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July 3, 2023

Via e-mail to IRP@tva.gov

Kelly Baxter
NEPA Specialist
400 West Summit Hill Drive
WT 11B
Knoxville, TN 37902-1499

RE: Scoping Notice for TVA 2024 Integrated Resource Plan and Environmental Impact Statement

Dear Ms. Baxter:

The Southern Environmental Law Center, Center for Biological Diversity, Appalachian Voices, Sierra Club, Protect Our Aquifer, and Memphis Community Against Pollution submit these comments in response to the Tennessee Valley Authority's notice of intent to prepare a new integrated resource plan (IRP) and related environmental impact study (EIS). These comments fully incorporate the analysis in the attached report by energy experts from the Applied Economics Clinic.[1]

The world has changed since the 2019 IRP. The climate crisis has deepened, with more frequent and intense heat waves, longer fire seasons and more severe wildfires, degraded air quality, more heavy downpours and flooding, increased drought, more intense storms, and harm to wildlife and ecosystems. In response, the United States has committed to limiting global warming to no more than 2°C relative to pre-industrial temperatures,[2] and President Biden has established a national goal to achieve a "carbon pollution-free electricity sector by 2035."[3] In 2022, Congress enacted the Inflation Reduction Act of 2022,[4] which President Biden heralded as "the

[1] Chirag T. Lala et al., Applied Economics Clinic, *Assessing TVA's IRP Planning Practices* (June 2023), **Attachment 1**.
[2] Paris Agreement to the United Nations Framework Convention on Climate Change art. 2 section 1(a), Dec. 12, 2015, T.I.A.S. No. 16-1104 (aiming to hold the increase in global average temperature to "well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change").
[3] Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, 86 Fed. Reg. 7619, 7622 (Feb. 1, 2021); Executive Order 14082, Implementation of the Energy and Infrastructure Provisions of the Inflation Reduction Act of 2022, 87 Fed. Reg. 56861, 56862 (Sept. 16, 2022).
[4] Pub. L. 117-169, 136 Stat. 1818 (2022).

single largest and most ambitious investment in the ability of the United States to advance clean energy, cut consumer energy costs, confront the climate crisis, promote environmental justice, and strengthen energy security."[5] Among its other provisions, the IRA creates billions of dollars of incentives for deploying carbon-free technology. TVA is eligible for many of these incentives. To implement the IRA, Executive Order 14,082 directs federal agencies—including government-owned corporations—to "driv[e] progress to . . . achieve a carbon pollution-free electricity sector by 2035," and "promot[e] construction of clean energy generation, storage, and transmission[.]"[6]

Based on a review of TVA's three prior IRPs, Applied Economics Clinic recently concluded that TVA's 2011, 2015, and 2019 IRPs generally failed to:

- anticipate the size of coal retirements;
- limit the planned or actual growth of gas capacity; and
- plan adequately for a decarbonized gas system following 2019.[7]

Instead, TVA's IRPs, including the 2019 IRP, adopt broad planning ranges that deprive decisionmakers and the public of the ability to meaningfully assess the consistency of the utility's investments against its plans.[8] By deciding not to decide, TVA's 2019 IRP "may also result in ad hoc decision-making as TVA has no other benchmark for capacity additions beyond large ranges that can accommodate numerous conflicting possibilities, strategic investments (or lack thereof), and costs."[9] In other words, not only does the 2019 IRP fail to account for the dramatically changed world of 2023, but even on its own terms, it is so vague that it does not in any way justify TVA's proposals to build new gas plants to replace retiring coal or otherwise add new gas capacity.

The 2024 IRP is a critical opportunity for TVA to lead the national response to climate change while providing affordable and reliable power for ten million people throughout the region. To take advantage of this opportunity, Conservation Groups recommend the following:

Decarbonization

- **No new fossil fuels:** Since February 2021, TVA has rushed to add 5,900 MW of new gas-fired power plants, despite mounting evidence that a clean energy portfolio is more cost effective. Synapse Energy Economics has calculated that replacing TVA's coal plants with a clean energy

[5] Exec. Order 14,082, Implementation of the Energy and Infrastructure Provisions of the Inflation Reduction Act of 2022, 87 Fed. Reg. 56,861 (Sept. 12, 2022).
[6] *Id.* at 56,862.
[7] AEC IRP Report, 16.
[8] *Id.*
[9] *Id.*

portfolio would save ratepayers $9.4 billion over twenty years.[10] By replacing all of TVA's fossil fuel plants with a clean energy portfolio by 2035, TVA would save families $255 billion by 2050.[11] TVA has attempted to justify the massive gas buildout by pointing to an outdated IRP, which did not include Inflation Reduction Act pricing, President Biden's decarbonization targets, or even TVA's less ambitious decarbonization targets. Despite these targets and a pending EPA rule,[12] TVA has not accounted for the costs of mitigating the greenhouse gas emissions from its coal and gas plants. Nor has TVA accounted for increasing fuel cost volatility for its gas plants, despite the fact that end-use customers throughout the Valley foot the bill. Without an up-to-date IRP, TVA has no basis to conclude that its massive investment in new gas plants contributes to a portfolio that achieves the lowest system cost. TVA should not make final decisions to invest in additional gas plants, including those currently proposed to replace the Kingston Fossil Plant and Cumberland Unit 2 (Cheatham County Gas Plant), until after TVA has completed updated long-term resource planning. Further, because TVA has relied on flawed and outdated analysis, proposed and under-construction gas plants should not be considered existing resources but instead should be considered potential capacity additions that must compete with other resources, including wind, solar, energy efficiency, battery storage of various durations, and demand response.

- **Decarbonization targets**: TVA must clearly incorporate net-zero climate targets as a policy goal and basic modeling limitation in its IRP. All TVA portfolios should achieve the federal climate goals of achieving a carbon-pollution free electricity sector by 2035.[13] TVA's 2019 IRP is rendered defunct by TVA's own emission targets, as well as by Executive Orders calling for a carbon-pollution free electricity sector by 2035. TVA should be transparent both about its scheduled

[10] Rachel Wilson et al., Synapse Energy Economics, *Clean Portfolio Replacement at Tennessee Valley Authority* (May 2022) (on file with agency).
[11] Pat Knight et al., Synapse Energy Economics, *TVA's Clean Energy Future* (March 2023) (on file with agency).
[12] EPA, New Source Performance Standards for Greenhouse Gas Emissions from New, Modified, and Reconstructed Fossil Fuel-Fired Electric Generating Units; Emission Guidelines for Greenhouse Gas Emissions from Existing Fossil Fuel-Fired Electric Generating Units; and Repeal of the Affordable Clean Energy Rule, 88 Fed. Reg. 33240 (May 23, 2023), https://www.federalregister.gov/documents/2023/05/23/2023-10141/new-source-performance-standards-for-greenhouse-gas-emissions-from-new-modified-and-reconstructed.
[13] *See* Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, 86 Fed. Reg. 7619, 7622 (Feb. 1, 2021); Executive Order 14082, Implementation of the Energy and Infrastructure Provisions of the Inflation Reduction Act of 2022, 87 Fed. Reg. 56861, 56862 (Sept. 16, 2022).

capacity additions and retirements, and about which resources will supply the necessary emission reductions to meet these climate goals.

Transparency

- **Modeling transparency**: TVA must be more transparent regarding its assumptions and modeling inputs, including its assumed carbon price and social costs of further investments in GHG-emitting resources. Accordingly, TVA should make its detailed technical appendix available for public review.

- **Targeted portfolio**: The TVA Act requires TVA to implement a "planning *and selection* process for new energy resources."[14] The 2019 IRP largely decided not to decide, including extremely broad ranges of potential resource additions. TVA's next IRP needs a clear selection of a portfolio with a more targeted preferred resource plan. The selected portfolio should provide schedules for prospective additions of resources. Absent these detailed expectations, planning ranges alone do not permit either TVA or other stakeholders to assess the environmental and economic impacts of the most likely resource additions or effectively evaluate the benefits of prior capacity additions.

- **All-resource request for proposals**: TVA should conduct an all-resource RFP of resources that could be made available today under current market prices. Resource cost assumptions uninformed by an all-resource RFP provide inferior information that biases modeling results.

- **Asset selection**: TVA's asset decisions have not always aligned with its own IRPs. For example, TVA is now relying on the 2019 IRP in considering how to replace the Kingston coal plant, but the 2019 IRP did not evaluate retiring Kingston. TVA must ensure that its site-specific planning documents—such as environmental impact statements for particular resource decisions—reflect the most recent IRPs' plans and methods that do not result in contradictions between overall-system and site-specific planning exercises. Site-specific planning exercises should also provide technical appendices with information on modeling inputs and outputs, including explaining departures from assumptions that informed the applicable IRP.

- **Stakeholder intervention and robust engagement**: Stakeholders should be able to intervene in the IRP process. That process should allow intervenors to submit discovery requests for information

[14] 16 U.S.C. § 831m-1(b)(1).

pertinent to the IRP. TVA should promptly respond to those requests. All intervenors should be authorized to submit comments and expert testimony to the TVA Board. An independent entity or the TVA Board should preside over an IRP hearing in which TVA and intervenors present their case under oath, subject to cross examination.[15]

- **Accessibility**: TVA should hold multiple public comment forums for the IRP throughout the TVA region, with at least one in each state and multiple in Tennessee. TVA should ensure that IRP hearings, forums, and working group meetings are open to the public and streamed live.

- **Equity and environmental justice:** TVA must ensure compliance with Executive Order 14091, including by proactively engaging with underserved communities, creating economic opportunity in rural America and advancing urban equitable development.[16]

- **Independent administration and advice**: An independent entity should provide oversight on public comments provided to the TVA Board outside the NEPA process. That entity should advise the TVA Board on whether and how those comments inform the final IRP. TVA should provide the TVA Board with independent expert staff, selected with input from the Board itself and a range of stakeholders, to support their engagement in the IRP process.

Clean Energy Resources

- **Inflation Reduction Act**: TVA should state clearly how it intends to maximize the benefits and programs of the Inflation Reduction Act. One example is the direct payment of IRA tax credits, allowing TVA and local power companies to finance eligible projects through direct payments from the U.S. Treasury.[17] TVA should model multiple IRA implementation strategies, including strategies in which TVA itself leverages direct pay and other provisions of the IRA, strategies in which TVA removes the harsh 5% cap on local renewables for Valley Long Term Partners and allows these local power companies to access affordable clean energy directly for the benefit of their ratepayers, and

[15] The Board is authorized to "conduct such public hearings as it deems appropriate on issues that could have a substantial effect on (i) the electric ratepayers in the service area; or (b) the economic, environmental, social, or physical well-being of the people of the service area." 16 U.S.C. § 831a(K).
[16] Executive Order 14091, Further Advancing Racial Equity and Support for Underserved Communities Through the Federal Government, 88 Fed, Reg, 10825 (Feb. 2, 2023).
[17] *See* Internal Revenue Service, Section 6417 Elective Payment of Applicable Credits, 88 Fed. Reg. 40528 (June 21, 2023).

strategies that combine these approaches. TVA needs to document how IRA programs affect its modeling, selected resource plans, and finances.

- **Solar ownership:** TVA must clarify how it demarcates "ownership" of solar and wind resources between its distribution utilities, power purchase agreements from other parties, and capacity that TVA outright owns. Currently, TVA does not specify why its claimed solar and wind resources are not reported in EIA data, nor the extent to which its renewable resources are capacity owned and operated by its distribution utility partners or capacity it has access to through power purchase agreements. TVA should also be transparent about ownership of renewable attributes, such as any renewable energy credits sold through TVA's Green Invest program.

- **Renewables data:** TVA should provide reliable annual or monthly data on its existing solar, wind, and storage capacity. These time-series data should also distinguish between utility-scale resources that represent TVA's own capacity, contracted capacity, and/or capacity from TVA's distribution utility or municipal partners that TVA claims as its own. These data are essential to an effective evaluation of TVA's past and future plans by making a comparison between proposed and actual renewable additions.

- **Fulfill the 2019 IRP's clean energy commitments**: In the 2019 IRP, TVA made several important commitments to expanding clean energy. Those include a "market potential study for energy efficiency and demand response," as well as "development of Distribution Resource Planning for integration into TVA's planning process."[18] TVA has not published either, and we are unaware of any significant progress made on these two important processes to date. TVA must follow through on these commitments to inform the 2024 IRP and as it works to expand energy efficiency, demand response, and distributed energy resources throughout the Valley.

- **Resiliency**: TVA must reassess the reliability and resilience of clean energy resources relative to fossil fuel resources. TVA has continually characterized gas-fired generation as resilient and clean energy resources as unreliable. TVA's rolling blackouts during Winter Storm Elliott told another story. Two coal plants and one-third of TVA's gas units failed.[19] Solar and storage performed as expected, including

[18] 2019 IRP at ES-5.

[19] *See generally* TVA, After Action Report: Winter Storm Elliott (May 2023).

during the blackout periods.[20] Not only did clean energy resources play an important role during Winter Storm Elliott, but they have contributed to grid resiliency during extreme weather throughout the country. During an extreme heat wave in California last summer, demand response and battery storage were broadly credited with keeping the lights on despite record demand.[21] During another heat wave this summer, solar helped Texas meet record demand.[22] Not only did gas infrastructure disproportionately fail during Winter Storms Elliot and Uri, but NERC found that "[i]n 2022, conventional generation experienced its highest level of unavailability (8.5%) overall since NERC began gathering [Generating Availability Data System] data in 2013 as measured by the weighted equivalent forced outage rate . . . ."[23]

- **Solar integration**: TVA should consider the role storage can play in its current plans to reach 10,000 MW of solar by 2035. TVA has repeatedly justified building new gas plants by citing the need to integrate 10,000 MW of solar.[24] TVA must analyze whether storage, including long-duration battery storage, can integrate solar better than new gas plants can. Not only does storage exceed gas plants' flexibility, but storage can use excess solar to charge, avoiding the need to curtail excess renewables. Additionally, TVA should consider policy changes that reduce land-use impacts and increase community resilience, such as opening up its policies on distribution-level projects, including local power company flexibility and net-metered rooftop solar.

- **Local environmental impacts**: TVA must account for the local environmental impacts of various energy resources. For example, TVA's generation fleet has significant impacts on water resources. Each type of generation has different impacts on groundwater and surface water, such as from use of cooling water or discharge of

[20] Robert Zullo, Tennessee Lookout, How Did Renewables Fare During Winter Storm Elliott (Jan. 31, 2023), https://tennesseelookout.com/2023/01/31/how-did-renewables-fare-during-winter-storm-elliott/.
[21] Anna Blaustein, Scientific American, How California Kept the Lights on During Monster Heat Wave (Sept. 16, 2022), https://www.scientificamerican.com/article/how-california-kept-the-lights-on-during-monster-heat-wave/.
[22] J. David Goodman, N.Y. Times, Facing Brutal Heat, the Texas Electric Grid Has a New Ally: Solar Power (June 23, 2023), https://www.nytimes.com/2023/06/23/us/texas-heat-solar-energy.html.
[23] North American Electric Reliability Corporation, *2023 State of Reliability Overview* (June 2023).
[24] Cumberland Fossil Plant Retirement, Final EIS ii; Johnsonville Aeroderivative Combustion Turbines Project, Final Environmental Assessment 1 (July 2022).

wastewater. TVA should mitigate local impacts on water resources by using recycled greywater and by prioritizing lower-impact capacity additions, such as demand response and energy efficiency.

Transmission

- **Transmission planning**: TVA must integrate transmission planning into its 2024 IRP process. TVA has consistently rejected clean energy alternatives for fossil fuel plant replacement in part because of the lead times required for transmission upgrades that TVA claims are necessary to accommodate renewable energy. This purported challenge, to the extent it has some basis in fact, could be avoided through transparent, proactive transmission planning that is coordinated with the IRP process. Such a process will also allow stakeholders to evaluate which transmission upgrades should be attributed to renewable energy and which are necessary due to deferred maintenance of transmission assets, localized load growth or other reasons. Further, TVA must study the potential for enhanced broader regional transmission. To date, TVA has not properly valued the benefits of transmission investments, particularly with respect to resiliency and renewables integration. While TVA was implementing rolling blackouts during Winter Storm Elliott, neighboring utility Southwestern Power Pool curtailed approximately 3,000 megawatts of wind, partly due to insufficient interregional transfer capacity.[25] The Department of Energy has found that substantial interregional transfer capability is required between the Southeast (i.e., TVA) and the Gulf region.[26]

Load Growth and Electricity Demand

- **Electrification of transportation and buildings**: TVA should model various electrification scenarios with different load growth projections. TVA should also evaluate whether the utility and its local power company customers can implement policies that promote the electrification of transportation and buildings while minimizing additional capacity requirements. For example, TVA should consider appropriate time-of-use rate structures that incentivize off-peak charging for electric vehicles. TVA should also consider the potential for vehicle-to-grid technology to provide demand-response services and other grid benefits. TVA should also evaluate how distribution resource planning and distributed energy resources, including

[25] *Wasted Wind and Tenable Transmission During Winter Storm Elliot*, RMI (Feb. 16, 2023).
[26] Department of Energy National Transmission Needs Study (Feb. 2023).

distributed solar, energy efficiency, and demand response, can support beneficial electrification.

- **Crypto-mining and other large, non-essential energy users**: While TVA does not disclose information about the location or energy demand of crypto-mining facilities or other non-essential energy users, publicly available information indicates that the total annual demand of crypto-mining facilities in the TVA region is at least 665 MW,[27] equivalent to a gas-fired power plant. TVA should use the IRP process to determine the scale and impacts of, and potential responses to, the increase in energy demand from crypto-mining facilities and other large non-essential energy users. TVA should examine demand response solutions for mitigating the harmful impacts of crypto-mining facilities and other large non-essential energy users.

Thank you for your consideration of our comments. Please contact us if we can answer any questions.

Sincerely,

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[27] See FracTracker Alliance, Cryptocurrency mining operations in the United States (Dec. 2022). Available at: https://ft.maps.arcgis.com/apps/webappviewer/index.html?appid=30c9ac5f2cd24732b0c8246cc1314107.

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Attachment 1

Assessing TVA's IRP Planning Practices

Prepared on behalf of the Southern Environmental Law Center (SELC)

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Applied Economics Clinic

June 2023

Applied Economics Clinic
Economic and Policy Analysis of Energy, Environment and Equity

Executive Summary

As the United States' largest public power producer, Tennessee Valley Authority (TVA) must plan and invest to meet aggressive decarbonization targets. TVA conducts regular Integrated Resource Plans (IRPs) to: 1) assess what its resource needs are; 2) evaluate what resources could meet those needs; 3) model different resource combinations under varying conditions; and 4) publish "planning ranges" estimating how much capacity it may add or retire for each resource. In principle, the IRPs should present reasonable ranges (and a schedule) against which TVA's actual capacity additions and retirements can be compared. TVA's 2011, 2015, and latest 2019 IRPs, however, neither clearly explained its planning processes nor gave an accurate picture of future resource decisions.

A useful IRP process has three key features: 1) It bases its modeling and analysis of potential resources on a survey or "all-resource RFP" of available energy resources and their characteristics; 2) the IRP designates a preferred portfolio—a combination of resource additions and retirements that together will meet future demand for power; and 3) the IRP's results and planning methods are adequate (an accurate enough) to inform subsequent site-specific instances of planning. This Applied Economic Clinic (AEC) report assesses TVA's 2011, 2015, and 2019 IRP results by comparing them with TVA's actual additions and retirements from 2011 to 2021 and finds TVA's process and results lacking. This report also compares TVA's 2019 IRP to site-specific planning for the replacement of TVA's Cumberland Fossil Plant. The report presents the following takeaways:

- **TVA must set aggressive climate goals** in line with the Paris Agreement's requirement to limit temperature increases and with the Biden Administration's executive orders requiring a carbon-free electric system by 2035.
- **TVA must be more transparent** regarding its assumptions and modeling inputs.
- **TVA must select a portfolio with a more targeted preferred resource plan** than its prior IRPs**.**
- **TVA should plan to utilize the grants, loans, and tax credits of the Inflation Reduction Act** to achieve aggressive climate targets.
- **TVA must clarify how it demarcates "ownership" of solar and wind resources** between its distribution utilities, power purchase agreements from other parties, and capacity that TVA outright owns, and provide reliable annual or monthly data on solar, wind, and storage capacity.
- **TVA should conduct an all-resource RFP for resources,** at market prices, that could be made available by the time new capacity is required, and compare and include price forecasts from reputable sources.
- **TVA must ensure that its site-specific planning documents reflect the most recent IRPs' plans and use methods that do not contradict overall-system- and site-specific planning exercises.**

Applied Economics Clinic
Economic and Policy Analysis of Energy, Environment and Equity

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About the Applied Economics Clinic

Based in Arlington, Massachusetts, the Applied Economics Clinic (AEC, www.aeclinic.org) is a mission-based non-profit consulting group that offers expert services in the areas of energy, environment, consumer protection, and equity from seasoned professionals while providing on-the-job training to the next generation of technical experts.

AEC's non-profit status allows us to provide lower-cost services than most consultancies, and when we receive foundation grants, AEC also offers services on a pro bono basis. AEC's clients are primarily public interest organizations—non-profits, government agencies, and green business associations—who work on issues related to AEC's areas of expertise. Our work products include expert testimony, analysis, modeling, policy briefs, and reports, on topics including energy and emissions forecasting, economic assessment of proposed infrastructure plans, and research on cutting-edge, flexible energy system resources.

AEC works proactively to support and promote diversity in our areas of work by providing applied, on-the-job learning experiences to graduate students—and occasionally highly qualified undergraduates—in related fields such as economics, environmental engineering, and political science. Over the past four years, AEC has hosted research assistants from Boston University, Brandeis University, Clark University, Tufts University, University of Denver, University of Massachusetts-Amherst, University of Massachusetts-Boston, University of Southern Maine, and University of Tennessee. AEC is committed to a just workplace that is diverse, pays a living wage, and is responsive to the needs of its full-time and part-time staff.

Founded in 2017 by Director and Senior Economist Elizabeth A. Stanton, PhD, AEC's talented researchers and analysts provide a unique service-minded consulting experience. Dr. Stanton has had more than two decades of professional experience as a political and environmental economist leading numerous studies on environmental regulation, alternatives to fossil fuel infrastructure, and local and upstream emissions analysis. AEC professional staff includes experts in electric, multi-sector and economic systems modeling, climate and emissions analysis, green technologies, and translating technical information for a general audience. AEC's staff are committed to addressing climate change and environmental injustice in all its forms through diligent, transparent, and comprehensible research and analysis.

I. Introduction

An integrated resource plan (IRP) is a study to determine how a power provider can best meet forecasted customer electric demand over a set period of time.[1] IRPs consider supply- and demand-side resources (central power stations, renewables, distributed energy resources, storage, and demand-side management) and develop scenarios to meet specific goals: minimizing risks, keeping costs low, or reducing environmental impacts.[2] The decisions made by the Tennessee Valley Authority (TVA) regarding its energy generation capacity are vital to the region's ability to meet climate targets and for the United States' ability to decarbonize its electric systems.

The U.S. Energy Policy Act of 1992 requires TVA to engage in a least-cost planning and selection process in which it treats supply- and demand-side resources on an equal footing basis while accounting for system operation features of those resources (such as diversity and reliability) and the ability to verify and measure energy savings from efficiency and conservation. [3] These planning processes, however, are only as good as the methods and assumptions utilized by TVA. TVA's IRPs illustrate successes and blind spots and, when examined over time, can show whether TVA is investing with science-based climate targets in mind.

TVA has a responsibility to ensure that its planning processes account for and reflect its own climate commitments over the next couple of decades. TVA's upcoming 2024 IRP is its first since committing to an 80 percent emissions reduction by 2035 from 2005 levels and to achieving net-zero emissions by 2050.[4] The 2024 IRP will also be the first since the United States established several science-based climate goals, including the commitment to limit global warming to "well below" 2 degrees Celsius pursuant to the Paris Agreement[5] and to achieve a "carbon pollution-free electricity sector no later than 2035" pursuant to multiple federal executive orders.[6] In its previous IRPs, TVA did not plan sufficiently for future

[1] TVA. "Integrated Resource Plan." Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan.
[2] Power system Engineering. "Integrated Resource Planning." Available at: https://www.powersystem.org/services/economics-rates-and-business-planning/resource-planning-and-demand-side-management/integrated-resource-planning/#:~:text=An%20Integrated%20Resource%20Plan%20(IRP,meeting%20a%20utility's%20electricity%20needs..
[3] U.S. GPO. *§831m–1. Tennessee Valley Authority least-cost planning program*. Available at: https://www.govinfo.gov/content/pkg/USCODE-2019-title16/pdf/USCODE-2019-title16-chap12A-sec831m-1.pdf.
[4] TVA. 2021. *TVA Strategic Intent and Guiding Principles.* Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/about-tva/board-of-directors/may-6-2021/strategic-plan-documentc67079e2-d479-4f3d-a13b-1fa6fd714cde.pdf?sfvrsn=bc7bb2e8_7. p. 20-22.
[5] United Nations. 2015. *Paris Agreement.* Available at: https://unfccc.int/sites/default/files/english_paris_agreement.pdf. p. 5.
[6] 1) White House. 2022. *Executive Order on the Implementation of the Energy and Infrastructure Provisions of the Inflation Reduction Act of 2022.* Available at: https://www.whitehouse.gov/briefing-room/presidential-actions/2022/09/12/executive-order-on-the-implementation-of-the-energy-and-infrastructure-provisions-of-the-inflation-reduction-act-of-2022/. 2) White House. 2021. *Executive Order on Tackling the Climate Crisis at Home and Abroad.* Available at: https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/; 3) White House. 2021. *Executive Order on Catalyzing Clean energy Industries and Jobs Through Federal Sustainability.* Available at: https://www.whitehouse.gov/briefing-room/presidential-actions/2021/12/08/executive-order-on-catalyzing-clean-energy-industries-and-jobs-through-

decarbonization. While TVA's coal capacity has fallen by 54 percent over the last several years, the addition of zero emission generation capacity has not kept pace with the addition of gas generation.

The report begins in **Section II** with a description of the Tennessee Valley Authority, its capacity and generation mix since 2011, and the role of TVA's IRPs. **Section III** examines the planning process that TVA utilizes in its IRPs to assess future resource needs and recommend planning ranges for select resources. **Section IV** compares TVA's planning ranges in its past three IRPs in 2011, 2015, and 2019 to the actual capacity additions and retirements undertaken by TVA. **Section V** presents a case study on the 2019 IRP, comparing TVA's individual resource (or site-specific) assessment methods with the integrated methodology used in TVA's IRPs and making recommendations on the use of specific methods. Finally, **Section VI** concludes with recommendations for TVA's upcoming 2024 IRP process.

II. The Tennessee Valley Authority

Established by an act of Congress in 1933, the Tennessee Valley Authority (TVA) is the largest public power provider in the United States partnering with municipal utilities and regional cooperatives) across seven states[7,8] to supply power to numerous delivery districts in Tennessee, Kentucky, Mississippi, Alabama, Georgia, North Carolina, and Virginia (see Figure 1).[9]

Out of the 153 power companies that purchase power from TVA to sell across the Tennessee Valley region, all but six are served through rolling power purchase agreements with 20-year notice of termination provisions, accounting for over 90 percent of TVA's revenue.[10,11] TVA also directly serves 58 industrial customers that together constitute 8 percent of its revenue.[12] The remaining 1 percent of TVA's revenue comes from power purchased by twelve utilities located in the Southeastern United States.[13] Through these arrangements, TVA's 29 hydroelectric sites (109 units), 14 solar sites, nine gas-fired combustion sites plants (86 units), eight gas-fired combined cycle sites (14 units), five coal-fired sites (25 units), three nuclear sites (7 units), one coal-fired co-generation unit, [14] and one pumped storage site (4 units) serve approximately 10 million people.[15]

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federal-sustainability/;

[7] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan. p. 1.

[8] TVA. 2019. *Integrated Resource Plan: A Notice by the Tennessee Valley Authority.* Federal Register: 84 FR 4987. Available at: https://www.federalregister.gov/documents/2019/09/17/2019-20104/integrated-resource-plan.

[9] TVA. "TVA's Local Power Company Providers." Available at: https://www.tva.com/energy/public-power-partnerships/local-power-companies.

[10] TVA. "Public Power for the Valley." Available at: https://www.tva.com/energy/public-power-partnerships.

[11] TVA. 2022. "TVA Reports Fiscal Year 2022 Financial Results." Available at: https://www.tva.com/newsroom/press-releases/tva-reports-fiscal-year-2022-financial-results.

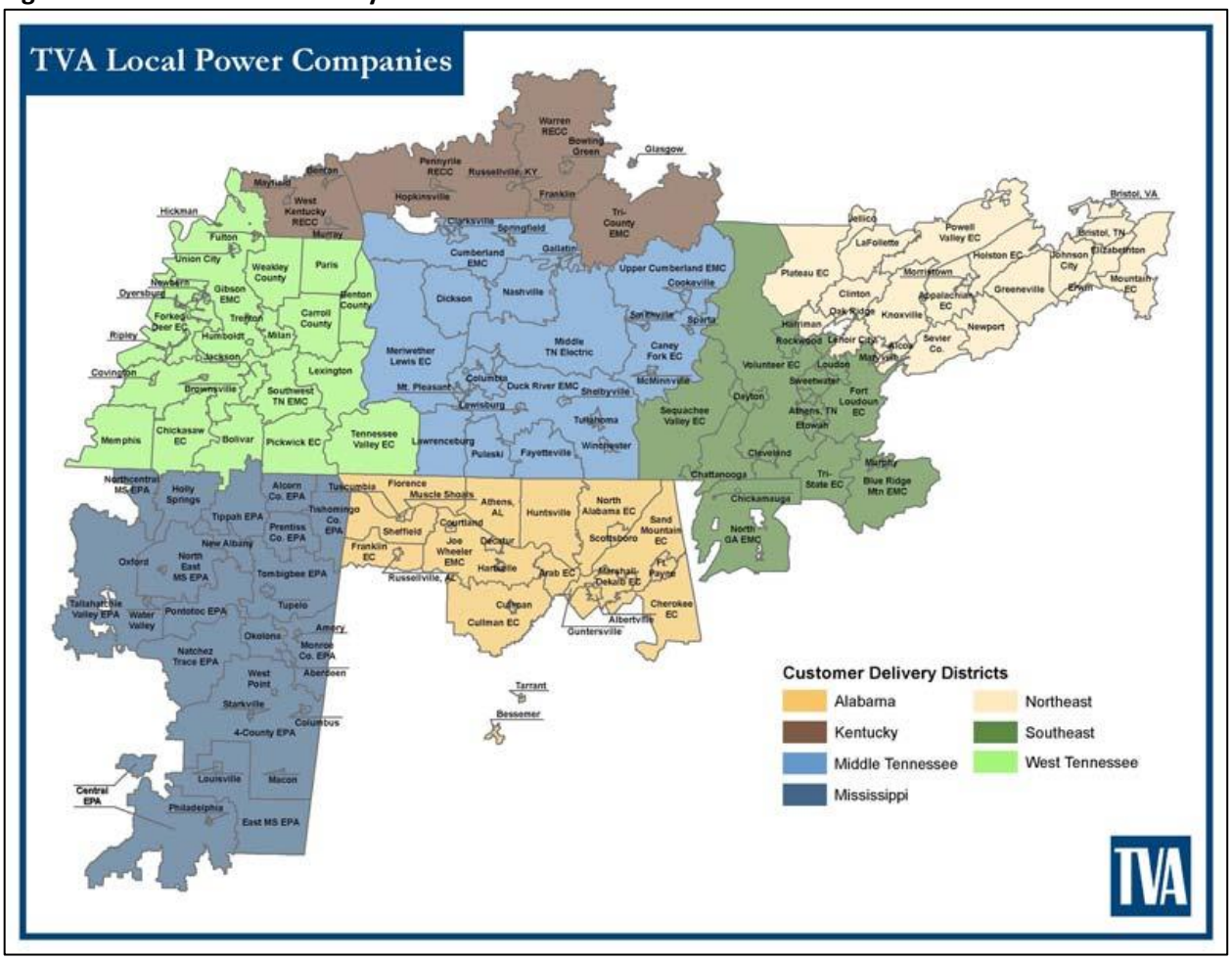
[12] TVA. "Public Power for the Valley." Available at: https://www.tva.com/energy/public-power-partnerships.

[13] Ibid.

[14] TVA. "Full Steam Ahead." Available at: https://www.tva.com/energy/full-steam-ahead.

[15] TVA. "Built for the People." Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/annual-report/fy21-tva-fact-sheet04b7ef82-7693-4b86-9326-8dcb612bc534.pdf?sfvrsn=19efd01f_3.

Figure 1. TVA customer delivery districts

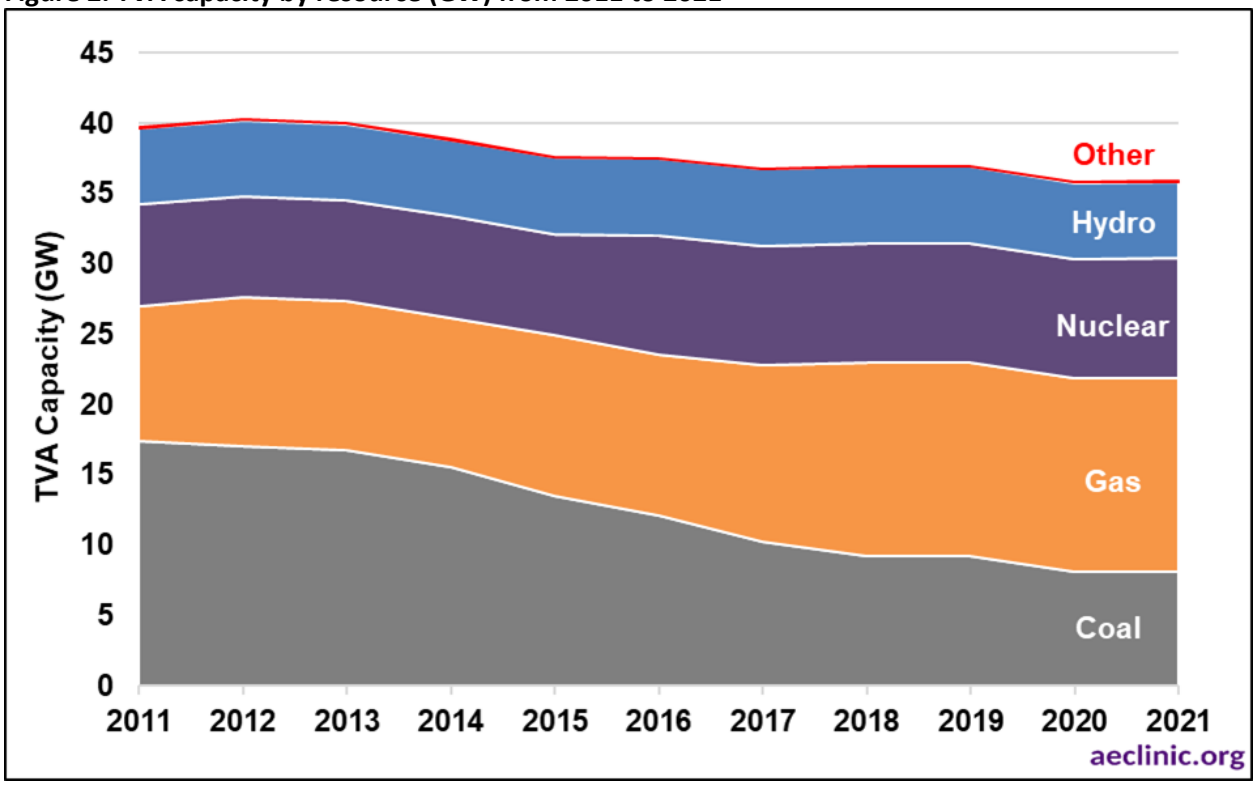


Source: Reproduced from TVA. "TVA's Local Power Company Partners." Available at: https://www.tva.com/energy/public-power-partnerships/local-power-companies.

In 2021, TVA owned 35.9 GW of electric capacity not including renewables, which has declined over time from 39.6 GW due entirely to coal retirements (see Figure 2). Gas is the single largest generating source, accounting for 38 percent (13.8 GW). Nuclear and coal respectively each account for 24 percent (8.5 GW) and 23 percent (8.0 GW), while hydroelectric capacity makes up the remaining 15 percent (5.4 GW). From 2011 to 2021, coal's share of capacity declined by nearly half, the remainder being replaced by nuclear (through the Watts Bar Nuclear Generating Station, which added 1,150 MW of electric generating capacity[16]) and gas, which increased by 44 percent between 2011 and 2021.

[16] EIA. 2016. "First new U.S. nuclear reactor in almost two decades set to begin operating." Available at: https://www.eia.gov/todayinenergy/detail.php?id=26652.

Figure 2. TVA capacity by resource (GW) from 2011 to 2021



Note: "Other" refers to oil (which drops from 27 to 23 MW between 2011 and 2021) and wind capacity (which is 2 MW from 2011 to 2021). This graph only includes data from U.S. EIA, which is incomplete with regard to TVA's solar and wind capacity.
Source: U.S. EIA. September 22, 2022. Form EIA-860 detailed data with previous form data (EIA-860A/860B). Available at: https://www.eia.gov/electricity/data/eia860/.

U.S. Energy Information Administration data on TVA's wind and solar resources is incomplete. However, TVA alludes to the available and contracted renewable capacity in other sources. In its *Renewable Highlights* document for Fiscal Year 2022, TVA claimed to have 8,264 MW of operating and contracted renewables capacity as of Fiscal Year 2022.[17] There are minimal data on how much operating solar and wind capacity TVA claims as its own. According to data compiled by the Southern Environmental Law Center (SELC) from TVA's 10-K forms[18], most of TVA's "operating capacity" is likely under power purchase contracts—rising from at least 84.3 MW of solar in 2018 to 510 MW of solar in 2022 (see Table 1). TVA has 1,240 to 1,242 MW of wind from power purchase contracts from 2018 to 2022 and also claims to have 1,828 MW of contracted power that is not yet operating in 2022, up from 53 MW in 2018.[19] As of 2022, TVA further "expects" 2,338 MW of contracted power that will be online between 2023 and 2025.[20] Note that it is also unclear whether or not the data in Table 1 are comprehensive; EIA reports TVA to have had 2

[17] TVA. *Renewable Highlights: Fiscal Year 2022.* Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/energy/valley-renewable-energy/tva-renewables-highlights-report---fiscal-year-2022.pdf?sfvrsn=41675a30_1. p. 2.
[18] SELC calculations using: TVA. "SEC Filings." Available at: https://tva.q4ir.com/financial-information/sec-filings/default.aspx.
[19] Ibid.
[20] Ibid.

MW of wind capacity from 2011 to 2021, but does not specify whether that capacity is owned or purchased. The data in Table 1 do not specify any owned wind capacity.

Table 1. TVA's operating solar and wind capacity (MW)

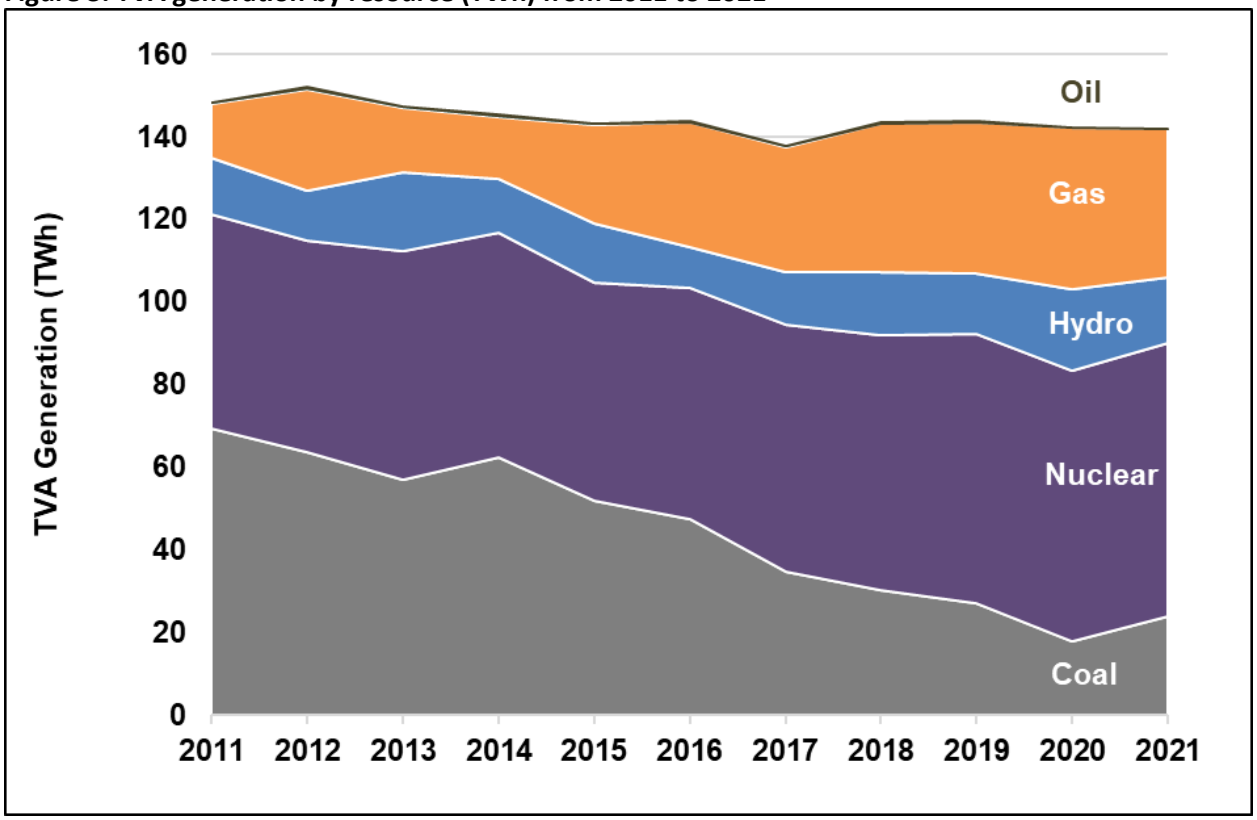
		2018	2019	2020	2021	2022
Solar	TVA-Owned	1.0	1.0	1.0	1.0	1.0
	Power Purchase Contracts	84.3	132.5	133.0	360.0	510.0
	Total	**85.3**	**133.5**	**134.0**	**361.0**	**511.0**
Wind	TVA-Owned	0.0	0.0	0.0	0.0	0.0
	Power Purchase Contracts	1,242.0	1,242.0	1,242.0	1,242.0	1,240.0
	Total	**1,242.0**	**1,242.0**	**1,242.0**	**1,242.0**	**1,240.0**

Source: SELC calculations using: TVA. "SEC Filings." Available at: https://tva.q4ir.com/financial-information/sec-filings/default.aspx.

In 2021, the largest share of TVA's generation came from nuclear at 47 percent (66.4 TWh, see Figure 3). Gas- and coal-fired resources accounted for 42 percent (or 59.6 TWh), while the remaining 11 percent (or 15.8 TWh) was generated at hydroelectric facilities (11 percent).[21] The share of nuclear generation has increased since 2011 (when it provided just 35 percent or 51.8 TWh). Hydro has also remained static in terms of its generation—providing 15.8 TWh in 2021 and 13.7 TWh in 2011 (11 and 9 percent respectively). Gas and coal have seen the most dramatic change. Coal fell from 69.4 TWh to 23.8 TWh (46.9 percent to 16.8 percent) while gas increased from 13 TWh in 2011 to 35.8 TWh in 2021 (8.8 percent to 25.3 percent). As discussed in Section III, these changes reflect TVA's unplanned coal retirements over the last decade and large-scale expansion of gas capacity.

[21] AEC calculations using: US EIA. September 22, 2022. Form EIA-860 detailed data with previous form data (EIA-860A/860B). Available at: https://www.eia.gov/electricity/data/eia860/

Figure 3. TVA generation by resource (TWh) from 2011 to 2021



Note: This graph only includes data from U.S. EIA, which is incomplete with regard to solar and wind capacity.
Source: U.S. EIA. September 22, 2022. Form EIA-923 detailed data with previous form data (EIA-906/920). Available at: https://www.eia.gov/electricity/data/eia923/.

TVA's climate goals

In March 2021, TVA announced its "aspiration to achieve net zero carbon emissions by 2050" in its *Strategic Intent and Guiding Principles* document.[22] In achieving this goal, TVA views "natural gas as a bridge" between coal retirements and solar expansion, and argues that gas facilitates coal retirements, solar energy expansion, and maintains system reliability and resiliency.[23] TVA also states that it is "developing a path" to approximately 80 percent carbon reduction of 2005 levels by 2035 by extending the life of the current nuclear and hydro fleets, adding 10,000 MW of solar by 2035,[24] and collaborating with local power companies to plan and leverage demand-side solutions.[25] Finally, TVA also planned to execute

[22] TVA. 2021. *TVA Strategic Intent and Guiding Principles.* Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/about-tva/board-of-directors/may-6-2021/strategic-plan-documentc67079e2-d479-4f3d-a13b-1fa6fd714cde.pdf?sfvrsn=bc7bb2e8_7. p. 22.
[23] Ibid, 23.
[24] The solar additions that TVA highlighted as aspirations or goals in its 2021 *Strategic Intent and Guiding Principles* were published after its 2019 IRP.
[25] TVA. 2021. *TVA Strategic Intent and Guiding Principles.* Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/about-tva/board-of-directors/may-6-2021/strategic-plan-documentc67079e2-d479-4f3d-a13b-1fa6fd714cde.pdf?sfvrsn=bc7bb2e8_7. p. 22.

a 70 percent carbon reduction from 2005 levels by 2030.[26]

Since 2021, numerous federal executive orders have reiterated that federal agencies (like TVA) must prioritize, facilitate, and/or otherwise achieve a carbon pollution-free electric sector by 2035 and net-zero emissions economy-wide by no later than 2050.[27] TVA must ensure that subsequent IRPs plan future resources, additions, and retirements in line with these goals. As a federal agency, TVA is also responsible for contributing to the United States' efforts to keep global average temperature increases "well below" 2 degrees Celsius above pre-industrial levels per the 2015 Paris Agreement.[28]

TVA's IRP process

Title 16 U.S. Code § 831m-1 of the Energy Policy Act of 1992[29] requires TVA to "employ and implement a planning and selection process for new energy resources which evaluates the full range of existing and incremental resources (including new power supplies, energy conservation, and efficiency, and renewable energy resources) in order to provide adequate and reliable service" to TVA customers at the "lowest system cost."[30] The federally mandated planning process must account for:[31]

- Features of system operation: diversity, reliability, dispatchability, and other risk factors;
- Energy savings through conservation and efficiency; and
- Treatment of demand and supply resources "on a consistent and integrated basis."

In addition, the Tennessee Valley Authority Act of 1933 requires TVA's power system to be self-financing, operate as a nonprofit, and sell power at rates as low as feasible.[32]

TVA conducts its required planning process through IRPs,[33] long-term plans for the next 20 years of TVA

[26] Ibid, p. 21.
[27] 1) White House. 2022. *Executive Order on the Implementation of the Energy and Infrastructure Provisions of the Inflation Reduction Act of 2022.* Available at: https://www.whitehouse.gov/briefing-room/presidential-actions/2022/09/12/executive-order-on-the-implementation-of-the-energy-and-infrastructure-provisions-of-the-inflation-reduction-act-of-2022/. 2) White House. 2021. *Executive Order on Tackling the Climate Crisis at Home and Abroad.* Available at: https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/; 3) White House. 2021. *Executive Order on Catalyzing Clean energy Industries and Jobs Through Federal Sustainability.* Available at: https://www.whitehouse.gov/briefing-room/presidential-actions/2021/12/08/executive-order-on-catalyzing-clean-energy-industries-and-jobs-through-federal-sustainability/;
[28] United Nations. 2015. *Paris Agreement.* Available at: https://unfccc.int/sites/default/files/english_paris_agreement.pdf. p. 5.
[29] United States Code Annotated. *Title 16 § 831-m: Tennessee Valley Authority least-cost planning program*. WestLaw.
[30] Ibid, p. 1.
[31] Ibid, p. 1.
[32] 1) TVA. 2019. *Integrated Resource Plan: A Notice by the Tennessee Valley Authority.* Federal Register: 84 FR 4987. Available at: https://www.federalregister.gov/documents/2019/09/17/2019-20104/integrated-resource-plan; 2) United States Code Annotated. *Title 16 § 831-m: Tennessee Valley Authority least-cost planning program*. WestLaw. p. 4.
[33] TVA. 2019. *Integrated Resource Plan: A Notice by the Tennessee Valley Authority.* Federal Register: 84 FR 4987.

capacity, the goal of which is to identify a resource plan that functions well under different future conditions and accounts for metrics such as costs, risks, or environmental factors.[34] In this report, we review IRPs prepared by TVA in 2019,[35] 2015,[36] and 2011.[37] TVA's next IRP is expected to be completed by the end of 2024.[38] TVA's IRPs are accompanied with Environmental Impact Statements (EIS), as required under the U.S. National Environmental Policy Act of 1970.[39] Rather than providing a recommended or preferred resource plan, TVA IRPs to date have developed prospective ranges for capacity additions and retirements over 20-year planning periods (see Table 2)[40] based on a collection of scorecard-based metrics that include cost, financial risk, operational flexibility, macroeconomic effects, or environmental impacts or stewardship.[41] The IRPs publish a low- and high-end for capacity additions and retirements (together constituting a planning range). In the 2015 and 2019 IRPs TVA publishes planning ranges ten years and twenty years out from when the IRP calculations were undertaken. The "actual" column displays the addition to TVA capacity through 2021 for the given resource from TVA capacity in the IRP year. Blank spaces in the "Actual" column denote lack of sufficient data to calculate changes in capacity between the respective IRP year and 2021—the latest year available for EIA data. The "actual" column does not incorporate changes in capacity that have not yet occurred (i.e. anticipated additions or retirements). For a discussion of how TVA continues to prioritize gas in its site-specific decision-making see Section V.

Available at: https://www.federalregister.gov/documents/2019/09/17/2019-20104/integrated-resource-plan.

[34] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan. p. ES-1.

[35] Ibid, p. 1.

[36] TVA. *Integrated Resource Plan: 2015 Final Report*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/documents/2015_irp.pdf?sfvrsn=4892374_0.

[37] TVA. 2011. *Integrated Resource Plan: TVA's Environmental & Energy Future.* Available at: https://www.nrc.gov/docs/ML1217/ML12171A189.pdf.

[38] TVA. 2023. "TVA Engaging Public for Input on Next Integrated Resource Plan." Available at: https://www.tva.com/newsroom/press-releases/tva-engaging-public-for-input-on-next-integrated-resource-plan.

[39] TVA. *2019 Integrated Resource Plan: Executive Summary*. Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan. p. 2.

[40] TVA. 2019. *Integrated Resource Plan: A Notice by the Tennessee Valley Authority.* Federal Register: 84 FR 4987. Available at: https://www.federalregister.gov/documents/2019/09/17/2019-20104/integrated-resource-plan.

[41] TVA. 2019. *Integrated Resource Plan: A Notice by the Tennessee Valley Authority.* Federal Register: 84 FR 4987. Available at: https://www.federalregister.gov/documents/2019/09/17/2019-20104/integrated-resource-plan. p. 6-14.

Table 2. Summary of TVA planning ranges and capacity changes

IRP Year	Capcity Additions and Retirements	Planning Ranges (MW)		Timeframe	Actual
		Low	High		
2011	EEDR	3,600	5,100	2020	
	Renewable	1,500	2,500	2020	
	Coal-fired capacity idled	2,400	4,700	2017	
	Storage	850	850	2020-2024	0
	Nuclear	1,150	5,900	2013-2029	1,343
	Coal	0	900	2025-2029	-9,327
	Gas	900	9,300	2012-2029	4,178
2015	Demand Response	450	575	2023	
	Energy Efficiency	900	1,300		
	Wind	0	0		
	Solar	150	800		
	Hydro	50	50		0
	Nuclear	800	800		1,343
	Coal	0	0		-5,398
	Gas	700	2,300		2,331
	Demand Response	450	575	2033	
	Energy Efficiency	2,000	2,800		
	Wind	500	1,750		
	Solar	3,150	3,800		
	Hydro	50	50		0
	Nuclear	800	800		1,343
	Coal	0	-3,400		-5,398
	Gas	3,900	5,500		2,331
2019	Demand Response	0	0	2028	
	Energy Efficiency	0	1,800		
	Wind	0	1,800		0
	Solar	1,500	8,000		228
	Hydro	0	0		0
	Storage	0	2,400		
	Nuclear	0	0		74
	Coal	-2,100	-2,100		-1,150
	Gas - Combustion Turbine	-2,000	5,200		0
	Gas - Combined Cycle	-800	5,700		0
	Demand Response	0	500	2038	
	Energy Efficiency	0	2,200		
	Wind	0	4,200		0
	Solar	1,500	14,000		228
	Hydro	0	175		0
	Storage	0	5,300		
	Nuclear	0	0		74
	Coal	-2,100	-2,100		-1,150
	Gas - Combustion Turbine	-2,000	8,600		0
	Gas - Combine Cycle	-800	9,800		0

Note: The long-term planning ranges (2038 for the 2019 IRP and 2033 for the 2015 IRP) are inclusive of the short-term planning ranges (2028 for the 2019 IRP and 2023 for the 2015 IRP).
Source: 1) TVA. 2011. Integrated Resource Plan: TVA's Environmental & Energy Future. Available at: https://www.nrc.gov/docs/ML1217/ML12171A189.pdf.; 2) TVA. Integrated Resource Plan: 2015 Final Report. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/documents/2015_irp.pdf?sfvrsn=4892374_0.; 3) TVA. 2019. Integrated Resource Plan: A Notice by the Tennessee Valley Authority. Federal Register: 84 FR 4987. Available at:

https://www.federalregister.gov/documents/2019/09/17/2019-20104/integrated-resource-plan.; 4) U.S. EIA. September 22, 2022. Form EIA-860 detailed data with previous form data (EIA-860A/860B). Available at: https://www.eia.gov/electricity/data/eia860/; 5) U.S. EIA. September 22, 2022. Form EIA-923 detailed data with previous form data (EIA-906/920). Available at: https://www.eia.gov/electricity/data/eia923/.

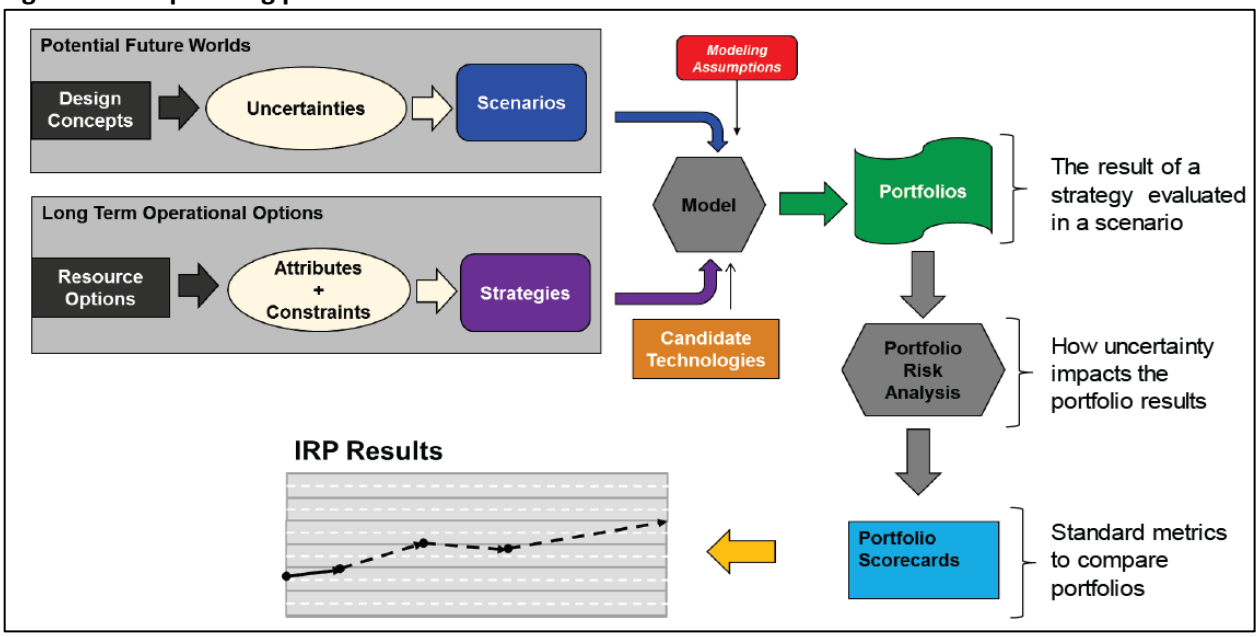
III. TVA's Planning Methods

In general, the goal of an IRP process is to facilitate the determination of a utility's future resource additions and retirements based on criteria such as the needs of the electric system, future demand, and environmental and climate goals. Once designed and approved, an IRP can function as a reference point in evaluating future resource decisions. TVA identifies the resources to include in its investment strategies, assesses multiple possible investment strategies, and then creates ranges of capacity additions or retirements for each strategy under different conditions. Throughout its planning process, TVA does not make publicly available the assumptions, parameters, and other modeling details used to arrive at the results. This black box approach makes it difficult to disentangle how TVA arrived at specific results, including its final recommended planning ranges. All three of TVA's previous IRPs (2011, 2015, and 2019) describe the use of a similar planning processes (see Figure 4).

1. TVA forecasts customer peak electric demand, including an additional reserve amount for contingencies.
2. TVA determines its existing and expected future power supply, or peak capacity.
3. TVA calculates a "capacity gap" between available supply and expected demand.
4. TVA creates possible scenarios representing futures that are not in its control and strategies based on business decisions that are in its control.
5. TVA models the least-cost combination of resources that would meet demand.
6. TVA analyzes its proposed portfolios to determine their financial, operational, and environmental impacts.
7. TVA subjects its portfolios to sensitivity analysis to test their robustness to supply and demand disruptions, market conditions, weather, technological improvements, and economic cycles;[42]
8. TVA compares portfolios based on a series of scorecard metrics.
9. TVA summarizes the results of the analysis in Steps 5 - 7 and presents ranges of recommended resource adoption and retirement for short- and long-term capacity expansion. TVA does not make a determination at the end of its IRPs as to how it will act on the published planning ranges.

[42] Ibid, p. 6-10.

Figure 4. TVA planning process



Source: Reproduced from TVA. 2019 Integrated Resource Plan Volume I – Final Resource Plan. Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan. p. 6-1.

This section reviews these steps in more detail in the TVA context and provides examples from each IRP.

Estimating a capacity gap: Steps 1 – 3

The 2011, 2015 and 2019 TVA IRPs estimate electric demand, supply, and a capacity gap using three steps:

1. **Peak demand:** Future demand for the IRP models is determined using projections of long-term growth in electric sales and peak demand based on quantitative models that link sales to factors driving growth, including economic activity, electric rates, and customer retention.[43]
2. **Power supply:** TVA then identifies what generating capacity is available to it today and in the near future—the available power supply—by examining TVA-owned resources, budgeted and approved projects, updates to existing assets, and its existing power purchase agreements.[44]
3. **Capacity gap:** TVA calculates its "capacity gap:"[45] the difference between TVA's peak demand (including its reserve requirement) and its power supply.[46]

[43] TVA. *Integrated Resource Plan: 2015 Final Report*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/documents/2015_irp.pdf?sfvrsn=4892374_0. p. 26.
[44] Ibid, p. 30.
[45] Also known as the "energy gap." Ibid, p. 33.
[46] Ibid, p. 33.

Creating portfolios: Steps 4 – 5

TVA constructs a series of alternative possible future scenarios with different economic, regulatory, technological, and social conditions that are not under TVA's control.[47] TVA then develops multiple possible business strategies.[48] A portfolio represents the resulting capacity addition plan from the application of a TVA business strategy to a scenario.[49]

TVA's 2019 IRP presents five scenarios:

- a current outlook scenario with modest growth and increasing efficiencies with little or no load growth;
- a scenario with an economic downturn;
- large-scale load growth scenario in the Tennessee Valley;
- a scenario with rapid policy-induced reduction in greenhouse gas emissions,
- increasing consumer demand for distributed energy resources (DERs); and
- a scenario in which new large-scale nuclear capacity is curtailed in favor of other options.[50]

TVA's 2019 IRP developed business strategies included:

- a base case retaining TVA's existing assumptions on cost trajectories;
- a move towards promoting DERs;
- an emphasis on investment in smaller units of capacity to promote operational flexibility;
- promoting electrification and demand management to control load shape; and
- promoting renewables at all scales.[51]

Each scenario-strategy combination (thirty in total) in TVA's 2019 IRP was used to develop a portfolio of resource additions and retirements which are then subjected to modeling (see Table 3). Each scenario-strategy combination represents a portfolio of potential capacity changes for TVA to make in response to the development of the capacity gap, conditions in the economy, policy, and electricity markets. TVA's next step is to determine the exact amount of capacity changes represented by those portfolios.

[47] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan. p. 2-1.
[48] TVA. *Integrated Resource Plan: 2015 Final Report*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/documents/2015_irp.pdf?sfvrsn=4892374_0. p. 12.
[49] Ibid, p. 12.
[50] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan. p. 2-1.
[51] Ibid, p. 2-2.

Table 3. TVA's 2019 scenario-strategy combinations (portfolios)

Scenarios	Strategies				
	A: Base Case	B: Promote DER	C: Promote Resiliency	D: Promote Efficient Load Shape	E: Promote Renewables
1: Current Outlook	1A	1B	1C	1D	1E
2: Economic Downturn	2A	2B	2C	2D	2E
3: Valley Load Growth	3A	3B	3C	3D	3E
4: Decarbonization	4A	4B	4C	4D	4E
5: Rapid DER Adoption	5A	5B	5C	5D	5E
6: No Nuclear Extensions	6A	6B	6C	6D	6E

Source: Reproduced from TVA. 2019 Integrated Resource Plan Volume I – Final Resource Plan. Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan. p. 7-1.

Assessing the portfolios: Steps 6 – 8

TVA models each resource portfolio for cost effectiveness, technical potential, fuel requirements, and operating limits.

The portfolios' precise capacity expansions are determined using a resource expansion optimization model called System Optimizer[52] from ABB that minimizes the cumulative present value of total revenue requirements (PVRR) subject to a series of constraints selected by TVA including limitations on the balance of supply and demand, the energy balance, the reserve margin, generation and transmission operation, fuel purchases and utilization, new resource capital and operating costs, existing resource and operating costs, fuel prices, and the pace of distributed generation and storage adoption.[53] Optimal (or least-cost) modeling results are strongly dependent on the modeler's selection of parameter values and other settings; different selections would lead to a different "optimal" result. TVA specifies modifications to the constraints for optimization for each scenario-strategy pairing. System Optimizer uses a dispatch methodology for the 20 years of the IRP (the study period) and a "representative hours" approach in which the generation and load (the amount of electricity demanded over a period of time) values for given periods in a week are scaled to span entire weeks, and days in a month. The capacity path with the lowest PVRR—based on TVA's parameter selections—becomes the optimized capacity plan or portfolio.

Each capacity portfolio is then subject to a financial analysis using the MIDAS[54] hourly production cost model that determines a PVRR with additional variables such as cash flows associated with financing over the full 20-year study period.[55] The model also calculates a system average costs to gauge the rate impacts

[52] ABB. "Adaptable, integrated optimization." Available at: https://new.abb.com/power-generation/solutions/power-plant-optimization.

[53] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan,p. 6-9.

[54] ABB. "Adaptable, integrated optimization." Available at: https://new.abb.com/power-generation/solutions/power-plant-optimization.

[55] TVA. *Integrated Resource Plan: 2015 Final Report*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/documents/2015_irp.pdf?sfvrsn=4892374_0. p. 63.

of a given portfolio.[56] TVA discounted future costs and revenue at 8 percent in the 2019 IRP,[57] the 2015 IRP,[58] and the 2011 IRP.[59]

The capacity portfolios are then subject to analysis to assess the sensitivity of modeling results to changes in key variables. In the 2019 IRP, for example, the variables used to assess uncertainty included: the prices of natural gas and coal, financial parameters like interest rates or operation and maintenance costs, and net sales forecast uncertainty for peak and energy (including demand, energy efficiency, electrification, behind-the-meter-solar, and combined heat and power).[60]

Each portfolio's performance is compared using a standardized series of metrics gathered in a scorecard. The 2019 scorecard's metrics included PVRR, CO_2 emissions, waste consumption of water, and per capita income for the Tennessee Valley among others (see Table 4).

[56] Ibid.

[57] Ibid, p. 6-9.

[58] TVA. *Integrated Resource Plan: 2015 Final Report*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/documents/2015_irp.pdf?sfvrsn=4892374_0. p. 63.

[59] TVA. 2011. *Integrated Resource Plan: TVA's Environmental & Energy Future.* Available at: https://www.nrc.gov/docs/ML1217/ML12171A189.pdf. p. 100.

[60] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan,p. 6-12.

Table 4. TVA 2019 IRP Scorecard

Category	Metric	Formula
Cost	PVRR ($Bn)	Present Value of Revenue Requirements over Planning Period
	Total Resource Cost ($Bn)	PVRR + Participant cost net of savings (bill savings, tax credits)
	System Average Cost ($/MWh)	$\frac{\text{NPV Rev Reqs (2019–2038)}}{\text{NPV Sales (2019–2038)}}$
Risk	Risk/Benefit Ratio	$\frac{95\text{th}_{(PVRR)} - \text{Expected}_{(PVRR)}}{\text{Expected}_{(PVRR)} - 5\text{th}_{(PVRR)}}$
	Risk Exposure ($Bn)	$95\text{th Percentile}_{(PVRR)}$
Environmental Stewardship	CO2 (MMTons)	Average Annual Tons of CO2 Emitted During Planning Period
	CO2 Intensity (lbs/MWh)	$\frac{\text{Pounds CO2 (2019–2038)}}{\text{MWh Generated \& Purchased (2019–2038)}}$
	Water Consumption (MMGallons)	Average Annual Gallons of Water Consumed During Planning Period
	Waste (MMTons)	Average Annual Tons of Coal Ash and Scrubber Residue During Planning Period
	Land Use (Acres)	Acreage Needed for Expansion Units in Each Portfolio (2038)
Operational Flexibility	Flexible Resource Coverage Ratio	$\frac{\text{Flexible Capacity Available for Max 3–Hour Ramp in each Strategy (2038)}}{\text{Capacity Required for Max 3–Hour Ramp in each Scenario (2038)}}$
	Flexibility Turn Down Factor	$\frac{\text{"Must Run" + "Non–Dispatchable" (2038)}}{\text{Sales (2038)}}$
Valley Economics	Percent Difference in Real Per Capita Income	Percent Difference in Real Per Capita Personal Income Compared to the Base Case (for each scenario)
	Percent Difference in Employment	Percent Difference in Non-Farm Employment Compared to the Base Case

Source: Reproduced from TVA. 2019 Integrated Resource Plan Volume I – Final Resource Plan. Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan,p. 6-15.

TVA's recommended capacity ranges: Step 9

Finally, TVA selects among the resource portfolios modeling to recommend capacity additions and retirements for each resource type. In contrast to the widely used practice of utility IRPs determining a single "preferred portfolio," TVA does not select a single portfolio or overall strategy in the recommendations of any of its IRPs. Instead, TVA publishes power supply ranges without making a specific recommendation based on prospective schedules of additions and retirements of each resource type. In its 2019 IRP, TVA's "target power supply ranges" represent the resulting minimum and maximum addition or retirement possibilities in the "current outlook scenario."[61] In its 2015 IRP, TVA's recommended power supply ranges draw from analysis on strategies that do not emphasize meeting needs with a specific resource type (i.e. TVA did not use strategies in a way that would "place specific targets on particular resource types"—for example, energy efficiency and renewables).[62] In both cases, TVA delineates the

[61] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan. p. 9-2.
[62] TVA. *Integrated Resource Plan: 2015 Final Report*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/documents/2015_irp.pdf?sfvrsn=4892374_0. p. 115.

circumstances in which analysis on its various portfolios ultimately contributes to the planning ranges it displays. Other electric utilities commonly use IRPs to recommend a single portfolio. A few examples, among many, of this practice are:

- The Northern Indiana Public Service Company's 2018 IRP selected a preferred plan among its various portfolios and provides a year-by-year snapshot of its chosen energy portfolio (Portfolio F)—the purchases leading up to which include solar, wind, battery storage, market purchases, and demand-side management—through 2038;[63]
- PacificCorp, in their 2023 IRP, publishes exact schedules for the retirement of coal and gas plans for their prospective resource mix from 2023 to 2052;[64]

TVA's failure to make firm recommendations on capacity addition and retirement limits the degree to which its IRPs can be treated as reliable indicators of TVA's future plans or metrics against which to compare TVA's past investments. For example, the 2019 IRP does not select portfolios constructed from the "Current Outlook" scenario, undermining evaluations of whether TVA is actually achieving a least-cost portfolio or aiming to achieve decarbonization goals. This lack of firm recommendations also limits the IRP's ability to function as a planning tool, as the capacity ranges proposed by TVA have been large—leaving open a broad set of plausible capacity additions or retirements. It may also result in ad hoc decision-making as TVA has no other benchmark for capacity additions beyond large ranges that can accommodate numerous conflicting possibilities, strategic investments (or lack thereof), and costs. There is little investigation of the feasibility of different capacity additions, nor of "all resource RFPs" that might solicit resources to meet TVA's target ranges. TVA also omits detailed timelines for the planned addition or retirement of resources, noting only that the ranges of additions and retirements should be met within five or ten years of the publication of the IRP.

IV. Comparing TVA's planning process to its evolving resource mix

TVA's additions and retirements planning ranges provide an overview of TVA's priorities over the last decade, in particular the extent to which TVA has shifted from coal- to gas-based generation. This section compares TVA's actual additions and retirements between 2011 and 2021 to the plans outlined in its 2011, 2015, and 2019 IRPs. The IRPs failed to:

- anticipate the size of coal retirements;
- limit the planned or actual growth of gas capacity; and
- plan adequately for a decarbonized gas system following 2019.

TVA's actual capacity additions and retirements can be calculated by subtracting its latest available

[63] NIPSCO. 2018. *Northern Indiana Public Service Company LLC Integrated Resource Plan.* Available at: https://www.nipsco.com/docs/librariesprovider11/rates-and-tariffs/irp/2018-nipsco-irp.pdf?sfvrsn=15. p. 172

[64] PacifiCorp. 2023. *2023 Integrated Resource Plan: Volume I.* Available at: https://www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/integrated-resource-plan/2023-irp/2023_IRP_Volume_I.pdf. p. 146-147.

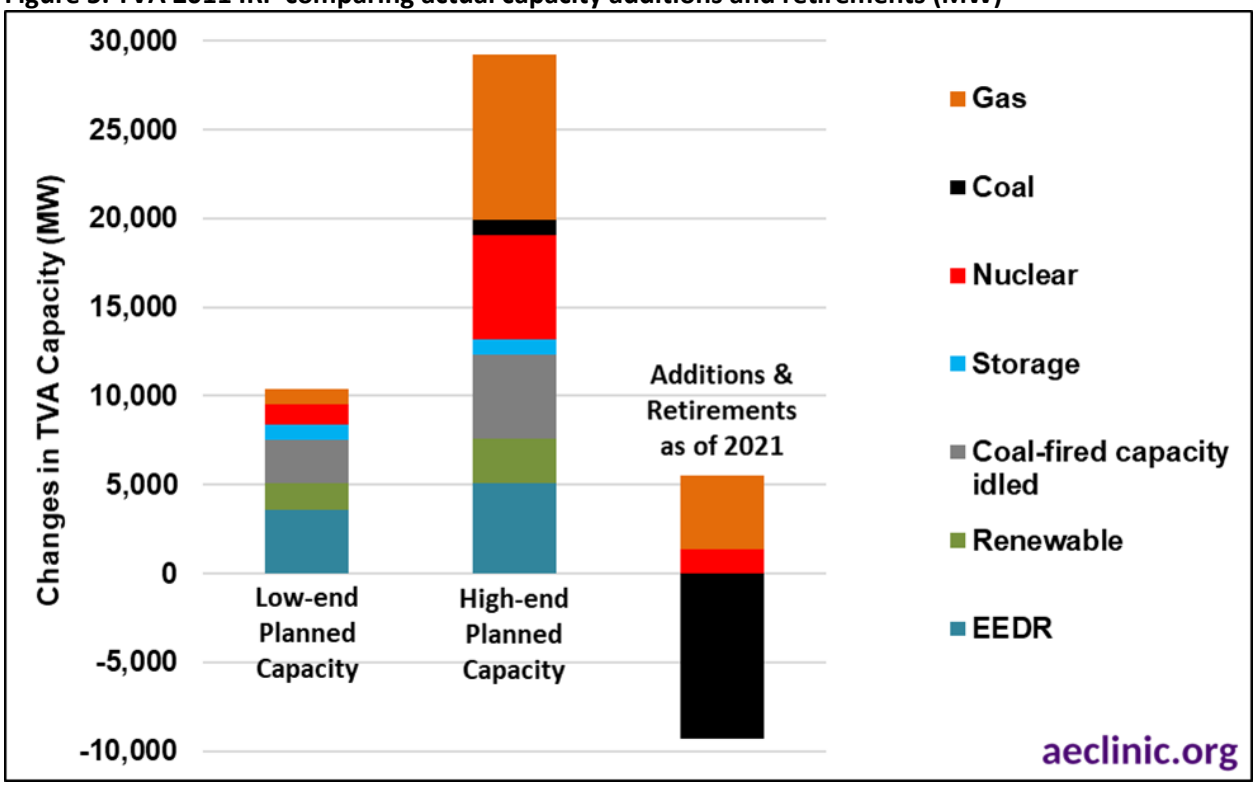
capacity data (2021) from the TVA capacity additions or retirements planned in the year the IRP was published (2011, 2015, or 2019). For example, TVA's gas capacity increased from 9,607 MW to 13,786 MW—resulting in an actual capacity additions of 4,178 MW. Comparing the actual capacity additions and retirements to their planned values can illustrate the extent of TVA's commitment to previous plans and the quality of assumptions or other aspects of the planning process. However more specific statements about their commitments to a particular strategy are precluded by TVA's lack of portfolio selection and opaque methods.

TVA publishes both short- (ten-year) and long-term (20-year) planning ranges in each of its IRPs (see Figure 5 through Figure 7). These planning ranges denote the amount of resource capacity TVA expects to add, idle, or retire by a given target year.

TVA's 2011 IRP failed to plan for coal retirements

Unlike later IRPs, the 2011 IRP planned for no coal retirements whatsoever; 2,400 MW to 4,700 MW of TVA's total 17,407 MW of coal capacity was planned to be idled through 2033 (see Figure 5). By 2021, TVA had already retired 9,327 MW of coal since 2011. TVA's additions (through 2021) of gas and nuclear are still within the 2011 IRP planned range: TVA has already added 4,178 MW of gas, 44 percent of the 2011 IRP's high-end goal for gas additions by 2029; and 1,343 MW of nuclear, 167 percent of the high-end goal for the period 2012-2029. The IRP did not anticipate the coal retirements that would occur in the coming decade and did not plan its other capacity additions accordingly. In fact, its high-end planning allows for a 900 MW addition of coal capacity. A full accounting of the reasons for TVA's failure to anticipate coal retirements would require further analysis, but the failure itself is indicative of a planning process with inaccurate load projections and/or mistaken core inputs or assumptions regarding coal's feasibility, cost, or environmental effects.

Figure 5. TVA 2011 IRP comparing actual capacity additions and retirements (MW)

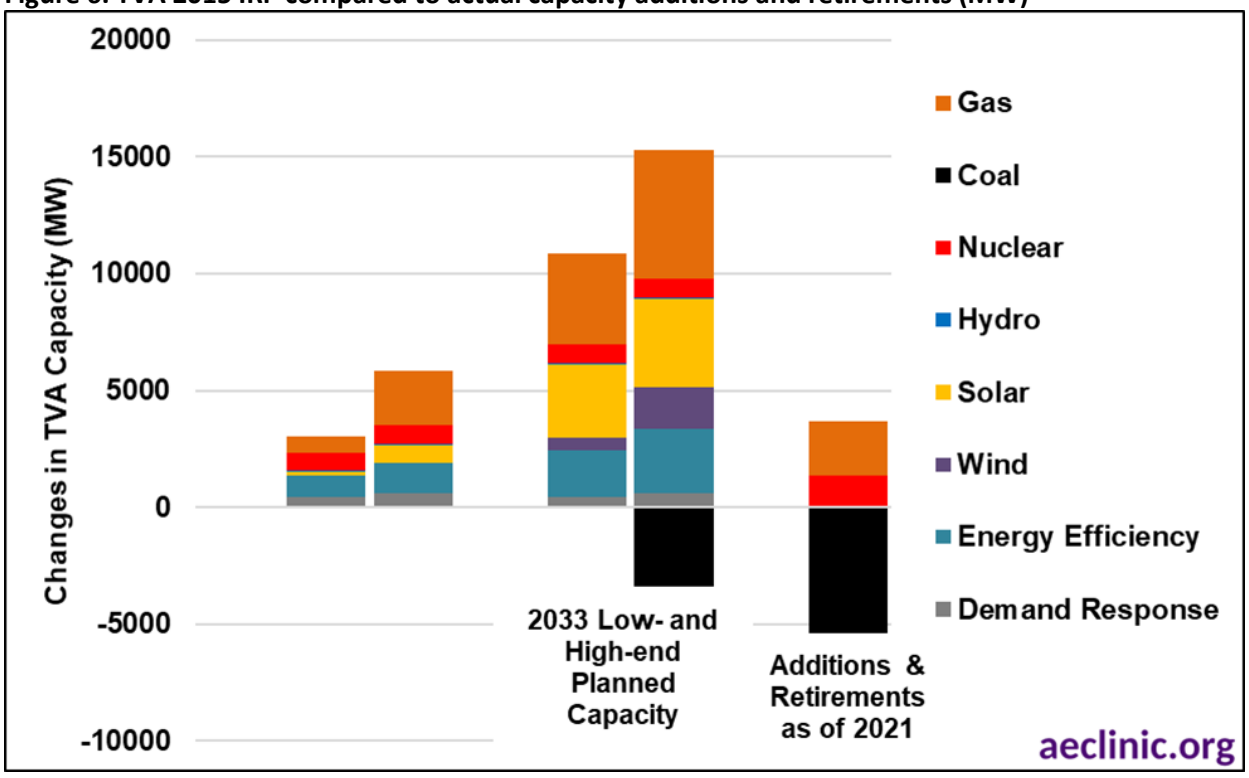


Note: Renewable capacity additions are not included in this graph due to a lack of available data on operating renewable capacity prior to 2018. High-end and low-end planned capacity are the maximum and minimums respectively for the resource planning ranges TVA proposes in its 2011 IRP. Finally, there are no specific timeframes for low-end and high-end planned capacity displayed in this figure because TVA assigns different timeframes to each resource (see Table 2).
Source: 1) TVA. 2011. Integrated Resource Plan: TVA's Environmental & Energy Future. Available at: https://www.nrc.gov/docs/ML1217/ML12171A189.pdf; 2) US EIA. September 22, 2022. Form EIA-923 detailed data with previous form data (EIA-906/920). Available at: https://www.eia.gov/electricity/data/eia923/.

TVA's 2015 IRP: expanding gas and nuclear

TVA' 2015 IRP planned for larger and more explicit commitments to specific renewables, such as wind and solar, and a firmer commitment to coal retirements (rather than idling coal capacity) (see Figure 6). TVA's coal retirements (2,331 MW since 2015) continued to greatly outpace its high-end predictions for both 2023 and 2033 in the 2015 IRP. Gas capacity additions by 2021 outpace the high end planned capacity additions through 2023 (2,331 MW of added gas capacity compared to no planned additions for 2023). The nuclear capacity added since 2015 exceeds the high end of planned capacity through 2023 and 2033 (both 800 MW). Once again, TVA underestimated the scale of subsequent coal retirements. Finally, while TVA does show expanded ranges for solar and wind capacity (previously combining them as "renewable" capacity in the 2011 IRP), the Authority provides insufficient data to assess the degree to which TVA's capacity fell within these planning ranges (see Table 1 for the data that are available via TVA's filings with the Securities and Exchange Commission (SEC)).

Figure 6. TVA 2015 IRP compared to actual capacity additions and retirements (MW)



Note: Gas in this figure is inclusive of both combustion turbine and combined cycle units. Data on renewable capacity additions are not included in this graph due to a lack of available data on operating renewable capacity prior to 2018. Planned capacity for 2033 is cumulative (i.e. includes the bars for 2023).
Source: 1) TVA. Integrated Resource Plan: 2015 Final Report. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/documents/2015_irp.pdf?sfvrsn=4892374_0.; 2) US EIA. September 22, 2022. Form EIA-923 detailed data with previous form data (EIA-906/920). Available at: https://www.eia.gov/electricity/data/eia923/.

TVA's 2019 IRP: A defunct IRP

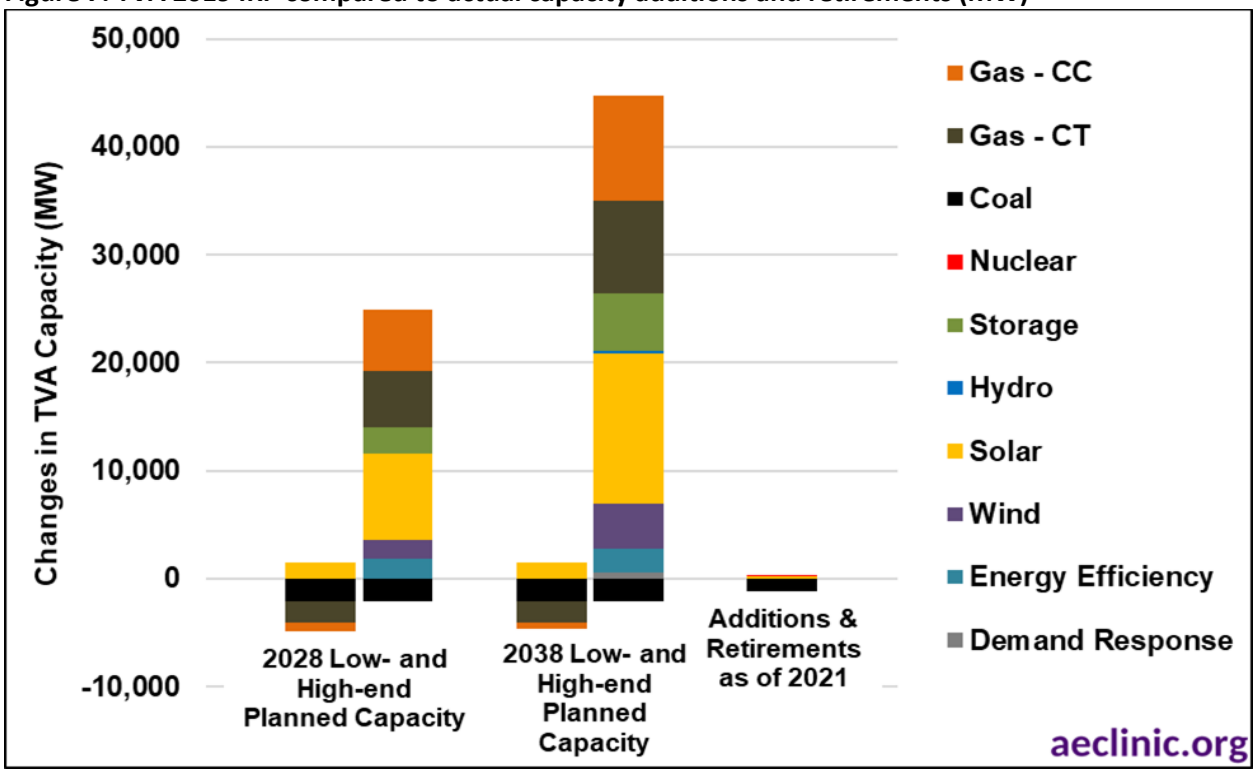
TVA's 2019 IRP plans for an acceleration of gas and solar capacity additions relative to the 2015 and 2011 IRPs (see Figure 7). As only two years passed between 2019 and the latest year of available capacity data from EIA, there is little to compare between actual and planned capacity changes. TVA has already retired 1,150 MW of coal—it planned to retire 2,100 MW at most by 2038—only promising to "evaluate" additional retirements of up to 2,200.[65] TVA also greatly expanded the scale of its gas planning ranges. The high-end planned capacity for 2028 and 2038 respectively is -2,000 to 8,600 for combustion turbines and -800 to 9,800 MW for combined cycle plants, together more than triple the high-end planned capacity for gas set in the 2015 IRP (2,300 MW for 2023 and 5,500 MW for 2033). TVA added 275.7 MW of solar capacity between 2018 and 2021, and another 150 MW by 2022—all of which was acquired through power

[65] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan. p. ES-4.

purchase contracts.[66] TVA has not added new owned- or purchased-wind capacity.[67] There is no schedule or chart tracking prospective gas additions, making it infeasible to assess the viability of gas additions at this scale (TVA has announced a number of specific gas additions since the IRP that can be used for comparison such as Kingston[68] and Cheatham[69].)

Finally, the 2021 announcement of TVA's net zero goal by 2050 renders the 2019 IRP defunct. Further, TVA cannot meet its obligations under the Paris Agreement or Federal executive orders based on this plan, due to the scale of planned gas additions.

Figure 7. TVA 2019 IRP compared to actual capacity additions and retirements (MW)



Note: Planned capacity for 2038 encompasses planned capacity for 2028.
Source: 1) TVA. 2019 Integrated Resource Plan Volume I – Final Resource Plan. Available at: https://www.tva.com/environment/environmental-stewardship/integrated-resource-plan..; 2) US EIA. September 22, 2022. Form EIA-923 detailed data with previous form data (EIA-906/920). Available at: https://www.eia.gov/electricity/data/eia923/.

Takeaways from the IRPs

Based on the assessment of TVA's planning process and the comparison of additions and retirements for

[66] SELC calculations using: TVA. "SEC Filings." Available at: https://tva.q4ir.com/financial-information/sec-filings/default.aspx.
[67] Ibid.
[68] TVA. 2023. "Kingston Fossil Plant Retirement." Available at: https://www.tva.com/environment/environmental-stewardship/environmental-reviews/nepa-detail/kingston-fossil-plant-retirement.
[69] TVA. 2023. "Cheatham County Generation Site." Available at: https://www.tva.com/environment/environmental-stewardship/environmental-reviews/nepa-detail/cheatham-county-generation-site.

each respective IRP:

1. TVA does not plan to halt the increase in gas capacity over the previous decade—its combined cycle and combustion turbine gas additions are larger than its solar and wind additions *combined* (up to 18,400 new gas proposed versus 1,500 MW to 14,000 MW of proposed wind and solar).
2. TVA's capacity planning ranges are of limited use in understanding its planning intentions. There are no prospective schedules for additions or retirements and the planning ranges are too large to draw useful conclusions regarding what would constitute success or failure of the planning exercise.
3. TVA does not publish or provide data on renewable capacity for the years 2011 to 2021 consistently across different data sources including U.S. EIA data, TVA's own publications, and data from the SEC.

V. TVA's 2019 IRP: A Case Study on the Cumberland Retirements

TVA's most recent IRP provides an opportunity for a more detailed assessment of planning methods and a comparison with related planning documents published in or after 2019: Cumberland Fossil Plant Environmental Impact Statement (EIS)—and its related system cost analysis—and a Concentric Energy Advisors review of recent studies critical of TVA planning.[70] A close examination of the Cumberland EIS and the Concentric Report indicates that:

1. The Cumberland EIS utilizes IRP results in a way that leads to incorrect conclusions;
2. TVA's individual resource (or site-specific) assessment methods (as exemplified by the Cumberland EIS) differ significantly in their assessments of viable capacity additions and retirements from the integrated methodology used in the Authority's IRP; and
3. Stakeholder processes make IRPs better, but the TVA process is not currently structured to facilitate effective stakeholder input.

TVA needs a new, up-to-date IRP, with a thorough stakeholder process to include the broadest set of ideas and solutions in an effort to keep ratepayer costs low while meeting TVA's and the nation's climate,

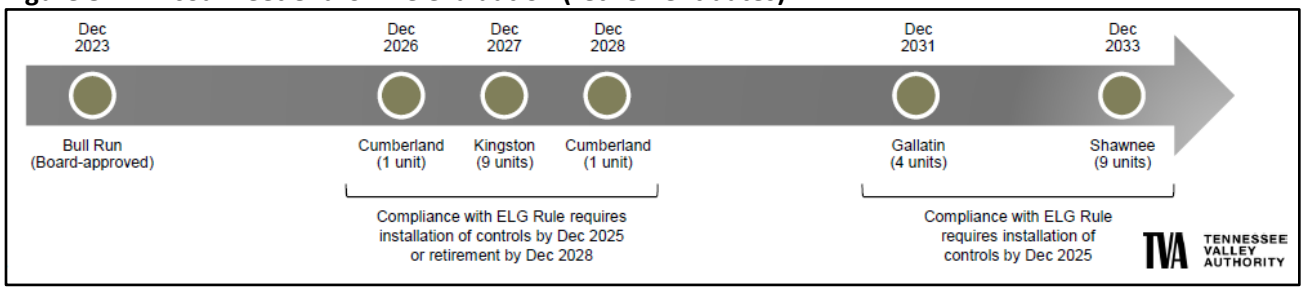
[70] 1) TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/2019-documents/tva-2019-integrated-resource-plan-volume-i-final-resource-plan.pdf?sfvrsn=44251e0a_4; 2) TVA. 2022. *Cumberland Fossil Plant Retirement. Final Environmental Impact Statement.* Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/cumberland-fossil-plant-retirement-final-eis4eeac6f0-b6bf-4843-9881-75d19ccf8ede.pdf?sfvrsn=d61f6b6f_7; 3) Concentric Energy Advisers. 2022. "Assessment of the Draft Environmental Impact Study and Response to Certain Reports." In *Cumberland Fossil Plant Retirement Final Environmental Impact Statement.* Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/cumberland-fossil-plant-retirement-final-eis4eeac6f0-b6bf-4843-9881-75d19ccf8ede.pdf?sfvrsn=d61f6b6f_7

environmental and economic development standards.

The Cumberland 1 and 2 retirements are not modeled in TVA's 2019 IRP.

Since its last IRP in 2019, TVA has put forth other plans that substantively disagree with the IRP's recommended planning ranges. TVA 2019 IRP calls for retirement of the Paradise 3 coal unit (1,150 MW nameplate capacity) in 2020 and Bull Run coal unit (950 MW) in 2023, and plans to "evaluate retirements of up to 2,200 MW of additional coal capacity if cost-effective."[71] TVA's Cumberland Fossil Plant Retirement plan, however, proposes additional coal unit retirements beyond the 2019 IRP plans: retiring an additional 1,300 MW by 2026 and another 1,300 MW by 2028. The Cumberland EIS also recommends a complete retirement of all TVA coal units: 9 units (1,700 MW) at Kingston in 2027, 4 units (1,255 MW) at Gallatin in 2031, and 9 units (1,575 MW) at Shawnee in 2033 (see Figure 8). The latter two retirements represent significant departures from the IRP that impact on major resource decisions not contemplated in the IRP. The additional 2,200 MW of retirements that TVA stated it would evaluate is still less than what is proposed in the Cumberland Fossil Retirement Plan, and also less than the full retirement of all TVA coal units. Cumberland EIS planning circumvents the requirements of the IRP, including stakeholder engagement—indicating that the IRP could have been more aggressive in planning for coal retirements.

Figure 8. TVA coal fleet end-of-life evaluation (retirement dates)



Source: Cumberland EIS Appendix B p.3

TVA incorrectly claims that the Cumberland Unit 1 retirement and replacement (or "Proposed Action Alternatives") is consistent with its IRP:

> *TVA's Proposed Action Alternatives align with the 2019 IRP near-term actions to evaluate engineering end-of-life dates for aging generation units to inform long-term planning and to enhance system flexibility to integrate renewables and distributed resources…The Preferred Alternative replaces coal-fired generation, consistent with the target supply mix adopted in the 2019 IRP and the Coal End-of-Life Evaluation for the aging coal fleet, and meets the purpose and need of the proposed action to have the replacement generation operating by 2026.*[72]

[71] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/2019-documents/tva-2019-integrated-resource-plan-volume-i-final-resource-plan.pdf?sfvrsn=44251e0a_4. p.ES-4.

[72] TVA. 2022. *Cumberland Fossil Plant Retirement. Final Environmental Impact Statement.* Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/cumberland-fossil-

> *The decision associated with this EIS is a specific, discrete component of TVA's blended Asset Strategy and consistent with the recommended target power supply mix in the 2019 IRP.*[73]

In fact, none of the 30 scenario-strategy combinations in the IRP anticipate additional coal retirements (beyond Paradise 3 and Bull Run) earlier than 2032 (although the model was permitted to select earlier retirements if found to be cost effective[74]). In contrast, TVA's Cumberland EIS makes a clear and compelling case for accelerating TVA coal plant retirements, citing the age and deterioration of TVA's fleet:

> *Following the completion of the Tennessee Valley Authority (TVA) 2019 Integrated Resource Plan (IRP), TVA began conducting end-of-life evaluations of its operating coalfired generating plants not already scheduled for retirement to inform long-term planning. This evaluation confirmed that the aging TVA coal fleet is among the oldest in the nation and is experiencing deterioration of material condition and performance challenges. The performance challenges are projected to increase because of the coal fleet's advancing age and the difficulty of adapting the fleet's generation within the changing generation profile. The continued long-term operation of some of TVA coal plants, including the Cumberland Fossil Plant (CUF), is contributing to environmental, economic, and reliability risks.*[75]

TVA's 2019 IRP does not anticipate a need to retire aging coal plants and therefore cannot provide a useful reference in making critical resource decisions.

The system planning presented in the 2019 IRP does not anticipate this need. This is a critical planning issue for TVA. An IRP that fails to consider a need to retire old and deteriorating coal plants—some of which are over 60 or more years old—cannot act as a useful reference in TVA's critical resource decisions. New IRP planning is essential given TVA's transformative resource retirement plan presented in the 2022 Cumberland EIS.

It is because of this divergence from TVA's most recent IRP that TVA and Concentric refer to new solar, storage and energy efficiency resources proposed as replacements for Cumberland as "additional" to the amounts already planned in the IRP (and not as part of the IRP's range of planned resource):

plant-retirement-final-eis4eeac6f0-b6bf-4843-9881-75d19ccf8ede.pdf?sfvrsn=d61f6b6f_7. p.iii,v

[73] TVA. 2022. "Appendix B: TVA Alternatives Evaluation." In Cumberland Fossil Plant Retirement: *Final Environmental Impact Statement*. p.22

[74] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/2019-documents/tva-2019-integrated-resource-plan-volume-i-final-resource-plan.pdf?sfvrsn=44251e0a_4. p.5-7.

[75] TVA. 2022. *Cumberland Fossil Plant Retirement. Final Environmental Impact Statement.* Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/cumberland-fossil-plant-retirement-final-eis4eeac6f0-b6bf-4843-9881-75d19ccf8ede.pdf?sfvrsn=d61f6b6f_7. p.iii

> *Solar additions tied to a replacement of the first CUF unit would need to be in addition to the 10,000 MW already included in TVA's base plans… Analysis indicated a need for 3,000 MW of additional solar to replace the annual energy of the first CUF unit, on top of the 10,000 MW of solar already included in the base plan.*[76]
>
> *The 2019 IRP range includes battery storage up to 2,400 MW by 2028 and up to 5,300 MW by 2038 (depending on technology costs, performance, and load growth). The Grid Strategies report characterizes batteries as a resource akin to a baseload generating resource capable of providing baseload energy and capacity across a majority of hours, while the Synapse report adds 32,000 MW of battery storage plus nearly 30,000 MW of solar in the Solar/Storage Replacement scenario.*[77]
>
> *Moreover, the amount of savings available at those cost levels in TVA's 2019 IRP was constrained to reflect adoption limitations with the underlying delivery strategies and incentive levels. This point was entirely ignored by the Grid Strategies report, which referenced the same source as the Synapse report to support the assertion that more energy efficiency savings were readily available.*[78]

TVA understates the potential for solar and storage resources in its 2019 IRP—to the extent that subsequent reports highlight the need for solar and storage additions well beyond the IRP's highest proposals for the same periods. If Cumberland retirement and replacement was within the (broad) parameters of the IRP, then the new resources proposed in the Cumberland Alternatives would be among the gas, solar and storage additions proposed within the IRP. In addition to -2,800 to 10,900 MW of new gas (combined cycle and combustion turbine) generation by 2028, the TVA 2019 IRP calls for:[79]

- 1,500 to 8,000 MW of new solar by 2028,
- From 0 to 2,400 MW of new storage by 2028, and
- Energy efficiency savings from 0 to 1,800 MW by 2028.

TVA and Concentric describe alternatives proposed to replace Cumberland as "in addition" to those planned amounts. TVA argues that Cumberland 1 can be replaced with 3,000 MW of new solar and 1,700 MW of new batteries[80]; the same amounts would be needed to replace the second unit. (TVA has not

[76] TVA. 2022. "Appendix B: TVA Alternatives Evaluation." In Cumberland Fossil Plant Retirement: *Final Environmental Impact Statement*. p.13, 14.
[77] TVA. 2022. "Appendix Q – Concentric Report – Response to Synapse and Goggin Reports." In *Final Environmental Impact Statement*. p.12.
[78] Cumberland EIS Appendix Q p.11
[79] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/2019-documents/tva-2019-integrated-resource-plan-volume-i-final-resource-plan.pdf?sfvrsn=44251e0a_4. p. 9-3 – 9-4.
[80] TVA. 2022. *Cumberland Fossil Plant Retirement. Final Environmental Impact Statement.* Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/cumberland-fossil-plant-retirement-final-eis4eeac6f0-b6bf-4843-9881-75d19ccf8ede.pdf?sfvrsn=d61f6b6f_7. p.53

presented modeling of the replacement of the second unit by any alternative.[81])

Together Cumberland 1 and 2 are 32 percent of TVA's coal capacity and 7 percent of its total capacity: Cumberland's 2026-2028 retirement is not a small change for TVA.[82] This major divergence from TVA's already three-year old 2019 IRP, should have been presented as a new IRP or (equivalently) with full reporting of modeling assumptions, methods, and results, updated to current-year knowledge and expectations, and made fully available for stakeholders and their third-party experts to review. Instead, new IRP-type modeling results that include the unplanned 2023 and 2026 Cumberland retirements were presented in an Appendix to the EIS as a 23-page PowerPoint slide deck, without a full reporting of modeling assumptions, methods, and results.[83]

TVA's modeling assumptions include numerous questionable choices and out-of-date values.

TVA incorrectly assumes that wind generation cannot be part of a viable replacement for Cumberland. The TVA 2019 IRP calls for sunsetting of existing wind contracts and no additional wind investments in the 20-year planning period, outside of an exploration of the sensitivity of modeling results to reductions in TVA's forecasted wind capital costs.[84] Alternatives A, B, and C do not include wind: "Not selected due to low wind speeds in Tennessee Valley and higher transmission costs for out-of-Valley wind, both of which increase relative costs. Wind can provide dependable capacity in both summer and winter, though intermittent."[85]

Concentric's assessment of the draft Cumberland EIS explains that TVA's wind capital cost assumption of $1,807 per kilowatt (kW) is higher than other recent estimates because it includes interconnection costs.[86] NREL's 2022 ATB resource costs, which also include interconnection costs[87], price new wind at $1,462 per

[81] TVA. 2022. *Cumberland Fossil Plant Retirement. Final Environmental Impact Statement.* Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/cumberland-fossil-plant-retirement-final-eis4eeac6f0-b6bf-4843-9881-75d19ccf8ede.pdf?sfvrsn=d61f6b6f_7. p.22; TVA. 2022. "Appendix B: TVA Alternatives Evaluation." In Cumberland Fossil Plant Retirement: *Final Environmental Impact Statement*. p.8

[82] TVA's nameplate coal capacity was 8,080 MW and total generation capacity was 35,866 MW as of 2021 Form EIA-860. Cumberland 1 and 2 are each 1,300 MW.

[83] TVA. 2022. "Appendix B: TVA Alternatives Evaluation." In Cumberland Fossil Plant Retirement: *Final Environmental Impact Statement*.

[84] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/2019-documents/tva-2019-integrated-resource-plan-volume-i-final-resource-plan.pdf?sfvrsn=44251e0a_4. p.ES-4 and ES-11

[85] TVA. 2022. "Appendix B: TVA Alternatives Evaluation." In Cumberland Fossil Plant Retirement: *Final Environmental Impact Statement*. p.15

[86] TVA. 2022. "Appendix Q – Concentric Report – Response to Synapse and Goggin Reports." In *Final Environmental Impact Statement*. p.8

[87] See https://atb.nrel.gov/electricity/2022/definitions#capex.

kW;[88] Concentric and the TVA 2019 IRP both cite NREL's 2019 ATB costs.[89] NREL's latest wind cost estimates—including interconnection costs—represents a 19 percent decrease from the costs used in TVA modeling. Based on these lower costs, updating assumptions in TVA's modeling has the potential to result in a recommendation for investment in new wind resources.

TVA wrongly assumes that energy efficiency cannot be part of a viable replacement for Cumberland. Alternatives A, B, and C do not include energy efficiency: "Dismissed as EE programs take time to scale and market, while also facing increasing costs for higher depth and penetration levels. EE is well-positioned to help TVA absorb load growth resulting from increased electrification of the economy in the future."[90] Concentric argues that additional energy efficiency savings—beyond the 1,800 MW by 2028 and 2,200 MW by 2038 planned for in TVA's 2019 IRP—are "overly optimistic"[91] Concentric disagrees with alternative modeling showing substantial energy savings at a low cost by 1) rejecting analysis that assumes that upfront efficiency costs can be financed over their lifetime (rather than paid in a lump sum up front), and 2) by criticizing higher cost efficiency investments allocated by other utilities to disadvantaged communities.

U.S. Energy Information Administration (EIA) data (self-reported by utilities) on energy efficiency savings reports 4.0 MW of incremental savings for TVA in 2019, 3.4 MW in 2020 and 1.7 MW in 2021.[92] TVA's slow progress towards meeting its 1,800 MW by 2028 and 2,200 MW by 2038 energy efficiency goals suggest a lot of potential still available for new and low-cost savings measures.

TVA implausibly assumes that demand response cannot be part of a viable replacement for Cumberland. TVA 2019 IRP's range of resource plans includes 0 to 500 MW of demand response (not counting expiring or retiring capacity) by 2028[93] and calls for a "short term action" market potential study for energy efficiency and demand response (which has not yet been completed three years after the publication of the IRP[94]). Cumberland Alternatives A, B, and C do not include demand response: "Dismissed as they are limited in the number of calls available and do not provide reliable firm, dispatchable power. DR can help TVA absorb load growth resulting from increased electrification of the economy and allow TVA to offset

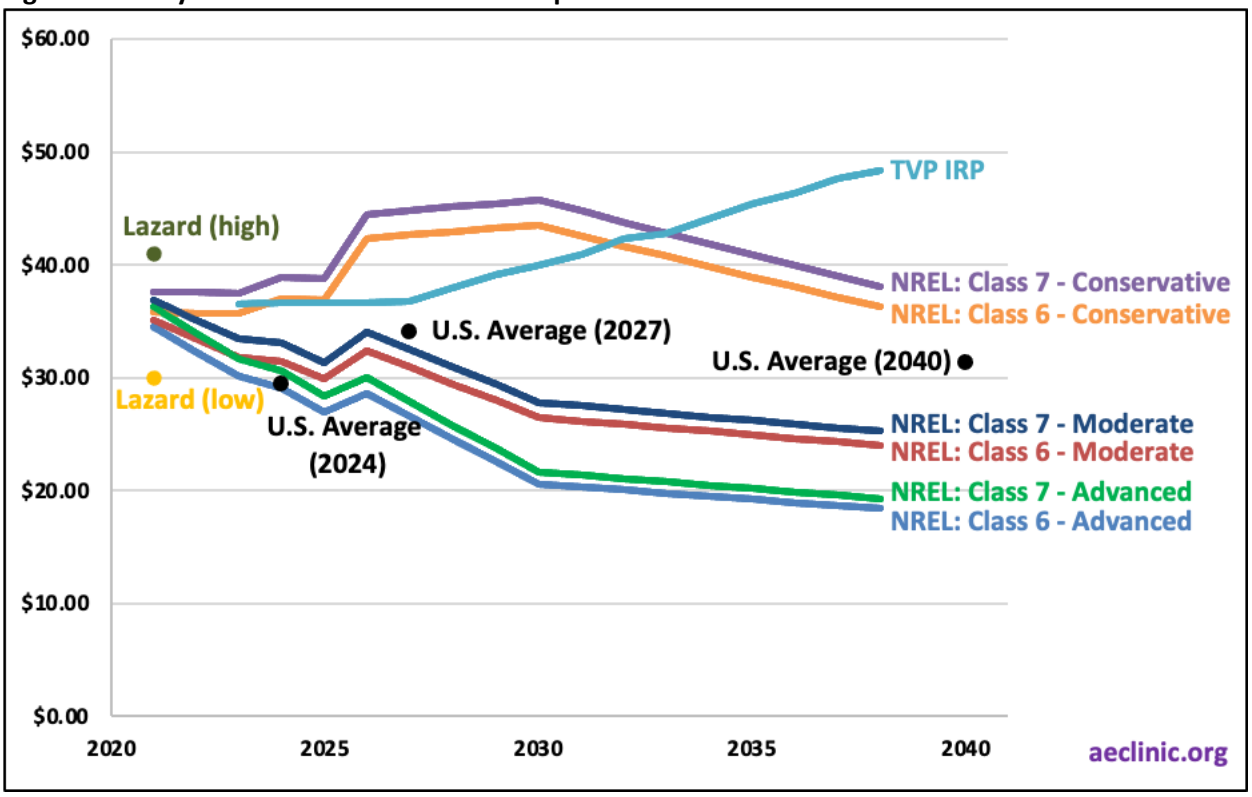
[88] NREL. "2022 Electricity ATB Technologies and Data Overview." Available at: https://atb.nrel.gov/electricity/2022/index.
[89] TVA. 2022. "Appendix Q – Concentric Report – Response to Synapse and Goggin Reports." In *Final Environmental Impact Statement*. p.8
[90] TVA. 2022. "Appendix B: TVA Alternatives Evaluation." In Cumberland Fossil Plant Retirement: *Final Environmental Impact Statement*. p.15
[91] TVA. 2022. "Appendix Q – Concentric Report – Response to Synapse and Goggin Reports." In *Final Environmental Impact Statement*. p. 8-11
[92] U.S. EIA. 2022. *Annual Electric Power Industry Report, Form EIA-861 detailed data files.* Available at: https://www.eia.gov/electricity/data/eia861/.
[93] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/2019-documents/tva-2019-integrated-resource-plan-volume-i-final-resource-plan.pdf?sfvrsn=44251e0a_4. p.ES-4
[94] TVA. 2022. "Appendix Q – Concentric Report – Response to Synapse and Goggin Reports." In *Final Environmental Impact Statement*. p.12

physical capacity needs."[95]

TVA improperly finds new gas generation to be more cost effective than renewables. TVA's modeling[96] concludes that system costs with the addition of a 1,450 MW gas combined cycle generator are $1.83 billion (20-year net present value (NPV)) lower than the addition of 3,000 MW solar and 1,700 MW storage—an added cost found by TVA to be 10 times greater than the cost of retirement without replacement. TVA's 20-year NPV system costs in the 2019 IRP range from $100 to 125 billion; but the financial analysis provided with the Cumberland EIS does not report several key data points essential to an effective third-party review: the added system cost of the gas combined cycle Alternative A, assumed gas prices and other commodity prices, and new resource costs.

TVA wrongly assumes that solar cannot be part of a viable replacement for Cumberland. The TVA 2019 IRP assumes solar levelized costs of energy to be $36.49 in 2023 rising to $48.40 in 2038, values that are substantially higher than other industry projections, particular in later years when TVA's solar cost assumptions exceed all common industry estimates (see Figure 9).

Figure 9. Utility-scale solar levelized cost comparison



Note. Class 6 and 7 resources refer to the NREL Annual Technology Baseline's solar resource classes, which vary based on the

[95] TVA. 2022. "Appendix B: TVA Alternatives Evaluation." In Cumberland Fossil Plant Retirement: *Final Environmental Impact Statement*. p.15

[96] TVA. 2022. *Cumberland Fossil Plant Retirement. Final Environmental Impact Statement.* Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/cumberland-fossil-plant-retirement-final-eis4eeac6f0-b6bf-4843-9881-75d19ccf8ede.pdf?sfvrsn=d61f6b6f_7. p. 80.

irradiance of the solar resource. Class 6 resources experience global horizontal irradiance of between 4.5 – 4.75 kWh/m²/day. Class 7 resources experience 4.25 – 4.5 kWh/m²/day.
Source: 1) TVA. 2019.TVA 2019 IRP. Figure 8-14 Wind and Solar Cost Comparison. p.8-14. Data extracted with WebPlotDigitizer; 2) LAZARD. 2021. Levelized Cost of Energy Analysis – Version 15.0. Available at: https://www.lazard.com/media/451881/lazards-levelized-cost-of-energy-version-150-vf.pdf. p. 2; 3) NREL. 2022. Annual Technology Baseline (ATB). Available at: https://atb.nrel.gov/electricity/2022/data; 4) NREL. "Utility-Scale PV." Available at: https://atb.nrel.gov/electricity/2022/utility-scale_pv; 5) U.S. EIA. 2022. "Levelized Costs of New Generation Resources in the Annual Energy Outlook 2022." Available at: https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf. p. 4.

U.S. EIA data report no growth in Tennessee utility-owned solar generation in 2019, 2020, or 2021 (solar capacity remained constant at 1.6 MW, with ownership by Nashville Electric Service). Total utility-scale solar located in Tennessee rose from 181 MW in 2018 up to 194 MW in 2021, none of which reported TVA ownership.[97] TVA has sharply increased its purchased solar power since 2018, indicating that it has much more room to add solar within its 2019 planning ranges. TVA added 425.7 MW of solar—entirely through power purchase contracts—between 2018 and 2022.[98] The TVA 2019 IRP proposes 1,500 to 8,000 MW of solar additions by 2028 and up to 14,000 MW by 2038.[99]

TVA without adequate evidence assumes that storage cannot be part of a viable replacement for Cumberland. TVA's assumed battery storage costs rely on its in-house estimation of uncertainty in future battery operation and on the assumption that existing battery cost projections are vulnerable to unexpected increases in fixed operations and maintenance. While it may be that this impactful choice can be substantiated, TVA has not provided sufficient evidence to demonstrate the reasonableness of the assumption.

It is also important to note that TVA's IRP and the Cumberland EIS plan take only 4-hour batteries into consideration, excluding the 8-hour and 10-hour batteries that are expected to form part of a needed suite of flexible, dispatchable peak resources within TVA's planning period. For instance, C Power procured two 8-hour lithium-ion battery systems in early 2022 to provide peak energy in California.[100]

The TVA 2019 IRP plans for 2,400 MW battery storage by 2028 and up to 5,300 MW by 2038.[101] Concentric compares additional storage in the Cumberland Alternative C to U.S. current-day installed battery resources:

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[97] U.S. EIA. 2022. *Annual Electric Power Industry Report, Form EIA-861 detailed data files.* Available at: https://www.eia.gov/electricity/data/eia861/.
[98] *SELC calculations using: TVA. "SEC Filings." Available at: https://tva.q4ir.com/financial-information/sec-filings/default.aspx*.
[99] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/2019-documents/tva-2019-integrated-resource-plan-volume-i-final-resource-plan.pdf?sfvrsn=44251e0a_4. p.ES-4
[100] Colthorpe, Andy. March 8, 2022. "Second eight-hour lithium-ion battery system picked in California long-duration storage procurement." *Energy Storage News.* Available at: https://www.energy-storage.news/second-eight-hour-lithium-ion-battery-system-picked-in-california-long-duration-storage-procurement/
[101] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/2019-documents/tva-2019-integrated-resource-plan-volume-i-final-resource-plan.pdf?sfvrsn=44251e0a_4. p.ES-4

> *In 2019, the U.S. Energy Information Administration indicated there was a total combined battery storage capacity of about 1,000 MW which grew to 1,500 in 2020 and then to over 4,500 in 2021. As part of Alternative C, adding 1,700 MW of storage by 2026 for the CUF retirement would result in TVA adding, owning, and operating more battery storage capacity over the next 4 years than the entire United States had in 2020. (Cumberland EIS Appendix Q p.15)*

This comparison of planned U.S. storage capacity in 2026 to existing capacity in 2021 muddies an important concern in electric resource planning and obscures the real potential to deploy cost effective peaking resources to TVA customers' benefit. Far from the 4,500 MW battery storage in operation in the United States in 2021, U.S. EIA's 2022 expectation for 2025 battery storage capacity is 30,000 MW;[102] a recent Bloomberg energy news report forecasts U.S. battery capacity of 50,000 MW in 2025 and 110,000 MW in 2030.[103] An additional 1,700 MW of storage as proposed in Alternative C would be an important part of that U.S. total, but it would in no way dwarf nationwide storage capacity as suggested by Concentric.

TVA's Cumberland replacement cost comparison appears to omit carbon prices. The TVA 2019 IRP assumes a $0 carbon price in its Current Outlook, Economic Downturn, Rapid DER Adoption and No Nuclear Extension future scenarios; an approximately $5 per ton in 2025 rising to $7 per ton in 2038 carbon price in the Valley Load Growth scenario; and an approximately $20 per ton in 2025 rising to $40 per ton in 2038 carbon price in the Decarbonization scenario.[104] (The IRP also explores a "double decarbonization" modeling sensitivity with carbon prices of $40 per ton in 2025 rising to $80 per ton in 2038.[105]) TVA does not reveal its policy assumptions used in developing the trajectories of these carbon prices nor does it explain why the prices vary the way they do in different scenarios. The addition of carbon prices in IRP modeling further improves the cost effectiveness of resource portfolios with greater shares of renewables, storage, energy efficiency and demand response and increases the investments in these zero-carbon resources recommended by optimization modeling. New Inflation Reduction Act funding, not modeled by TVA, would have a similar effect of making many zero-carbon resources more cost effective.

The Cumberland Retirement EIS's Final Alternatives Evaluation omits any mention of a carbon price and, indeed, any mention of the future scenario assumptions under which its Cumberland replacement cost analysis was conducted. The 1,450 MW gas combined cycle power plant proposed as Alternative A would generate 7 TWh per year, assuming the same 55 percent capacity factor used in the Cumberland EIS

[102] U.S. Energy Information Administration. December 8, 2022. "U.S. battery storage capacity will increase significantly by 2025". Available at: https://www.eia.gov/todayinenergy/detail.php?id=54939#:~:text=As%20of%20October%202022%2C%207.8,GW%20of%20battery%20storage%20capacity

[103] Henze, V. October 12, 2022. "Global Energy Storage Market to Grow 15-Fold by 2030". BloombergNEF. Available at: https://about.bnef.com/blog/global-energy-storage-market-to-grow-15-fold-by-2030/

[104] TVA. *2019 Integrated Resource Plan Volume I – Final Resource Plan*. Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/default-document-library/site-content/environment/environmental-stewardship/irp/2019-documents/tva-2019-integrated-resource-plan-volume-i-final-resource-plan.pdf?sfvrsn=44251e0a_4. p.6-6

[105] Ibid, IRP p.8-17

assessment of social costs.[106] Over a 20-year planning period, a rough approximation of the additional costs associated with carbon prices in Alternative A would be $840 million in the Valley Load Growth scenario, $4.2 billion in the Decarbonization scenario, and $8.4 billion using the double decarbonization carbon price before levelization.

TVA-sponsored analysis suggests spurious limitations to TVA renewable resource investment. Concentric's October 2022 report prepared for TVA as an assessment of its draft Cumberland EIS erroneously suggests that the results of MISO's 2021 Renewable Integration Impact Assessment are a limiting factor in TVA's short- and medium-term renewables additions:

> *Due to environmental mandates requiring "clean" generating resources by a certain date, and the uncertainty around the impact of a high penetration of zero-emitting generating resources on the power system, system operators have conducted highly detailed studies to explore how wind and solar growth would affect reliability and resiliency. These studies…have shown that the complexity of renewable integration escalates with the growing penetration of renewable energy, requiring significant physical and operational changes to the bulk power system. Over some renewable penetration ranges, complexity is constant when spare capacity and flexibility exist. However, at specific penetration levels, complexity rises dramatically as the excess capacity and flexibility are exhausted. These represent system inflection points, where the underlying infrastructure, system operations, or both need to be significantly modified to reliably achieve the next tranche of renewable deployment. (Cumberland EIS Appendix Q p.18)*

MISO's analysis finds that challenges to system integration begin when wind and solar levels exceed 30 percent of total system capacity and that, importantly, these challenges occur in the absence of RTO-wide investments in transmission and other integration upgrades. Concentric fails to mention that no IRP scenario-strategy combination exceeds 8 percent wind and solar by 2028 or 17 percent by 2038 on the TVA system. Adding solar proposed as Cumberland Alternative C raises the renewable share to 17 percent in 2028 and 26 percent in 2038 on the TVA system. Integration challenges posed by MISO reaching 30 percent wind and solar are not expected to occur in the TVA region in the next 20 years.

TVA finds Alternative C solar plus storage construction to be too long and too complex as compared to the Alternative A gas combined cycle generator. TVA anticipates the need for "Construction and operation of many (likely 20+) solar and storage facilities"[107] and finds that the Alternative C "Solar & storage and transmission projects fail to meet 2026 timeline by 3+ years and higher costs for reliability and environmental compliance at [Cumberland]."[108] Concentric refers to Alternative C as "orchestrating a symphony of assumed capabilities and costs of energy efficiency, solar, wind, and batteries along with the accompanying transmission upgrades" and concludes that it is "simply not a viable or rigorous approach as

[106] TVA. 2022. *Cumberland Fossil Plant Retirement. Final Environmental Impact Statement.* Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/cumberland-fossil-plant-retirement-final-eis4eeac6f0-b6bf-4843-9881-75d19ccf8ede.pdf?sfvrsn=d61f6b6f_7. p.273
[107] TVA. 2022. "Appendix B: TVA Alternatives Evaluation." In Cumberland Fossil Plant Retirement: *Final Environmental Impact Statement*. p.12
[108] Ibid, p.18.

a near-term alternative that meets system reliability requirements."[109]

International Energy Agency data for electric construction projects for 2010 to 2018 show renewable power completed 1.5 to 2 years more quickly than fossil-fuel resources.[110] In addition, if more time were needed to build a desired alternative, TVA's EIS reports that Cumberland retirement is not required until 2028[111] and that TVA could itself construct utility-scale solar rather than relying on the quick deployment of a large number of smaller third-party solar farms.[112] The issuance of an all-source or solar-specific request for proposals (RFP) in advance of performing both the 2019 IRP and the Cumberland EIS would have allowed for more accurate, market-based assumptions regarding both solar availability and solar costs.

If the Cumberland brownfield were converted to solar panels—an option not presented by TVA—its 2,388 acres (less 326 acres of coal ash pits[113]) would accommodate 900 MW of solar—30 percent of the total amount proposed in Alternative C.[114] TVA also omits the consideration of solar panels added to its Johnsonville and Gleason sites, proposed to accommodate additional gas combustion turbines under Alternative B.

TVA could increase the accuracy and relevancy of its planning by issuing an all-source RFP and using the resulting bids to set resource prices in modeling.

TVA's IRP-type analysis of the 2026 Cumberland coal unit retirement, not anticipated in the 2019 IRP, has only been made available to stakeholders in the form of a brief summary of modeling results, without the benefit of stakeholder input or detailed information regarding modeling scenarios, commodity and resources costs, carbon prices, and other key modeling inputs. The 2022 Cumberland analysis appears to share an additional serious flaw with the TVA 2019 IRP: Neither cost assessment draws real-world, real-time resource prices from an all-source RFP specific to the TVA context. The practice of issuing an all-source RFP in advance of IRP and other similar planning exercises (see for example the NIPSCO 2019 and 2021 IRPs)[115] has important advantages for increasing the accuracy and relevancy of planning and the potential to aid in reducing system costs for ratepayers.

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[109] TVA. 2022. "Appendix Q – Concentric Report – Response to Synapse and Goggin Reports." In *Final Environmental Impact Statement*. p.2

[110] International Energy Agency. October 26, 2022. "Average power generation construction time (capacity weighted), 2010-2018." *IEA.* Available at: https://www.iea.org/data-and-statistics/charts/average-power-generation-construction-time-capacity-weighted-2010-2018.

[111] TVA. 2022. "Appendix B: TVA Alternatives Evaluation." In Cumberland Fossil Plant Retirement: *Final Environmental Impact Statement*. p.3

[112] Ibid, p.12

[113] TVA. 2022. *Cumberland Fossil Plant Retirement. Final Environmental Impact Statement.* Available at: https://tva-azr-eastus-cdn-ep-tvawcm-prd.azureedge.net/cdn-tvawcma/docs/default-source/environment/cumberland-fossil-plant-retirement-final-eis4eeac6f0-b6bf-4843-9881-75d19ccf8ede.pdf?sfvrsn=d61f6b6f_7. p.10

[114] Based on a rule of thumb approximation of 1 kW of solar per 100 square feet.

[115] 1) NIPSCO. 2021. *Northern Indiana Public Service Company LLC 2021 Integrated Resource Plan.* Available at: https://www.nipsco.com/docs/librariesprovider11/rates-and-tariffs/irp/2021-nipsco-integrated-resource-plan.pdf; 2) NIPSCO 2018. *Northern Indiana Public Service Company LLC Integrated Resource Plan.* Available at: https://www.nipsco.com/docs/librariesprovider11/rates-and-tariffs/irp/2018-nipsco-irp.pdf?sfvrsn=83256851_16.

An all-source RFP solicits resources that could be constructed or otherwise made available today under current market expectations of near-time future pricing with an open-bidding process for any interested parties. The results of all-source RFPs should be compared and incorporated together with price forecasts from reputable sources.

Resource prices developed in this way have the greatest likelihood of conforming to market expectations regarding both cost and actual availability. Power purchase agreement prices have risen recently due to short-term supply chain issues and the rise in interconnection costs, but TVA should not face the latter issue and should not let higher prices prevent it from soliciting responses. TVA's IRP and Cumberland retirement analyses also lack (or fail to report) any resource portfolios developed through unconstrained optimization. TVA's IRP modeling includes 30 constrained optimization runs of scenario-strategy pairings, and several related sensitivity runs, but fails to explore a portfolio developed through model optimization in the context of any and all resources being made available for model selection. Unconstrained optimization is an important tool available to utility planners in IRP and other similar resource planning exercises that permits the development of new resource combinations without an intervening filter of modeler selection.

VI. Recommendations

TVA is planning to produce a new IRP by late 2024. Two major changes have occurred since the 2019 IRP that are essential to reflect in any new planning process. First, TVA has committed to a climate goal of net zero greenhouse gas emissions by 2050, with an 80 percent carbon reduction by 2035 and a 70 percent carbon reduction by 2030. TVA is also subject to the Paris Agreement's commitment to help limit temperature increases from pre-industrial levels and to the Biden-Harris Administration's executive orders calling for carbon-free electricity by 2035. Second, Congress passed the Inflation Reduction Act, and it was signed into law by President Biden. The bill dramatically expanded numerous tax credits, grants, and other subsidization schemes for zero emission energy and storage resources. The following recommendations for TVA's planning process in that IRP and for subsequent site-specific planning exercises are based on these key developments together with the assessments of TVA's IRPs and site-specific planning methods:

- **TVA must incorporate its own net zero by 2050 commitment as well as the 2035 federal decarbonization goal as clear policy goals and basic modeling limitations in its IRP and craft plans in which all portfolios achieve these goals.** TVA's 2019 IRP is rendered defunct by the release of TVA's own emissions targets and federal climate goals. TVA should be transparent both about its scheduled capacity additions and retirements, and about which resources will supply the necessary emission reductions to meet its own climate goals, those of the Paris Agreement, and the instruction to federal agencies to pursue a goal of carbon-free electricity by 2035.
- **TVA must be more transparent regarding its assumptions and modeling inputs**, including its assumed carbon price and social costs of further investments in emitting resources—preferably making a detailed technical appendix available for public review.
- **TVA's IRPs need a clear selection of a portfolio with a more targeted preferred resource plan**.

The selected portfolio should provide schedules for prospective additions and retirements of coal and gas plants as well as the for the addition of zero emission sources of power. Absent these detailed expectations, planning ranges alone do not permit either TVA or other stakeholders to assess the impacts of the most likely resource additions or effectively evaluate the environmental or economic benefits of prior capacity additions.

- **TVA should state clearly how it intends to utilize the grants, loans, and tax credits of the of the Inflation Reduction Act**. One example provision is direct pay of IRA tax credits; this provision explicitly state that TVA can access credit money for eligible projects through direct payments from the U.S. Treasury. TVA needs to document how IRA programs affect its modeling, selected resource plans, and finances.

- **TVA must clarify how it demarcates "ownership" of solar and wind resources between its distribution utilities, power purchase agreements from other parties, and capacity that TVA outright owns.** Currently, TVA does not specify why its claimed solar and wind resources are not reported in EIA data, nor the extent to which its renewable resources are capacity owned and operated by its distribution utility partners or capacity it has access to through power purchase agreements. TVA should also be transparent about the renewable attributes committed to third parties through renewable energy credits.

- **TVA should provide reliable annual or monthly data on solar, wind, and storage capacity**. These time-series data should also distinguish between utility-scale resources that represent TVA's own capacity, contracted capacity, and/or capacity from TVA's distribution utility or municipal partners that TVA claims as its own. The data are essential to an effective evaluation of TVA's past and future plans by making a comparison between proposed and actual renewable additions.

- **TVA should conduct an all-resource RFP of resources that could be made available today under current market prices.** Resource cost assumptions made in the absence of an all-resource RFP provide inferior information that biases modeling results, and compare and include price forecasts from reputable sources.

- **TVA must ensure that its site-specific planning documents, such as environmental impact statements, reflect the most recent IRPs plans and use methods that do not result in contradictions between overall-system- and site-specific planning exercises.** Site-specific planning exercises should also provide detailed technical appendixes with information on modeling inputs and outputs. Site-specific planning exercises should state clearly how their proposed capacity additions (and assessments of the viability or infeasibility of alternative additions) integrate with or alter the findings of the most recent IRP.