State, Consolidated Edison.

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84 NREL, ADAPTING EXISTING ENERGY PLANNING, *supra* note 34, at v–vii, 20–26.

85 SEAN ERICSON ET AL., NAT'L RENEWABLE ENERGY LAB., APPLICATIONS OF MEASURING AND VALUING RESILIENCE IN ENERGY SYSTEMS 4 (2023), https://perma.cc/5LGR-3NNL (emphasis in original).

86 *Id.* 5–15.

87 *Id.* at 16–17.

88 The New York State Energy Research and Development Authority (NYSERDA) partnered with NREL on resiliency metric standardization, but as of early 2025 does not have anything on its website suggesting the Authority has operationalized the NREL-identified metrics. *See, e.g.*, *Resilient Energy Systems*, N.Y. STATE ENERGY RSCH. & DEV. AUTH., https://perma.cc/N2CV-YYLX (last visited Feb. 10, 2025) (discussing resilience generally but not using the NREL framework in its overview). NREL's 2023 literature review on the resiliency metric standardization does not include any case studies showing use of the metrics. *See generally* LAURA LEDDY ET AL., NAT'L RENEWABLE ENERGY LAB., MEASURING AND VALUING RESILIENCE: A LITERATURE REVIEW FOR THE POWER SECTOR (2023), https://perma.cc/CTZ5-NPAZ. Thus, it appears these models have not yet been put into practice to guide resilience investment decisions.

Finally, the section concludes with examples of resilience planning outcomes, including common physical grid changes that resilience planning may recommend.

A. The Climate Resilience Planning Framework

According to a 2016 guide by the U.S. Department of Energy (DOE),[89] climate change resilience planning generally includes two primary components: a vulnerability assessment and a resilience plan.[90] The vulnerability assessment involves gathering climate change projections—such as increasing temperatures and extreme weather—and considering how these changes may impact the utility's assets in the future.[91] Based on that vulnerability assessment, the utility then creates a resilience plan that prioritizes cost-effective efforts it can take in response to the identified vulnerabilities, such as relocating assets in likely flood zones or placing transmission lines underground.[92] Resilience planning is also an iterative process.[93] After formulating an initial resilience plan, the utility assesses prior efforts and the success of interventions, before evaluating updated vulnerability assessments and adjusting the plan accordingly.[94]

When conducting vulnerability assessments, utilities should assess individual assets.[95] This requires cataloguing each asset, what category of operations it implicates (i.e., distribution, transmission, generation, or general operations), what function it serves, and the particular risks to which it is vulnerable.[96] For example, utilities should identify all transmission assets and catalogue information, including each asset's location, replacement costs, and information relevant to risks, such as surrounding vegetation or the asset's elevation and flood protections.[97]

After compiling asset information, utilities should begin assessing potential climate impacts. At this stage, utilities should use probabilistic models, accounting for both best- and worst-case scenarios.[98] The data used in models should also be forward-looking, rather than solely historical,

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89 U.S. DEP'T OF ENERGY, CLIMATE CHANGE AND THE ELECTRICITY SECTOR: GUIDE FOR CLIMATE CHANGE RESILIENCE PLANNING (Sept. 2016) [hereinafter DOE PLANNING GUIDE], https://perma.cc/66UD-KXA3.

90 *Id.* at iii.

91 *Id.* at iv.

92 *Id.*; Webb et al., *supra* note 9, at 584.

93 *See* DOE PLANNING GUIDE, *supra* note 89, at 29, 83, 86–89.

94 *Id.* at iv–v.

95 *Id.* at 26–27; *see also* SHERRY STOUT ET AL., NAT'L RENEWABLE ENERGY LAB. & USAID, POWER SECTOR RESILIENCE PLANNING GUIDEBOOK: A SELF-GUIDED REFERENCE FOR PRACTITIONERS 4 (2019) [hereinafter NREL RESILIENCE GUIDEBOOK], https://perma.cc/P3ZN-PXFC (discussing the need to "highlight the assets that will need to be protected under various scenarios").

96 DOE PLANNING GUIDE, *supra* note 89, at 26–27.

97 *Id.* at 26.

98 *Id.* at 17.

to adequately account for climate change.[99] Similarly, the data should be relatively localized.[100] These models should also be implemented in other planning processes, such as least-cost or transmission planning, to ensure all aspects of operations consider relevant climate risks.[101]

After completing the vulnerability assessment, when developing a resilience plan, utilities should weigh the costs and benefits associated with any particular response to ensure resilience measures are economically justifiable.[102] Commentators also suggest supplementing this cost-benefit analysis with avoidance of "maladaptive" measures, which are efforts that increase reliance on fossil fuels and exacerbate the climate impacts to which resilience planning is intended to respond.[103] Therefore, resilience is better served by investing in distributed, renewable energy sources rather than investing in hardening fossil fuel infrastructure.[104] Utilities should also develop flexible adaptation measures to accommodate different futures, given the uncertainty in long-term climate modeling.[105]

Beyond the structure of the planning process, the DOE provides a range of best practices for utilities, three of which are particularly pertinent here. First, engaging the public and stakeholders "should be among a utility's highest priorities in resilience planning."[106] Second, utilities should also assess threats and plan over a lengthy time horizon—up to fifty years—to account for the useful life of any new asset investments.[107] Third, utilities should also consider third-party assets their service relies on, such as reliance on other entities' distribution infrastructure.[108]

The National Climate Resilience Framework released under the Biden Administration offers a series of recommendations for resilience planning, much like those recommended by the DOE Planning Guide.[109] The Framework, however, is intended to extend well beyond the electricity grid, reaching all aspects of the federal government, including the thirty federal agencies—such

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99 *See id.* at 31–32.

100 *Id.* at 18, 31. Different regions of the US face different threats and therefore have distinct vulnerabilities. *See* U.S. DEP'T OF ENERGY, OFF. OF ENERGY POLICY AND SYSTEMS ANALYSIS, A REVIEW OF CLIMATE CHANGE VULNERABILITY ASSESSMENTS: CURRENT PRACTICES AND LESSONS LEARNED FROM DOE'S PARTNERSHIP FOR ENERGY SECTOR CLIMATE RESILIENCE (2016), https://perma.cc/5FNN-7FG5. Overreliance on localized data, however, can increase the risk of systemic bias. DOE PLANNING GUIDE, *supra* note 89, at 18.

101 *Id.* at 63–64, 83.

102 Utilities may also consider "breakeven analysis" or "robust decision making" to capture benefits that are difficult to quantify. *Id.* at 79–80; *see also* Webb et al., *supra* note 9, at 590 (explaining the challenge of doing cost-benefit analyses with respect to climate resilience because the benefits of climate resilience "will depend (at least in part) on future climate outcomes).

103 Webb et al., *supra* note 9, at 584–85.

104 *Id.* at 585.

105 Such measures may also be termed "no regret" strategies. DOE PLANNING GUIDE, *supra* note 89, at 91.

106 *Id.* at 8; *see also* NREL RESILIENCE GUIDEBOOK, *supra* note 95, at 51 (listing engagement with stakeholders as a step in planning for power sector resilience).

107 DOE PLANNING GUIDE, *supra* note 89, at 10.

108 *Id.* at 28–29, 38–39.

109 *See generally* THE WHITE HOUSE, NATIONAL CLIMATE RESILIENCE FRAMEWORK 8 (2023), https://perma.cc/J3H6-V525 [hereinafter NATIONAL CLIMATE RESILIENCE FRAMEWORK].

as TVA—that have current climate adaptation plans.[110] The Framework notes that electric grid resilience can, among other things, "protect Americans during times of extreme temperatures."[111] First, these plans "must be connected to other planning documents and processes."[112] Second, agencies should set tangible goals to measure their progress in key areas.[113] Finally, agencies can and should encourage community engagement in their planning processes.[114]

B. Model Climate Resilience Planning: Con Edison

Con Edison (ConEd), an electric utility serving 3.3 million people in and around New York City,[115] undertook a comprehensive climate assessment in aftermath of Superstorm Sandy.[116] This intensive and lengthy endeavor "is widely regarded as the gold standard for climate resilience planning in the electric utility sector."[117] ConEd's planning, which began with a vulnerability assessment,[118] engaged an array of governmental and private stakeholders and was largely consistent with identified best practices for grid resilience planning.[119]

The study evaluated projected changes in climate through 2080, including effects on precipitation, sea level, extreme weather events, and temperature.[120] Leveraging customized downscaled data and considering realistic worst-case scenarios to reduce uncertainty,[121] ConEd compiled vulnerabilities down to the distribution level. This involved comparing projected climate effects to the utility's current assets, design standards, and operations.[122] ConEd systematically grouped assets based on their commodity type (electric, gas, or steam) and identified the specific hazards that posing threats to each group.[123] For electric assets, the study determined that

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110 *See id.* at 8; *see also Federal Progress, Plans, and Performance*, COUNCIL ON ENV'T QUALITY, OFF. OF THE FED. CHIEF SUSTAINABILITY OFFICER (last visited Feb. 10, 2025), https://perma.cc/85B5-BGV6 (providing links to federal agencies with climate adaptation plans).

111 NATIONAL CLIMATE RESILIENCE FRAMEWORK, *supra* note 109, at 14.

112 *Id.* at 9.

113 *Id.* at 11.

114 *Id.* at 19.

115 CON EDISON, CLIMATE CHANGE VULNERABILITY STUDY 38 (2019), https://perma.cc/J5EM-TBRF [hereinafter CONED 2019 VULNERABILITY STUDY]. While ConEd only provides electric services to 3.3 million people, it serves approximately ten million people when accounting for its steam and gas services. *See About Con Edison*, CON EDISON (last visited Feb. 10, 2025), https://perma.cc/RJ2R-MK47.

116 CONED 2019 VULNERABILITY STUDY, *supra* note 115, at 1.

117 Webb et al., *supra* note 9, at 597.

118 *Id.* at 602–03.

119 *Id.* at 602.

120 *Id.* at 603; CONED 2019 VULNERABILITY STUDY, *supra* note 115, at 19–25.

121 Webb, et al., *supra* note 9, at 603; CONED 2019 VULNERABILITY STUDY, *supra* note 115, at 17–19.

122 Webb, et al., *supra* note 9, at 603; CONED 2019 VULNERABILITY STUDY, *supra* note 115, at 39–45.

123 CONED 2019 VULNERABILITY STUDY, *supra* note 115, at 32–33 (evaluating hazards common to the utility's gas, electric, and steam assets); *id.* at 39–45 (evaluating hazards specific to the utility's electric assets); *id.* at 50–51

changing temperature, sea level rise, precipitation, and extreme weather were the most serious.[124] The study also considered downstream effects of these threats, noting, for example, that salt spread to combat ice accumulation during extreme winter events can “infiltrate the underground distribution system, causing arcing and failure of underground components.”[125]

For each identified threat, the study provided a set of potential measures that ConEd could or would implement. These measures ranged from minor interventions, such as replacing transmission wires to reduce electricity loss due to lines sagging in higher temperatures,[126] to major undertakings like placing critical sections of distribution or transmission lines underground.[127] Collectively, the identified resilience strategies were intended to guide ConEd’s proposed investment of $1 billion in hardening infrastructure against climate change.[128] Although the utility’s plan did not offer details on ConEd’s specific allocation of funds or expected outcomes,[129] the planning process indicates that the vulnerability assessment is a major driver ConEd’s choices on resilience strategies.

In addition to the vulnerability assessment, ConEd has released Climate Change Implementation Plans to “specify a governance structure and a strategy for implementing adaptation options over the next 5, 10, and 20 years.”[130] Although ConEd’s primary resilience effort was the continuation of its $1 billion storm hardening investment, ConEd provided in its Plans a series of additional resilience measures.[131] These include deploying submersible equipment in floodplains, upgrading and weatherproofing transmission substations, and undergrounding high-risk lines.[132]

(focusing on hazards relevant to the utility's gas assets); *id.* at 53–55 (discussing climate hazards to the utility's steam assets).

124 *See id.* at 39–45.

125 *Id.* at 45.

126 *See id.* at 47.

127 *See id.*

128 *Id.* at 1.

129 *See Our Climate Change Resiliency Plan*, CON EDISON (last visited Feb. 10, 2025), https://perma.cc/RM8L-9N6R (stating that the $1 billion investment in projects like tree trimming, hazardous tree removal, and the installation of smart meters has helped ConEd "avoid nearly 1.2 million customer interruptions to date").

130 CONED 2019 VULNERABILITY STUDY, *supra* note 115, at 1. For the resulting plans, see CON EDISON, CON EDISON CLIMATE CHANGE RESILIENCE PLAN (Feb. 2025), https://perma.cc/LBN7-LTMY [hereinafter CON EDISON 2025 CLIMATE CHANGE RESILIENCE PLAN] and Con Edison, Climate Change Implementation Plan, N.Y. State Pub. Serv. Comm'n, Case Nos. 19-E-0065, 19-G-0066 (Dec. 29, 2020), https://perma.cc/PM3K-7ZBM [hereinafter ConEd 2020 Climate Change Plan].

131 CON EDISON 2025 CLIMATE CHANGE RESILIENCE PLAN, *supra* note 130, at 32–47.

132 *Id.* at 39 (outlining the proposed investment in submersible equipment); *id.* at 46–47 (detailing substation enclosure upgrades); *id.* at 41–42 (explaining the proposal for selective undergrounding of high-risk electrical lines).

Consistent with best practices, ConEd has iterated its vulnerability assessment, with an updated document released in 2023.[133] The updated assessment underscores the tangible impact of ConEd's resilience investments, reporting that storm hardening investments had prevented more than one million weather-related outages. The assessment further refines ConEd's understanding of its vulnerabilities by updating climate projections and reassessing the utility's prioritization of resilience measures.[134] Notably, although the updated assessment finds that temperatures will increase more than previously projected, ConEd's prior sea level projections remain accurate.[135] However, the new assessment highlights that these greater-than-anticipated temperature increases will further increase demand in the form of air conditioning, increase the rate of vegetation growth interrupting distribution and transmission lines, and create greater health risks for ConEd employees.[136] An updated resilience plan was filed with NYPSC in 2025, to address the vulnerabilities identified in the 2023 assessment.[137]

ConEd's resilience planning is considered the "gold standard" for several reasons.[138] Most notable is its thoroughness. In its vulnerability assessments, ConEd exhaustively evaluates both the threats that its infrastructure faces and the assets that are implicated by each threat.[139] Additionally, it hews closely to the resilience planning framework put forth by the DOE by independently developing its vulnerability assessment and resilience plan.[140] Finally, the planning process is consistent with best practices in its balanced and effective engagement of subject-matter experts and other stakeholders, use of customized climate projections that draw on cutting-edge climate science, and its prioritization of resilience investments that respond to the identified threats.[141] The ConEd planning process, therefore, serves as a practical supplement to DOE's resilience planning framework, offering a blueprint for utilities to effectively apply DOE's resilience planning principles.

C. Climate Resilience Planning Outcomes

Although assessing resilience remains a challenge, there exists some consensus among electric grid experts on measures that utilities can adopt to enhance it. This section delineates

[133] *See generally* Con Edison, Con Edison Climate Change Vulnerability Study (Sept. 2023), https://perma.cc/9B6D-SV5P [hereinafter ConEd 2023 Vulnerability Study].

[134] *Id.* at 1–2.

[135] *Id.* at 2–3.

[136] *Id.* at 6.

[137] *See id.* at 8; on Edison 2025 Climate Change Resilience Plan, *supra* note 130.

[138] *See* Webb et al., *supra* note 9, at 597.

[139] *See* ConEd 2019 Vulnerability Study, *supra* note 115, at 39–45; *see also* Webb et al., *supra* note 9, at 597 (contrasting the ConEd vulnerability assessment to those conducted by other utilities).

[140] *See supra* nn. 89–108 and accompanying text.

[141] *See* Webb et al., *supra* note 9, at 602–03.

some common examples of resilience measures, emphasizing the indispensable role of an effective resilience planning process in determining the appropriateness of these measures.

One strategy to improve grid resilience is removing vulnerable infrastructure from dangerous areas. An illustrative example is the underground placement of powerlines, which provides these wires insulation against severe weather.[142] Pacific Gas and Electric (PG&E), faced with escalating wildfire risk across California, has embarked on an ambitious ten-thousand-mile undergrounding plan, with over 870 miles completed as of January 2025.[143] However, this undertaking comes at a substantial price tag. PG&E estimates that the project will initially cost $3.3 million per mile.[144] A similar resilience measure is placing grid infrastructure and assets on higher-ground areas that are less vulnerable to flooding or sea level rise. For example, ConEd noted in its 2025 Climate Change Resilience Plan that it will mitigate the risk of flooding to substations "through infrastructure improvements such as raising assets, installing flood barriers, and relocating control rooms."[145]

Another strategy is creating redundancy and distributing energy generation resources more broadly throughout the grid. Microgrids, for example, offer flexibility for customers when primary infrastructure becomes inoperable. Puerto Rico, in the aftermath of Hurricane Maria, incorporated more microgrids in its grid structure.[146] Similarly, energy storage can provide a backup to primary power sources after extreme weather events. Storage projects may range from utility-scale batteries that purchase and store excess power that can be put back on the grid in times of greater demand or outages to smaller batteries placed at homes and businesses that provide back-up power during minor outages.[147] Some utilities have already embraced battery initiatives to bolster resilience. A case in point is Green Mountain Power (GMP), a Vermont public utility facing escalating infrastructure maintenance costs due to the increasing severity and

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[142] *See e.g.,* U.S. DEP'T OF ENERGY, GRID DEPLOYMENT OFF., UNDERGROUNDING TRANSMISSION AND DISTRIBUTION LINES: RESILIENCE INVESTMENT GUIDE 3 (Sept. 2024), https://perma.cc/CSH4-4PX3.

[143] *See* PAC. GAS & ELEC., UNDERGROUNDING: A SAFER, STRONGER AND MORE AFFORDABLE ENERGY FUTURE (Oct. 2024), https://perma.cc/8ASG-KV4V (discussing the ambitions of the project and progress up to October 2024); *Undergrounding and System Upgrades*, PAC. GAS & ELEC., https://perma.cc/86TV-378V (last visited Feb. 10, 2025).

[144] *Permanently Reducing Wildfire Risk: PG&E Hits Significant Milestone as 350 Miles of Trenching Completed on Path Toward 2023 Undergrounding Goal*, PAC. GAS & ELEC. CORP. (Oct. 11, 2023), https://perma.cc/Y5YB-3WJE. PG&E predicts these prices will decreases by about fifteen percent by 2026. *Id.* These costs will pass on to consumers, increasing their bills. Adam Beam, *PG&E's Plan to Bury Power Lines and Prevent Wildfires Faces Opposition Because of High Rates*, AP (Oct. 17, 2023, 7:53 a.m. CT), https://perma.cc/96C2-K3PM.

[145] CON EDISON 2025 CLIMATE CHANGE RESILIENCE PLAN, *supra* note 130, at 37.

[146] *See* Justin Gundlach, *Microgrids and Resilience to Climate-Driven Impacts on Public Health*, 18 HOUS. J. HEALTH L. & POL'Y 77, 126 (2018). These updates, unfortunately, have not stopped Puerto Rico from experiencing major power outages. *See, e.g.*, Luis Ferré-Sadurní et al., *Most of Puerto Rico Is Darkened by New Year's Eve Blackout*, N.Y. TIMES (Dec. 31, 2024), https://perma.cc/W9W9-PL6Y.

[147] TVA is working to incorporate grid-scale storage with a 20 megawatt battery demonstration project. *See* TVA 2021 ADAPTATION PLAN, *supra* note 32, at 15.

frequency of major weather events.[148] In October 2023, GMP sought approval from the Vermont Public Utility Commission for an innovative strategy: providing small-scale and utility-owned battery storage to each of its customers, among other distribution and transmission projects to harden the grid.[149] GMP argued that costs of hardening or undergrounding all of its infrastructure far exceeded the expense of these new battery systems.[150] The commission approved the amendment to the utility's multi-year rate plan that allows for spending $150 million in investments to harden the grid.[151] Although the Commission did not approve the proposed $30 million in spending for residential storage, it indicated that GMP could make a separate tariff filing that offers more evidence, including cost-benefit analysis, for the project.[152]

Effective resilience planning empowers utilities to pinpoint the most serious vulnerabilities and identify the most cost-effective measures for each.[153] ConEd's post-Sandy resilience planning process is once again a helpful example. After identifying the range of hazards climate change poses to its infrastructure and operations,[154] ConEd identified what measures were most effective to remedy the identified threats.[155] This process of discerning threats and identifying cost-effective, targeted responses is the core of resilience planning.

III. Climate Resilience and the Tennessee Valley Authority

Although many utilities are grappling with resilience planning and the challenges that climate change poses to the electric grid, TVA provides a unique example of electric system resilience planning. Created during the Great Depression,[156] TVA is—unlike most public utilities, which are

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148 Petition for Approval of Green Mountain Power's Zero Outages Initiative as a Strategic Opportunity Under Its Multi-Year Regulation Plan, Vt. Pub. Util. Comm'n, Case No. 23-3501-PET ¶¶ 6–7 (Oct. 9, 2023) [hereinafter GMP Petition].

149 *See id.* ¶ 17; Ivan Penn, *Vermont Utility Plans to End Outages by Giving Customers Batteries*, N.Y. Times (Oct. 9, 2023), https://perma.cc/BYB5-4QRX.

150 *See* GMP Petition, *supra* note 148, ¶ 17.

151 Order Granting in Part the Petition of Green Mountain Power Corporation for Approval of the Zero Outages Initiative, Vt. Pub. Util. Comm'n, Case No. 23-3501-PET, at 4 (Oct. 18, 2024).

152 *Id.* at 28–29.

153 *See* DOE Planning Guide, *supra* note 89, at 54–58, 77–84.

154 *See* ConEd Vulnerability Study, *supra* note 115, at 32–45.

155 *See* Con Edison 2025 Climate Change Resilience Plan, *supra* note 130, at 31–47.

156 *See* Tennessee Valley Authority Act of 1933, Pub. L. No. 73-17, 48 Stat. 58 (1933) (codified as amended at 16 U.S.C. §§ 831–831ee).

subject to state regulation—a federal agency[157] and can sue and be sued.[158] The TVA Act provides TVA with a variety of social, ecological, and economic objectives[159] and broad powers to pursue them.[160] Included in these powers is the authority to "produce, distribute, and sell electric power" within its prescribed territory.[161] Today, TVA uses electricity sales and sales of bonds financed by future energy revenues to fund its operations.[162]

TVA exercises significant control over electric infrastructure across a broad swath of the southeast. TVA's footprint includes 10 million people scattered across nearly all of Tennessee and portions of Alabama, Mississippi, Kentucky, Georgia, North Carolina, and Virginia.[163] With a monopoly on electricity generation[164] and transmission in this region,[165] TVA supplies wholesale power to 153 distributors.[166] These local power companies (LPCs)—which include both municipal energy authorities and rural cooperatives—then distribute the power to end consumers.[167]

Many factors illustrate the importance of a resilient TVA grid. In particular, the effects of climate change will exacerbate severe weather events like Winter Storm Elliott in the region.[168]

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[157] *See* U.S. GEN. ACCT. OFF., EMD-82-54, REPORT TO SENATOR JIM SASSER: TENNESSEE VALLEY AUTHORITY—OPTIONS FOR OVERSIGHT (Mar. 19, 1982), https://perma.cc/7KLE-ER5D (outlining means by which Congress can oversee TVA); Mays v. Tenn. Valley Auth., 699 F.Supp.2d 991, 1005–06 (2010). TVA is exempt from state regulatory oversight unless authorized by Congress. Posey v. Tenn. Valley Auth., 93 F.2d 726, 727 (5th Cir. 1937). Absent this authorization, the powers Congress provided to TVA will generally preempt state law or regulation on the same subject. *See* TENN. ATT'Y GEN. OP. 14-20 (2014), https://perma.cc/32BL-K429.

[158] *See Mays*, 699 F.Supp.2d at 1006. TVA's sole stockholder is the United States. Tenn. Valley Auth. v. Hill, 437 U.S. 153, 157 (1978).

[159] 16 U.S.C. § 831 (defining the "purposes" of TVA, including "maintaining and operating [federal] properties," "National defense," "agricultural and industrial development," "improv[ing] navigation in the Tennessee River," and "control[ling] destructive flood waters").

[160] *See* Comment, *The Tennessee Valley Authority Act*, 43 YALE L.J. 815, 818 (1934) ("The Corporation is given generous specific powers and may, in addition thereto, exercise whatever other powers are necessary for the execution of its delegated functions.").

[161] 16 U.S.C. § 831d(l).

[162] *About TVA*, TENN. VALLEY AUTH., https://perma.cc/HV85-7N8T (last visited Feb. 10, 2025); *Investment Opportunities,* TENN. VALLEY AUTH., https://perma.cc/8A4A-PE2G (last visited Feb. 10, 2025) (describing bonds available).

[163] TENN. VALLEY AUTH., ENERGY (2023), https://perma.cc/X9E6-PTM3 (showing a map of TVA's service territory and major generating assets); *About TVA*, *supra* note 162 (stating the number of households TVA serves).

[164] *See* COX & SCHMIT, *supra* note 8, at 13–14.

[165] *See id.* The Federal Energy Regulatory Commission (FERC) may have the discretion to require TVA to provide transmission services to Local Power Companies (LPCs) but has declined to do so as recently as 2021. Athens Utilities Bd. Gibson Elec. Membership Corp. Joe Wheeler Elec. Membership Corp. Volunteer Energy Coop., 177 FERC ¶ 61,021 (2021).

[166] *About TVA*, *supra* note 162.

[167] *Public Power for the Valley*, TENN. VALLEY AUTH., https://perma.cc/7699-3LVE (last visited Feb. 11, 2025). TVA also provides direct power to over 60 large industrial customers and seven federal installations, as well as selling a small portion of excess power to other utilities on the interchange market. *Id.*

[168] *See supra* nn. 1–8 and accompanying text; Rachel Licker, *How Is Climate Change Affecting Winter Storms in the US?*, UNION OF CONCERNED SCIENTISTS: THE EQUATION (Feb. 1, 2023, 2:57 p.m.), https://perma.cc/LZA4-B6WU; *see*

Moreover, the region houses all sixteen critical infrastructure sectors that the Department of Homeland Security has identified as central to national security and economic health. Each of these sectors rely on TVA power and, in turn, resilient grid infrastructure.[169] Finally, some scholars have argued that public utilities may have a legal duty to adapt to the changing climate, which includes adequate and transparent consideration of climate risks in planning for resilience.[170] Assuming judicial recognition, neglecting this duty could expose utilities like TVA to legal liability, emphasizing the urgency of climate-conscious resilience strategies.[171]

A. TVA's Climate Adaptation Planning as Electric System Resilience Planning

TVA's core resilience planning efforts are outlined in its adaptation plans and updates,[172] with the latest resilience measures noted in its 2020 Climate Change Adaptation and Resiliency Plan,[173] 2021 Climate Action Adaptation and Resiliency Plan,[174] 2022 Climate Adaptation Plan Progress Update,[175] and 2024 Climate Adaptation Plan.[176] Given the Trump Administration's revocation of the executive orders requiring these reports, it is unlikely that TVA will continue to produce these formal and public adaptation plans in the next several years. Nevertheless, these plans offer a window into how TVA is approaching electric system resilience.

In its 2020 Plan, TVA suggests, consistent with its participation in the DOE Partnership for Energy Sector Climate Resilience, that it has incorporated the DOE Planning Guide's resilience planning framework into its processes.[177] In several areas, TVA's reports track the Planning Guide's framework closely. For instance, TVA emphasizes in its 2020 Plan the importance of stakeholder engagement and asserts that the company incorporates stakeholder input in developing its

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also Zamuda et al., *supra* note 7, at 5-12 (discussing the challenges the Texas electric system faced during Winter Storm Uri in 2021).

169 *See Critical Infrastructure Sectors*, *supra* note 24 (listing critical infrastructure sectors); TVA 2020 ADAPTATION PLAN, *supra* note 24, at 7 (noting these sectors' reliance on TVA power).

170 *See* Rossi & Panfil, *supra* note 9, at 1206–08.

171 *See id.*

172 *See Federal Sustainability Plans and Performance*, TENN. VALLEY AUTH., https://perma.cc/9ZZM-SLAH (last visited Feb. 11, 2025) (listing TVA's "Climate Statements & Plans"). TVA's adaptation plans address more than just the resilience of the electricity system. TVA includes plans for its buildings, staff, and duty to protect biological and cultural resources in these reports. *See, e.g.*, TVA 2020 ADAPTATION PLAN, *supra* note 24, at 38.

173 TVA 2020 ADAPTATION PLAN, *supra* note 24.

174 TVA 2021 ADAPTATION PLAN, *supra* note 32.

175 TENN. VALLEY AUTH., CLIMATE ADAPTATION PLAN: 2022 PROGRESS UPDATE (2022), https://perma.cc/VU8L-4YGK [hereinafter TVA 2022 PLAN UPDATE].

176 TENN. VALLEY AUTH., CLIMATE ADAPTATION PLAN (2024), https://perma.cc/FTU7-R7LE [hereinafter TVA 2024 ADAPTATION PLAN].

177 TVA 2020 ADAPTATION PLAN, *supra* note 24, at 4–6; TVA 2021 ADAPTATION PLAN, *supra* note 32, at 20.

resilience efforts.[178] Details about how TVA gets stakeholder engagement, the weight TVA gives stakeholder feedback, or changes that TVA has made based on stakeholder input, however, is not included in the reports. TVA also follows the DOE's recommendations on using data to identify vulnerabilities, with TVA noting that it has downscaled data "specifically tailored to [its] assets and service territory."[179] For example, TVA developed its risk assessment in its 2024 plan using the White House Council on Environmental Quality's Federal Climate Mapping for Resilience and Adaptation Application.[180] TVA plans also incorporate projected increases in temperature—leading to greater use of air conditioning—into its demand forecast.[181] According to the reports, TVA also uses the information gathered for its adaptation planning to inform its IRP and transmission planning processes.[182]

TVA's adaptation plans identify various "risks and opportunities,"[183] including increased electricity demand from higher temperatures,[184] decreased transmission capacity due to wildfires,[185] less electric generation at hydropower facilities resulting from drought,[186] energy infrastructure flooding risks,[187] and other challenges from extreme weather.[188] Despite this acknowledgment of climate change challenges, TVA has identified only a handful of substantive resilience measures for its electric system, the most prominent being a battery storage project.[189] Much of TVA's implementation strategy as outlined in its 2024 Adaptation Plan is to incorporate climate risks and risk assessments into other planning and decision making.[190] According to the

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[178] *See* TVA 2020 ADAPTATION PLAN, *supra* note 24, at 2, 4, 29, 33–34, 48; *see also* TVA 2021 ADAPTATION PLAN, *supra* note 32, at 4, 20, 22; TVA 2022 PLAN UPDATE, *supra* note 175, at 5–7.

[179] TVA 2020 ADAPTATION PLAN, *supra* note 24, at 5, 11, 44; *cf.* DOE PLANNING GUIDE, *supra* note 89, at 18 (discussing the use of climate model outputs). *But see* TVA 2022 PLAN UPDATE, *supra* note 175, at 2 ("TVA is working . . . to obtain projected temperature and precipitation data from various global climate models and downscaled them to the Tennessee Valley region."). TVA notes its data "is continuously refined" and IPCC scenarios "inform precipitation, temperature, and load forecasting projections." *Id.* at 7.

[180] TVA 2024 ADAPTATION PLAN, *supra* note 176, at 7.

[181] TVA 2020 ADAPTATION PLAN, *supra* note 24, at 3, 5; TVA 2022 PLAN UPDATE, *supra* note 175, at 4. TVA also incorporated the results of National Climate Assessments into its resilience planning. *See* TVA 2024 ADAPTATION PLAN, *supra* note 176, at 8, 31 (citing U.S. GLOB. CHANGE RSCH. PROGRAM, FIFTH NATIONAL CLIMATE ASSESSMENT (2023) and U.S. GLOB. CHANGE RSCH. PROGRAM, FOURTH NATIONAL CLIMATE ASSESSMENT (2018), respectively).

[182] TVA 2020 ADAPTATION PLAN, *supra* note 24, at 4, 19 (discussing TVA's IRP process); *id.* at 35 (discussing regional transmission planning); TVA 2021 ADAPTATION PLAN, *supra* note 32, at 20.

[183] TVA 2024 ADAPTATION PLAN, *supra* note 176, at 19.

[184] *Id.* at 9.

[185] *Id.* at 14.

[186] *Id.* at 12.

[187] *Id.*

[188] *Id.* at 13; *see also* TVA 2020 ADAPTATION PLAN, *supra* note 24, at 21–25; TVA 2021 ADAPTATION PLAN, *supra* note 32, at 17–20.

[189] TVA 2020 ADAPTATION PLAN, *supra* note 24, at 17; TVA 2021 ADAPTATION PLAN, *supra* note 32, at 15, 19; TVA 2022 PLAN UPDATE, *supra* note 175, at 4.

[190] *See* TVA 2024 ADAPTATION PLAN, *supra* note 176, at 19–22.

2024 Report, a key milestone is the "complet[ion of the] updated Integrated Resource Plan" addressing "[e]xtreme temperatures and precipitation, flooding, drought, wildfire, etc."[191]

B. The GAO Report and TVA's Updated Resilience Planning Efforts

A December 2022 report from the Government Accountability Office (GAO) assesses TVA's management of climate-related risk.[192] The GAO report outlines the various climate change risks that TVA faces, such as rising temperatures, greater precipitation and flooding, drought, and wildfires.[193] The report then reviews TVA's recent efforts in managing this risk.[194] In concluding TVA's efforts so far have been insufficient, the GAO report emphasizes that the TVA's lack of a thorough review of its operations and assets' vulnerabilities to climate change is a significant oversight.[195] In particular, the report notes that "TVA has not conducted an inventory of assets and operations vulnerable to climate change, or identified and prioritized resilience measures to address these climate change vulnerabilities."[196] Although TVA has done a general inventory of operations and assets, the GAO report states that "TVA has not assessed the risks that climate change may pose to all major planning processes or assets," such as the risk of flooding to substations.[197]

GAO concludes with three recommendations to improve TVA's climate change adaptation planning. First, the report urges TVA to conduct a vulnerability assessment addressing the likelihood and degree of damage due to climate change.[198] Second, the report recommends that TVA use that vulnerability assessment to develop a resilience plan outlining measures taken in response to the identified vulnerabilities.[199] Third and finally, the report states that TVA should implement a plan to reassess and iterate on the resilience plan and vulnerability assessment.[200] Notably, these three recommendations closely match the framework provided in the DOE Planning Guide, which TVA has ostensibly used in guiding its resilience planning over the last several years.[201]

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191 *Id.* at 25.

192 *See generally* U.S. GOV'T ACCOUNTABILITY OFF., TENNESSEE VALLEY AUTHORITY: ADDITIONAL STEPS ARE NEEDED TO BETTER MANAGE CLIMATE-RELATED RISKS 16 (Dec. 2022), https://perma.cc/KY5W-FMCY [hereinafter GAO REPORT].

193 *Id.* at 9–15.

194 *Id.* at 16–19.

195 *Id.* at 22.

196 *Id.*

197 *Id.* at 23.

198 *Id.*

199 *Id.*

200 *Id.*

201 *See supra* Section II.A.

TVA's initial response to the report was equivocal,[202] but the company has since agreed with the GAO's recommendations.[203] In its updated response in June 2023, TVA informed the GAO that the company had established "a cross-functional team" and would overhaul its resilience and risk management efforts.[204] TVA noted in its revised 2024 Climate Adaptation Plan that it had "formed an internal review team to evaluate existing processes in response to the GAO's findings" and "established priority actions" for improving its climate resiliency.[205]

C. TVA's Other Planning Processes

Although TVA's resilience plans state that it incorporates resilience into its other planning processes, it is not always clear how or to what extent this is true. For example, TVA claims to consider resilience in its transmission planning,[206] but TVA does not publicize its transmission planning process or offer public information on the results of that process. Environmental and other public interest groups have criticized TVA's planning process for its opacity, lack of opportunities for collaboration with other entities, and its exclusion from the IRP process.[207] Because TVA's website does not include public transmission planning documents, it is uncertain to what extent, if any, resilience is considered or promoted through TVA's transmission planning.[208]

TVA has also asserted that its IRP process includes resilience considerations. TVA typically develops an IRP every five years that identifies likely decisions regarding generation sources to meet electricity demand over a twenty-year period.[209] The IRP provides guidance on TVA's

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[202] GAO REPORT, *supra* note 192, at 23 ("In its written comments, TVA neither agreed nor disagreed with [the GAO's] three recommendations.").

[203] *See Tennessee Valley Authority: Additional Steps Are Needed to Better Manage Climate-Related Risks*, U.S. GOV'T ACCOUNTABILITY OFF., https://perma.cc/CZ5C-8856 (last visited Feb. 11, 2025) (documenting TVA responses as of June 2023 to the GAO's recommendations).

[204] *Id.*

[205] TVA 2024 ADAPTATION PLAN, *supra* note 176, at 5.

[206] *See supra* note 182 and accompanying text.

[207] *See, e.g.*, MICHAEL GOGGIN, SIERRA CLUB, INCORPORATING TRANSMISSION INTO TVA'S IRP FOR TRULY "INTEGRATED" RESOURCE PLANNING 1 (2024), https://perma.cc/P2Q7-GAPK; Liam Niemeyer, *Congress Urged to Reform TVA to Improve Transparency, Decision Making*, TENN. LOOKOUT (Feb. 1, 2025, 5:00 a.m.), https://perma.cc/J3JH-YG8V; Maggie Shober & Bryan Jacob, *TVA, Our Nation's Largest "Public" Utility Has the Least Public Planning Process*, S. ALL. FOR CLEAN ENERGY (Feb. 2, 2024), https://perma.cc/A53J-YNRN.

[208] TVA is subject to the Freedom of Information Act (FOIA), which allows the public to request the release of certain internal information, such as transmission planning documentation. *See Freedom of Information Act*, TENN. VALLEY AUTH. (last visited Feb. 11, 2025), https://perma.cc/FBE2-GU6G. FOIA, however, comes with a range of exclusions, including that agencies may restrict access to pre-decisional, deliberative documents. *Id.*

[209] *See* TENN. VALLEY AUTH., DRAFT INTEGRATED RESOURCE PLAN 2025 VOLUME 1 at A-1 (2024), https://perma.cc/9U23-T6JM [hereinafter DRAFT 2025 IRP] ("Between IRP cycles, which is typically every four to five years, TVA annually updates plans based on current forecasts for key assumptions and analyzes sensitivities and stochastics to

decisionmaking for changes to its power system, but it does not dictate specific asset decisions.[210] The IRP process includes public comment and a working group of stakeholders, including representatives of LPCs and public interest groups.[211]

The objective of the plan is to ensure that TVA can provide "adequate and reliable service" at the "lowest system cost."[212] The Sixth Circuit has noted that, in weighing the costs and benefits of decisions, "the term 'costs,' . . . means more than dollars and cents."[213] Namely, the TVA Act's instruction to consider "costs" requires TVA to consider both economic costs and harms to human or environmental health.[214] The TVA Act also requires TVA to consider not only reliability, but also "diversity, . . . dispatchability, *and other factors of risk*."[215] Therefore, resilience is an appropriate consideration in the IRP process under the TVA Act.[216]

TVA has discussed resilience in its IRPs. One of the five strategies included in TVA's 2019 IRP was "promot[ing] resiliency," which incentivized generation sources that were "small" and "agile," in order to minimize short-term disruptions.[217] Similarly, TVA's Draft 2025 IRP—which TVA expects to finalize in spring 2025—notes that its scenario planning focused on "potential paths for providing affordable, reliable, *resilient*, and increasingly cleaner energy into the future."[218] The Draft IRP evaluates six external scenarios that could affect TVA's energy system and five business strategies TVA could employ.[219] The last of these strategies is a "resiliency focus," which would "emphasize[] smaller units and the promotion of storage, along with strategic transmission investment, to drive wider geographic resource distribution and additional resiliency across the system."[220] But neither the 2019 IRP nor the 2025 Draft IRP goes into great deal about the effects (or projected effects) of the investments. Indeed, groups like the Southern Alliance for Clean

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better understand risk."). The TVA Act requires that TVA use a least-cost planning approach when selecting new energy resources. 16 U.S.C. § 831m-1(b)(1).

210 *See* Kentucky Coal Ass'n, Inc. v. Tennessee Valley Auth., 804 F.3d 79, 803 (6th Cir. 2015) (noting the IRP "creates broad strategy alternatives and guidelines," but "does not dictate a specific series of actions") (cleaned up).

211 *See* 16 U.S.C. § 831m-1(d) (requiring TVA to "provide an opportunity for public review and comment" before making final decisions on "a major new energy resource"); *Engagement in the 2025 IRP*, TENN. VALLEY AUTH., https://perma.cc/GP77-K8PN (last visited Feb. 12, 2025) (providing information on the TVA-chosen IRP Working Group, which "is a diverse group of stakeholders," including academics, local power companies, and nongovernmental organizations, who offer feedback on the IRP).

212 16 U.S.C. § 831m-1(b)(1).

213 *Kentucky Coal Ass'n, Inc.*, 804 F.3d at 802.

214 *Id.*

215 16 U.S.C. § 831m-1(b)(2)(A) (emphasis added).

216 *See id.*

217 TENN. VALLEY AUTH., 2019 INTEGRATED RESOURCE PLAN: VOLUME I - FINAL RESOURCE PLAN (2019), https://perma.cc/3CJB-5363 [hereinafter 2019 IRP].

218 DRAFT 2025 IRP, *supra* note 209, at ES-5 (emphasis added).

219 *Id.* at ES-6.

220 *Id.*

Energy have criticized TVA's 2025 Draft IRP for failing to identify a preferred strategy that could alert stakeholders to TVA's likely grid investments in the coming years.[221]

It is also notable that TVA's recent actions, including the outcome of the 2019 IRP, do not necessarily optimize grid resilience. For example, the 2019 IRP prioritizes increased use of natural gas, particularly if TVA's service area experiences significant load growth through increasing population size, demand, and electrification.[222] This is true even if TVA adopted a strategy to promote resilience.[223] Since 2020, TVA has proposed nine gas plants, the total capacity of which far exceeds the proposed capacity for other types of generation.[224] This natural gas buildout is not necessarily the best approach to resilience; during Winter Storm Elliott, the sub-zero temperatures acutely affected natural gas production, leading to TVA's production shortfall.[225] Additionally, because TVA's IRP process excludes consideration of its transmission assets and connected distribution grids, the process does not provide a truly integrated plan for the region's electricity system. The limited scope of the IRP, therefore, makes it difficult for TVA to consider a range of relevant measures that may promote resilience, such as distributed generation and new transmission infrastructure.

TVA has also contractually constrained the ability of LPCs to promote resiliency through distributed generation.[226] TVA rolled out its revised contracts in August 2019, which the vast majority of its LPCs have signed.[227] TVA may not contract with LPCs for terms longer than twenty years,[228] but these contracts provide for a twenty-year term with automatic annual renewal,

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221 *See, e.g.*, Maggie Shober, *TVA Draft IRP — Exceedingly Broad Planning Is Meaningless*, S. ALL. FOR CLEAN ENERGY (Sept. 23, 2024), https://perma.cc/BRT6-4B7L; DEVI GLICK ET AL., SYNAPSE ENERGY ECONOMICS, INC., REVIEW OF TENNESSEE VALLEY AUTHORITY'S DRAFT 2025 INTEGRATED RESOURCE PLAN 9–10 (Dec. 11, 2024), https://perma.cc/BCL4-YXN7 (offering recommendations for improving the Draft IRP in a report prepared for the Sierra Club). The U.S. Environmental Protection Agency also submitted comments on the TVA's Notice of Intent to create a programmatic environmental impact statement for its latest IRP. *See* U.S. Env't Prot. Agency, EPA Comments on the Tennessee Valley Authority's Notice of Intent (NOI) to develop a Programmatic Environmental Impact Statement for the 2024 Integrated Resource Plan, Tennessee (July 3, 2023). Among its numerous suggestions, the EPA advised "that the IRP consider alternatives that are consistent with TVA's Adaptation Plan" and "how alternatives may exacerbate climate change impacts to surrounding areas." *Id.* at 4.

222 *See* 2019 IRP, *supra* note 217, at 7-4.

223 *Id.*

224 *See* Caroline Eggers, *TVA Plans 9th Gas Plant Since 2020*, 90.3 WPLN News (Sept. 20, 2024), https://perma.cc/NH69-SA83.

225 AFTER ACTION REPORT, *supra* note 1, at 12 (noting that Winter Storm Elliott impacted coal, gas, and independent power production).

226 *See* CAROLINE COX & MADELINE FLYNN, THE TVA EFFECT: CLEAN ENERGY GOALS AND PUBLIC POWER at 9–10, 17 (2023), https://perma.cc/LE7K-H3E2; Daniel Tait & Joe Smyth, *TVA Attempts to Chain Local Power Companies to Longer Contracts in Effort to Prevent Defection Risk*, ENERGY & POL'Y INST. (Sept. 22, 2019), https://perma.cc/P2QQ-2DFN.

227 *TVA Board Adopts Principles of Public Power Flexibility*, TENN. VALLEY AUTH. (Feb. 13, 2020), https://perma.cc/7YJV-9ZPP (stating 135 of the 153 LPCs served by TVA had signed the contracts, termed the "Valley Partner option," as of February 2020).

228 16 U.S.C. § 831i.

meaning that signatory LPCs must provide twenty years' notice to end their contract.[229] TVA's new contracts also provide signatory LPCs with the option to generate up to five percent of their average energy demand through distributed generation within the LPC's service area.[230] While this provision increases an LPCs flexibility with respect to distributed generation, it provides a hard cap on the extent to which LPCs can increase their resilience through new generation sources.

Winter Storm Elliott again shows the extent to which TVA's relationship with the region's local power companies can undermine resilience efforts. Even if an LPC had the full five percent of their demand met by distributed generation, it would not have been sufficient to overcome the demand reduction required by TVA during the storm.[231] Thus, TVA's restriction of LPCs' distributed generation capacity in turn restricts LPCs' ability to improve the resilience of the region's grid.

Recall GMP's effort to institute a battery storage program to enhance the Vermont grid's resilience.[232] While the merits of TVA adopting a similar approach are debatable, TVA's current resilience planning process would not allow for adequate consideration of such an alternative. For example, while TVA identifies extreme weather as a relevant climate threat, the primary response noted in its plans thus far has been the development of a grid-scale battery storage project.[233] TVA's plans do not provide justification for the measure and, most importantly, they do not provide for consideration of alternatives. Therefore, neither unorthodox solutions—such as GMP's approach—nor more traditional approaches—such as undergrounding transmission lines or incentivizing distributed generation—are adequately evaluated as alternative measures to address extreme weather within the TVA fence.

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[229] *See* Zack Hale*, 4 Utilities Target TVA's New Long-Term Contract Program in Complaint with FERC*, S&P GLOB. (Jan. 12, 2021), https://perma.cc/QL8T-3FBW. A subsequent legal challenge to these contracts was unsuccessful. *See* Protect Our Aquifer v. Tenn. Valley Auth., 654 F. Supp. 3d 654, 664 (W.D. Tenn. 2023) (granting TVA's motion for summary judgment based on the conclusion that plaintiffs lacked standing for some claims and the finding that TVA complied with the legal requirements relevant to the remaining claim under the National Environmental Policy Act).

[230] *TVA Adopts Principles of Public Power Flexibility*, *supra* note 227.

[231] *See* AFTER ACTION REPORT, *supra* note 1, at 13 (noting TVA required LPCs to reduce demand by ten percent for more than five hours on December 24, 2022).

[232] *See supra* nn. 148–152 and accompanying text.

[233] *See* TVA 2021 ADAPTATION PLAN, *supra* note 32, at 15, 19. TVA has cited resiliency concerns to justify fossil fuel buildout elsewhere, most notably arguing that resiliency needs justified the proposed combined cycle combustion turbine plant and battery storage energy system in Cheatham County. Tenn. Valley Auth., Cheatham County Generation Site Scoping Report 6–7 (Nov. 2, 2023), https://perma.cc/R9QV-74RL.

D. Governance and Structure: Relation to Planning Practices

The shortcomings of TVA's resilience planning processes may be a result, in part, of the company's governance. State utility commissions and state legislatures have often been leaders in developing resilience frameworks and requirements for public utilities. But as a federal agency, TVA is free from state utilities regulation.[234] FERC has only limited jurisdiction over TVA due to jurisdictional limitations in the Federal Power Act.[235] And Congress scarcely exercises its oversight authority in a meaningful way. Thus, there are few mechanisms for imposing a resilience planning framework on TVA.

To the extent TVA considers resilience, it does not appear to be directly grounded in the TVA Act. But some states have taken measures to codify resilience as a motivating concern for public utilities. For example, in California, CPUC requires utilities to consider resilience in their IRP.[236] Likewise, in New York, a 2022 law provides a statutory mandate for utilities to conduct vulnerability assessments.[237] New York law also requires utilities to submit resilience plans and receive approval from the New York Public Service Commission.[238] Utilities must iterate on the plan at least every five years [239] and consult stakeholders from various fields including consumer and environmental advocates.[240] The law allows utilities to recoup the "prudently incurred" costs of implementing the resilience plans through adjustments to its rates.[241]

Because TVA is rarely subject to state regulation,[242] federal action has driven most of TVA's resilience planning efforts. Specifically, federal executive orders have provided the primary impetus for the incorporation of resilience into TVA's planning practices.[243] For example,

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[234] *See* Order Authorizing Disposition of Jurisdictional Facilities, Quantum Choctaw Power, LLC, 150 FERC ¶ 62,155 at 3 (Mar. 16, 2015) ("[N]either Choctaw nor TVA is subject to rate regulation by any state authorities."),

[235] *See, e.g.*, 16 U.S.C. § 824k(j) (exempting TVA from orders under 211 of the Federal Power Act to provide "transmission services to another entity"). The exact contours of FERC's authority over TVA are subject to debate. *See, e.g.*, Ethan Howland, *FERC Rejects Utilities' Request to Open TVA to Competition*, UTIL. DIVE (Oct. 22, 2021), https://perma.cc/N5G9-FLJL (explaining the different views of FERC Commissioners on whether FERC has the authority to open TVA's transmission system to other utilities).

[236] CAL. PUB. UTILS. CODE § 454.52(a)(1)(G).

[237] *See* N.Y. PUB. SERV. LAW § 66(29)(a) (McKinney) (mandating that each electric utility in the state prepare and submit a climate vulnerability study).

[238] *See id.* § 66(29)(b).

[239] *Id.* § 29(f).

[240] *Id.* § 29(h).

[241] *Id.* § 29(g).

[242] *See* TENN. ATT'Y GEN. OP. 14-20, *supra* note 157, at 4–5 (concluding that state regulation of pole attachments for LPCs is not "clearly preempted by the TVA Act" because TVA has not exercised its discretion in the area and Congress has acted to reserve authority over pole attachment to states).

[243] *See* TVA 2020 ADAPTATION PLAN, *supra* note 24, at 4 ("TVA continues to maintain its *Adaptation and Resiliency Plan* consistent with *Executive Order 13834, Regarding Efficient Operations* . . . ."); 2021 TVA PLAN, *supra* note

President Obama issued Executive Order 13,514 in October 2009, instructing federal agencies to appoint sustainability officers, submit sustainability plans, and emphasize sustainability in their operations. [244] The executive order recommended achieving these goals by, among other things, "increas[ing] the effectiveness of local planning for . . . locally generated renewable energy."[245] Despite not mentioning resilience, this executive order spawned TVA's initial climate adaptation and sustainability plans, with the former planning process now accounting for the bulk of TVA's consideration of resilience.[246]

Although the Obama administration later revoked that executive order—and subsequent administrations issued and revoked a series of executive orders on similar issues[247] — the Biden Administration's executive order on resilience matters, Executive Order 14,057, made resilience planning a priority for federal agencies.[248] But these executive orders were typically aimed at generic resilience rather than grid-specific resilience planning, reducing their potential to spur TVA to action.[249] Nonetheless, TVA cites these executive orders as compelling its recent resilience planning, and federal legislation has not directly mandated TVA resilience planning.

147, at 24 (referencing Executive Order 14,008); 2022 TVA PLAN UPDATE, *supra* note 175, at 7 (referencing Executive Order 14,057). The DOE Planning Guide, the development of which TVA participated in, also states that it was written in response to an executive order. DOE PLANNING GUIDE, *supra* note 89, at ii (referencing Executive Order 13,653).

244 *See* Exec. Order 13,514, 74 Fed. Reg. 52,117, §§ 1–2, 7–8 (Oct. 8, 2009).

245 *Id.* § 2(f)(ii).

246 *See* TENN. VALLEY AUTH., STRATEGIC SUSTAINABILITY PERFORMANCE PLAN: EXECUTIVE ORDER 13514 at 3 (June 2, 2010), https://perma.cc/L73G-P56M (stating that the Plan "addresses key aspects of [TVA's] energy, environmental, economic, and social resources and responsibilities" pursuant to Executive Order 13,514); TENN. VALLEY AUTH., TVA STATEMENT ON CLIMATE CHANGE ADAPTATION at 1 (June 1, 2011), https://perma.cc/JTM9-L3BU (referencing Executive Order 13,514); TENN. VALLEY AUTH., CLIMATE CHANGE ADAPTATION ACTION PLAN: EXECUTIVE ORDER 13514 at 3 (June 29, 2012), https://perma.cc/TQD7-68U2 (noting that the Plan was prepared in conformity with Executive Order 13,514). Subsequent climate adaptation plans, stemming from the 2011 statement and 2012 plan, include most of TVA's resilience planning. *See Federal Sustainability Plans and Performance*, *supra* note 172 (listing plans and reports).

247 President Obama later revoked Executive Order 13,514 through Executive Order 13,693 in March 2015. Exec. Order 13,693, 80 Fed. Reg. 15,871, § 16(b) (Mar. 25, 2015). President Trump subsequently revoked Executive Order 13,693 through Executive Order 13,834. Exec. Order 13,834, 83 Fed. Reg. 23,771, § 8 (May 22, 2018). Two executive orders during the Biden Administration revoked Executive Order 13,834. Exec. Order 13,990, 86 Fed. Reg. 7,037, § 7 (Jan. 25, 2021); Exec. Order 14,057, 86 Fed. Reg. 70,935, § 604 (Dec. 13, 2021). Ending this saga, President Trump revoked both Biden Administration executive orders on his first day in office. Exec. Order 14,154, 90 Fed. Reg. 8,353, § 4 (Jan. 29, 2025).

248 *See* Executive Order 14,057, *supra* note 247, § 503(b) ("The heads of principal agencies shall develop, implement, and update Climate Adaptation and Resilience Plans that build on the agency's plan submitted pursuant to section 211 of Executive Order 14008."). Although TVA is not a principal agency under the Order's definition, the Order "encourage[d]" other agencies to participate. *Id.* § 503(d).

249 *See, e.g.,* Exec. Order 14,008, 86 Fed. Reg. 7,619, § 211(a) (Feb. 1, 2021) (requiring each agency head to submit a draft action plan focusing on climate resilience and outlining "the agency's climate vulnerabilities" but not focusing specifically on energy).

This reliance on executive orders for pushing resilience planning has several flaws. First, executive orders are by their nature "weaker" law than statutes.[250] For example, an agency's noncompliance with an executive order will generally not provide a cause of action for private citizens.[251] That is, if TVA had chosen not to consider resilience at all under applicable executive orders, a customer in the region could not successfully sue TVA and obtain a federal court order mandating resilience planning.[252] Second, executive orders are easily rescinded by the issuing administration or a subsequent administrations.[253] Finally, they are typically aimed toward agencies generally, and therefore are not targeted to the resilience planning framework necessary for an electric utility.[254] In this respect, TVA's voluntary participation in the DOE's Grid Resilience Partnership can be regarded as an effort to improve its resilience planning. However, as illustrated above, TVA's efforts to improve resilience have not been entirely consistent with the recommendations of that program.

The economic realities of TVA's business model may also make it more difficult for the company to embrace certain resilience strategies. For example, the grid may be more resilient if households across the region have distributed generation resources, but the power produced by these assets would result in less power purchased from TVA. Because TVA does not currently receive taxpayer funding, the resulting reduction in revenue would pose a threat to TVA's ongoing operations. Therefore, it is natural for TVA to oppose such resilience measures.[255]

TVA's strong monopoly over energy generation and transmission in its service territory also creates a challenge for other entities interested in implementing resilience strategies like distributed generation.[256] Although TVA may not provide power outside of its prescribed area, TVA has statutory and contractual protection from customers within the prescribed area seeking other power suppliers.[257] The resultant monopoly makes it unlikely that any other entity will be able to construct a new generation source within TVA's fence and connect it to the transmission

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[250] *See, e.g.,* Recent Executive Order, *Civil Rights — Employment Discrimination — Executive Order Prohibits Federal Government and Contractor Employment Discrimination on the Basis of Sexual Orientation or Gender Identity. — Exec. Order No. 13,672, 79 Fed. Reg. 42 (July 23, 2024)*, 128 HARV. L. REV. 1304, 1304–05 (2015) (noting "the relative weakness of executive orders as compared to statutory protections").

[251] *See* Pars v. Cent. Intel. Agency, 295 F.Supp.3d 1, 4 (D.D.C. 2018) (stating that executive orders do not create a private right of action "without specific foundation in congressional action" (quoting *In re* Surface Mining Regulation Litig., 627 F.2d 1346, 1357 (D.C. Cir. 1980))).

[252] *See id.*

[253] *See* ABIGAIL A. GRABER, CONG. RSCH. SERV., R46738, EXECUTIVE ORDERS: AN INTRODUCTION 15 (Mar. 29, 2021), https://perma.cc/C9DG-7VWP.

[254] *See e.g.,* Exec. Order 14,008, *supra* note 249, § 211 (requiring general planning for climate resilience).

[255] *See* Tenn. Valley Auth., Annual Report (Form 10-K), at 6 (Nov. 15, 2021) (noting increased adoption of distributed energy generation and microgrids as a financial risk to TVA).

[256] *See* COX & SCHMIT, *supra* note 8, at 2–3, 13–14.

[257] *See id.*

system.[258] Even though TVA and FERC ostensibly retain the discretion to open TVA's transmission system to other power suppliers, it has not yet occurred.[259]

TVA also has asserted the authority to impose significant contractual obligations on LPCs,[260] including automatic contract renewal and caps on distributed energy generation.[261] These provisions provide another hurdle to LPCs seeking to enhance their resilience or explore alternative energy sources. Therefore, improving the efficacy of grid resilience planning within the TVA footprint will likely require statutory provisions, further voluntary efforts at improvement, or changes in governance.

E. Effective Resilience Planning: A Comparative Perspective

TVA's various planning processes differ substantially from ConEd's resilience planning process. Most notably, ConEd conducted a thorough review of its assets and each asset's potential vulnerability. Although TVA's adaptation plans indicate that there is a similar review of assets, the public reports provide only general discussion of climate hazards and do not rank the risks different asset types face from each likely climate impact.[262] As the GAO report on TVA's climate change planning notes, this lack of specificity results in an incomplete picture of the climate risks TVA faces, which, in turn, provides insufficient information to guide TVA's decision-making process in prioritizing resilience measures.[263] While ConEd did not provide an exact breakdown

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[258] *Id.* at 14.

[259] *See* Order on Petition, Athens Utils. Bd. v. Tenn. Valley Auth., 177 FERC ¶ 61,021 (Oct. 21, 2021) (declining to require TVA to provide transmission services to LPCs seeking alternative power suppliers).

[260] *See* McCarthy v. Middle Tenn. Elec. Membership Corp., 466 F.3d 399, 406 (6th Cir. 2006) ("Courts have acknowledged that the TVA Act accords the TVA a great amount of discretion in its contractual relations with municipalities." (internal quotation marks omitted)).

[261] *See* COX & FLYNN, supra note 226, at 9–10.

[262] *Compare* CONED 2019 VULNERABILITY STUDY, *supra* note 115, at 14–15, 40–45 (discussing the climate change vulnerabilities electric system assets face and the secondary vulnerabilities that also present risks) *and* CONED 2023 VULNERABILITY STUDY, *supra* note 133, at 44–46 (showing level of vulnerability to temperature, flooding, and wind and ice for asset groups and discussing methodology for assessing vulnerability of assets and asset subcomponents), *with* TVA 2021 ADAPTATION PLAN, *supra* note 32, at 17–20 (providing a table of climate threats, potential impacts, and location of further analysis and disclosure) *and* TVA 2024 ADAPTATION PLAN, *supra* note 176, at 10–14 (identifying and describing "area[s] of impact or exposure" to climate hazards but not discussing the challenges to specific asset types).

[263] *See* GAO REPORT, *supra* note 192, at 19–21; *see also* DOE PLANNING GUIDE, *supra* note 89, at 9 ("Utilities undertaking a comprehensive vulnerability assessment may benefit from a complete, system-wide understanding of climate hazards . . . ."); *id.* at 26 ("One critical input to the vulnerability assessment is an inventory of the assets and operations that could be affected by climate-related threats. Identifying, characterizing, and inventorying a utility's assets and operations will provide useful insights on the various ways in which climate impacts may disrupt services and how best to prioritize and implement operational resilience measures.").

of its $1 billion storm hardening investment, it appears these decisions were guided by the information gathered from the vulnerability assessment.[264] Contrast this with TVA's 2021 Plan, which notes that the utility will prioritize its grid-scale battery project but does not disclose other efforts that are being evaluated to combat the severe weather risks TVA's grid faces.[265]

ConEd also conducted its climate planning through a centralized process focused exclusively on electric service and climate change. Although TVA's climate adaptation plans fill a similar role, their wide range of concerns—such as conservation of aquatic species—make them less apt to exhaustively consider grid resilience.[266] TVA's process is further fragmented by the fact that resilience is purportedly considered separately in climate adaptation plans, IRPs, and transmission planning without clear integration between these planning processes.[267] In sum, TVA and ConEd engage in fundamentally different planning processes and have taken widely divergent measures to increase resilience.

These stark differences in resilience planning are likely the result of the vastly different regulatory and operational environments in which the utilities operate. ConEd is a subsidiary of ConEd, Inc., which trades on the New York Stock Exchange and is one of the nation's largest investor-owned energy companies.[268] On the other hand, TVA's sole owner is the US government.[269] Because ConEd is publicly traded, it is responsive to market forces and its dispersed shareholders, incentivizing it to adopt any cost-effective resilience measure. TVA would seemingly be subject to the same forces, but because Congress—representing TVA's stockholder—does not often provide meaningful oversight of TVA's operations, resilience may not be considered sufficiently.

Similar dynamics are found in the structure and authority of the two utilities. ConEd was historically vertically integrated, but its generation, transmission, and distribution components were "unbundled" in the 1990s to introduce competition in generation.[270] TVA, on the other hand, does not currently and did not historically have distribution infrastructure but retains its intertwined generation and transmission functions. The "anti-cherry-picking" provision, in

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[264] *See* ConEd 2020 Climate Change Plan, *supra* note 130, at 1.

[265] TVA 2021 ADAPTATION PLAN, *supra* note 32, at 19.

[266] *See* TVA 2024 ADAPTATION PLAN, *supra* note 176, at 10–11 (listing natural resources and cultural resources as assets that TVA includes in its climate adaptation planning).

[267] TVA 2020 ADAPTATION PLAN, *supra* note 24, at 4, 19 (discussing how TVA considers resilience in the IRP process); *id.* at 35 (explaining that TVA considers resilience in its regional transmission planning); TVA 2021 ADAPTATION PLAN, *supra* note 32, at 17–20 (including the IRP as a source of analysis for climate change threats to the TVA electric system); TVA 2022 PLAN UPDATE, *supra* note 175, at 7 ("TVA continues its efforts to ensure climate change adaptation and resiliency are integrated into agency and regional planning . . . ."); TVA 2024 ADAPTATION PLAN, *supra* note 176, at 9 (noting that TVA is updating its IRP).

[268] *See About Con Edison*, *supra* note 115.

[269] *See* Tenn. Valley Auth. v. Hill, 437 U.S. 153, 157 (1978).

[270] ANGUS CHAN ET AL., NYU STERN, INNOVATING A NEW BUSINESS MODEL FOR ELECTRIC UTILITIES: CONSOLIDATED EDISON'S BROOKLYN & QUEENS DEMAND MANAGEMENT PROJECT 3 (Jan. 2019), https://perma.cc/FJ6Q-CVC4.

addition to FERC's refusal to require TVA to open its transmission, means TVA's generation and transmission remain effectively monopolies. Because ConEd provides distribution services, it is more capable of considering—and, in fact, incentivized to consider—the resilience measures necessary in distribution infrastructure. This is contrasted with TVA's sometimes oppositional relationship with LPCs on resilience measures.[271]

Although FERC has regulatory authority over both ConEd and TVA,[272] the scope of that authority differs for the two utilities. ConEd is part of the New York Independent System Operator,[273] while TVA is not part of such an organization.[274] There are substantial regulatory implications for utilities within these organizations, including FERC oversight of their governance structures.[275] This additional layer of governance may increase resilience by encouraging competition and promoting open access to transmission infrastructure. This approach is antithetical to TVA's monopoly and FERC's denial of LPC's requests to open TVA's transmission infrastructure to competitors.

The New York State Public Service Commission (NYPSC) also regulates ConEd.[276] TVA, however, is not subject to state energy regulation. This is notable because NYPSC's order for utilities to establish working groups to conduct vulnerability studies spurred ConEd's updated vulnerability assessment.[277] NYPSC reviewed the associated implementation plans for steps each utility would take to prepare for climate change.[278] This state-level oversight can provide additional assurance that resilience measures are adequately and transparently considered.

Two other differences between the utilities' approaches to resilience planning bear noting. First is the utilities' treatment of transmission planning. ConEd conducts long-range transmission

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271 Because TVA is funded through its electric power sales, it is financially advantageous to TVA that LPCs to purchase all electricity from TVA, even if distributed generation would improve resilience and therefore benefit consumers. *See* Tenn. Valley Auth., Annual Report (Form 10-K), at 7 (Nov. 14, 2024) (noting increased adoption of distributed energy generation as financial risks to TVA); *see also* COX & FLYNN, supra note 226, at 9–10 (describing TVA's recent contractual changes which restrain the ability of LPC's to increase their resilience).

272 *See Regulations and Oversight*, CON EDISON, https://perma.cc/5ZRH-GTLG (last visited Feb. 11, 2025); Tenn. Valley Auth., Annual Report (Form 10-K), at 29 (Nov. 14, 2024).

273 *See* NYISO, FED. ENERGY REGUL. COMM'N (Jan. 27, 2025), https://perma.cc/XGL7-HFGL; NEW YORK ISO, NYISO MARKET PARTICIPANT LIST (Dec. 23, 2024), https://perma.cc/2KJK-KYN2.

274 *See Electric Power Markets*, FED. ENERGY REGUL. COMM'N (May 16, 2023), https://perma.cc/L8ZQ-SFJS (showing power markets throughout the United States and explaining that "[u]tilities in the Southeast are vertically integrated and virtually all the physical sales in the Southeast are done bilaterally").

275 *See* Shelley Welton, *Rethinking Grid Governance for the Climate Change Era*, 109 CAL. L. REV. 209, 226 (2021).

276 *See Regulations and Oversight*, *supra* note 272 (discussing the relevant regulators at the federal and state levels).

277 *See* N.Y. STATE DEP'T OF PUB. SERV., ANNUAL REPORT 2022–2023 at 10 (2023), https://perma.cc/44VD-D5PM.

278 *See id.*; *PSC Approves Utility Climate Change Resilience Plans* N.Y. STATE DEP'T PUB. SERV. (Dec. 19, 2024), https://perma.cc/49A7-3PH9.

planning and provides for public comment in the process.[279] TVA has no such public transmission plan, leaving little room for input about its plans for transmission expansions and upgrades.[280] This distinction is important because, much like distribution infrastructure, transmission can play a significant role in resilience. According to some reports, TVA has suggested that it will undertake an integrated transmission planning process, separate from its current integrated resource planning process.[281] Second, ConEd has created a specialized governance structure to "manag[e] climate risk and resilience" by including climate change in its "design, operations, and planning,"[282] a measure TVA has not taken. An internal governance structure like ConEd's targeted at addressing climate risks may be an effective measure to enhance resilience and ensure these risks are responded to appropriately.

These differences between TVA and ConEd illustrate that the former is subject to far less oversight by both governmental organizations and stakeholders, decreasing incentives to appropriately consider resilience. These distinctions not only impact resilience planning processes but can also manifest in the form of different prioritization and consideration of resilience measures.

IV. Improving Climate Resilience Planning in the Tennessee Valley

The rolling blackouts instituted during Winter Storm Elliott in December 2022 were just the beginning. The United States has experienced in the last two decades an unprecedented number of severe natural disasters.[283] As climate change continues, climate scientists project more extreme weather events, not less.[284] And with these increasing storm impacts come an increasing need for a resilient electric grid.[285]

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[279] *See* CON EDISON, THE LONG RANGE TRANSMISSION PLAN, 2013–2023 at 4 (2013), https://perma.cc/BBZ3-7D9V (discussing the time horizon for transmission plans and the timeline for public review and comments on the transmission plan).

[280] JONATHAN GELDOF ET AL., AM. COUNCIL ON RENEWABLE ENERGY, RECOMMENDATIONS FOR REDUCING COSTS AND IMPROVING RELIABILITY FOR TENNESSEE VALLEY AUTHORITY CUSTOMERS 7 (Jan. 30, 2025), https://perma.cc/A9MH-DP67.

[281] *See, e.g. id.*; S. ALL. FOR CLEAN ENERGY, SOLAR IN THE SOUTHEAST 18 (7th ed., July 2024), https://perma.cc/C7PU-4FKM.

[282] 2023 CON EDISON CLIMATE CHANGE RESILIENCE PLAN, *supra* note 130, at 5.

[283] *See* Adam B. Smith, *2024: An Active Year of U.S. Billion-Dollar Weather and Climate Disasters*, NOAA: Climate.gov (Jan. 10, 2025), ; *see also, e.g.*, CITY OF AUSTIN & TRAVIS CNTY., WINTER STORM URI AFTER-ACTION REPORT & IMPROVEMENT PLAN TECHNICAL REPORT (Oct. 27, 2021), https://perma.cc/7L2L-JW4Y; Katie Myer, *Thousands Are Still Without Power More than Two Weeks After Hurricane Helene*, NAT'L PUB. RADIO (Oct. 14, 2024, 4:28 p.m. ET), https://perma.cc/5NEQ-XBZD.

[284] *See* U.S. DEP'T OF ENERGY, QUADRENNIAL ENERGY REVIEW: TRANSFORMING THE NATION'S ELECTRICITY SYSTEM: THE SECOND INSTALLMENT OF THE QER at S-12 (Jan. 2017), https://perma.cc/LQC5-DPS9.

[285] *See id.* at 4-2, 4-26, 4-28–4-32.

Utilities that fail to plan for resilience adequately and transparently not only risk imposing unnecessary outages on their customers but may also face potential legal liability.[286] As recommended by the DOE, comprehensive vulnerability assessments are a necessary first step for effective resilience planning. TVA should, consistent with GAO recommendations, start by cataloguing its assets and thoroughly considering the threats faced by each. These assessments should be based on updated, reputable climate projections, and TVA must consider these climate change impacts by building uncertainty into its modelling.

Once TVA has identified relevant vulnerabilities, it must act on them. In conducting its resilience planning, TVA can and should consider various methods to increase its efficacy and facilitate LPC participation. First, TVA should consider opening its planning process to least-cost resource proposals from LPCs and potentially others, including customers and project developers. Second, TVA should integrate both transmission planning and resilience concerns into the IRP process, providing more transparency in its transmission planning process. Third, TVA should encourage LPCs to conduct their own resilience planning, potentially integrating these plans into TVA's broader resilience planning framework.

Finally, TVA should further encourage LPCs to develop flexible generation resources. While this should entail TVA eliminating its five percent cap on distributed generation, TVA could also incentivize LPC resilience while retaining such a cap. TVA could calculate the five percent cap based on capacity factors, an approach adopted by the Nashville Electric Service. TVA could also clarify that customer dedicated generation projects and LPC-side battery storage do not count toward this five percent cap. TVA could encourage LPCs to capitalize on partnerships with private developers by, for example, providing direct financing. Additionally, TVA could work with specific LPCs on a case-by-case basis to invest in resilience projects that extend above the five percent threshold. This could be done based on specific criteria that provide a process for doing so and ensure these projects are integrated into TVA's resilience planning process.

[286] *See* Rossi & Panfil, *supra* note 9, at 1156–57.

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