A Clean Energy Portfolio Is Still the Best Option for TVA

Synapse Response to TVA's Environmental Impact Statement and Concentric's Appendix Q

Prepared for Sierra Club

January 6, 2023

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1. TVA's 2019 IRP Is Insufficient and Obsolete

In December of 2022, TVA released a final Environmental Impact Statement (EIS) for replacing the coal-fired Cumberland Fossil Plant. In this EIS, TVA identified Alternative A as its preferred alternative replacement of the Cumberland Plant, which consists of building new natural gas resources, instead of a clean energy portfolio it considered as part of Alternative C that featured solar photovoltaics ("PV") and battery storage.

TVA's recommendation to continue reliance on fossil resources for another several decades is a blatant contradiction to its 2021 carbon reduction commitments, including its commitment to be net zero by 2050.[1] As discussed in Synapse's original May 2022 report on clean energy alternatives to TVA's then-proposed gas plants, TVA is currently heavily dependent on fossil resources.[2] Coal and gas make up 42 percent of generation, nuclear accounts for 42 percent, hydro and biomass comprise 11 percent, and finally wind and solar together make up 3 percent of TVA's generation as of 2021. If TVA replaces the 2.4 gigawatts of capacity from Cumberland with gas, TVA will likely increase its reliance fossil energy, given that a new combined cycle plant will likely be dispatched more often the existing Cumberland coal unit. This would cement its reliance on fossil resources for at least half its generation and continue to remain behind the times.

1.1. Concentric's blind defense of TVA's 2019 IRP is concerning, and its report is mired in erroneous logic and numerous red flags

The 2019 IRP is outdated and does not provide a solid basis and analytic framework for future resource decisions.

Concentric Energy Advisors' (Concentric) assessment of TVA's 2019 IRP as providing "a solid basis and analytic framework for future resource decisions"[3] is detached from reality. First, TVA's 2019 IRP is out-of-date. As we discuss later in this section, its modeling does not reflect the effect of recent price volatility, supply chain challenges, and winter reliability challenges. Additionally, it does not incorporate incentives from two recent groundbreaking pieces of legislation: the *Infrastructure Investment and Jobs*

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[1] Tennessee Valley Authority. 2021. Leadership & Innovation on a Path to Net-Zero. Available at: https://www.tva.com/environment/environmental-stewardship/sustainability/carbon-report.

[2] Wilson, R., I. Addleton, J. Tabernero. *Clean Portfolio Replacement at Tennessee Valley Authority,* Synapse Energy Economics. May 2022.

[3] Concentric Energy Advisors. 2022. *Assessment of the Draft Environmental Impact Study and Response to Certain Reports.* 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

Act (IIJA) and the *Inflation Reduction Act* (IRA), which are both expected to lower transmission, wind, solar, and storage investment costs. The omission of these recent changes in the January 2019 IRP is understandable, of course, as the IRP predated the legislation and other market changes. But what is concerning is Concentric and TVA's late 2022 insistence that its 2019 IRP covered the range of changes expected from the IRA (it is silent on other market impacts) and that it therefore should proceed with its recommendation from the EIS without further analysis.

Second, TVA's 2019 IRP did not adequately consider all resource options; specifically, it ignored resources that require new high voltage DC transmission (HVDC). As we discuss further in Section 2, transmission build-out enables access to new resources across a more diverse geographic region and should be considered as part of TVA's resource planning exercise. For example, new HVDC lines can give TVA access to wind located in the Southwest Power Pool (SPP), Midcontinent Independent System Operator (MISO), and Electric Reliability Council of Texas (ERCOT) territories. These resources combined with solar and battery storage projects within TVA's territory would allow TVA to meet its energy and capacity needs. They would also substantially diversify supply in a way that a single gas-fired generator cannot. Instead of evaluating transmission as part of a resource plan or taking a leadership role in spearheading the necessary transmission build-out, TVA simply dismissed as too expensive or infeasible any resource option that requires transmission build-out.

TVA's broad direction and decisions need to be reset and reevaluated

Concentric asserts, "The evaluation of the near-term implementation measures to implement the strategy outlined in the IRP should be more about testing the consistency of the measures with the strategy ***as opposed to attempting to reset TVA's broad direction or decisions***."[4] We believe this to be untrue: re-setting TVA's strategy is exactly what the company and its customers need in the wake of the IRA, the IIJA, and other recent market changes that will have a dramatic impact on long-term resource planning.

Analyzing solar and storage in TVA's 2019 IRP analysis is important, but the absence of wind in its results is glaring and reflects inappropriate constraints and shortcomings in TVAs analysis. Further, TVA and Concentric's decision to use the model's selection of solar over wind as an opportunity to pit solar against wind is unhelpful. Wind resources complement solar and storage resources by bringing winter and nighttime generation to the TVA system and helping to lower the amount of storage needed. TVA can invest in wind from outside of the region to supplement TVA-owned or contracted firm transmission into TVA (not just transmission within TVA).

[4] Appendix Q, Observation 2.

Concentric's claim that resource portfolios that exclude natural gas must rely on overly optimistic assumptions about "nascent technologies" is completely wrong

Contrary to what Concentric claims, it is reasonable to exclude combined-cycle gas plants from resource selection if you have high-performing SPP/MISO/ERCOT wind, storage, and solar PV resources available, as is the case for TVA. These resources together provide a solid output-diverse energy portfolio and render gas-fired energy unnecessary to meet load requirements. To provide an example, in Tucson Electric Power's IRP Preferred Portfolio, utility-scale renewables and distributed generation account for 71 percent of retail sales by 2035.[5]

Further, wind, storage, and solar are far from nascent technologies. According to the U.S. Energy Information Administration, annual wind turbine capacity additions in the United States set a record in 2020, totaling 14.2 GW and surpassing the previous record of 13.2 GW added in 2012.[6]

As we discuss in Section 2 of this report, the remarkable growth in U.S. battery storage capacity is outpacing even the early growth of the country's utility-scale solar capacity. U.S. solar capacity began expanding in 2010 and grew from less than 1.0 GW in 2010 to 13.7 GW in 2015 while wind grew from 1.5 GW in 1998 to 6.3 GW in 2003.[7] In comparison, we expect battery storage to increase from 1.5 GW in 2020 to 30.0 GW in 2025. Much like solar power, growth in battery storage would change the U.S. electric generating portfolio.[8] These technologies have been successfully installed and implemented for over a decade and are projected to continue growing in popularity in future years.

Concentrics's claim that combined-cycle resources provide a solid foundation for renewable integration relies on outdated logic.

Concentric's claim that TVA needs a combined cycle (CC) gas plant to back up the integration of renewables relies on the same outdated and incorrect logic that utilities have been repeating for more than a decade now. The inclusion of buzz words like "diverse," "resilience," "difficult operating conditions," and "flexible and dispatchable gas resources" to justify reliance on a CC is an insufficient alternative to actual, robust analysis.

Concentric also links the need for a CC to extreme statements about the complexity of renewable integration. But the sort of complexity discussed is irrelevant at the low level of renewable penetration

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[5] Tucson Electric Power. 2020. "2020 Integrated Resource Plan." Available at: https://docs.tep.com/wp-content/uploads/Portfolios_Dashboards.pdf

[6] U.S. Energy Information Administration. 2021. "The United States installed more wind turbine capacity in 2020 than in any other year." *Today in Energy.* Available at: https://www.eia.gov/todayinenergy/detail.php?id=46976

[7] US DOE. 2022. "Land Based Market Wind Report: 2022 Edition." Accessible at: https://www.energy.gov/eere/wind/wind-market-reports-2022-edition#wind

[8] U.S. Energy Information Administration (EIA). 2022. "U.S. battery storage capacity will increase significantly by 2025." *Today in Energy*. December 8. Accessible at https://www.eia.gov/todayinenergy/detail.php?id=54939.

currently on the TVA system, or the new renewables that would result with an all-renewable replacement of Cumberland. Solar and wind currently make up only 3 percent of TVA's generation. In the event that Cumberland were replaced with all renewables, TVA still has plenty of existing fossil resources to manage purported concerns around extreme levels of renewable integration without needing new fossil generation. Although solar and wind resources are not dispatchable, they are predictable; and they become partially dispatchable when paired with battery storage resources. TVA is hardly alone in tackling this challenge. Many other utilities such as TEP are successfully working through similar, or even greater resource planning challenges. Given the amount of dispatchable generation that TVA currently has available and the low penetration of renewables on its system, TVA is a long way away from facing the type of integration and implementation challenges that other utilities are facing.

1.2. Record gas prices, the Inflation Reduction Act, and other broad market and regulatory changes since 2019 make the 2019 IRP out-of-sync with current trends

Changes in the market

There have been broad changes in the market since TVA created its 2019 IRP. Aside from the passage of the IRA, discussed below, natural gas prices have become increasingly volatile and reached record highs, coal prices have dramatically increased in the Appalachia region, extreme weather events have tested the resiliency of utility systems, transmission reform is being evaluated across the country, and inflation and supply chain challenges have impacted the costs to maintain existing resources and build new ones. All these factors represent significant changes in key inputs to TVA's 2019 IRP, yet the company based its recent EIS recommendation to replace Cumberland with gas on this outdated analysis.

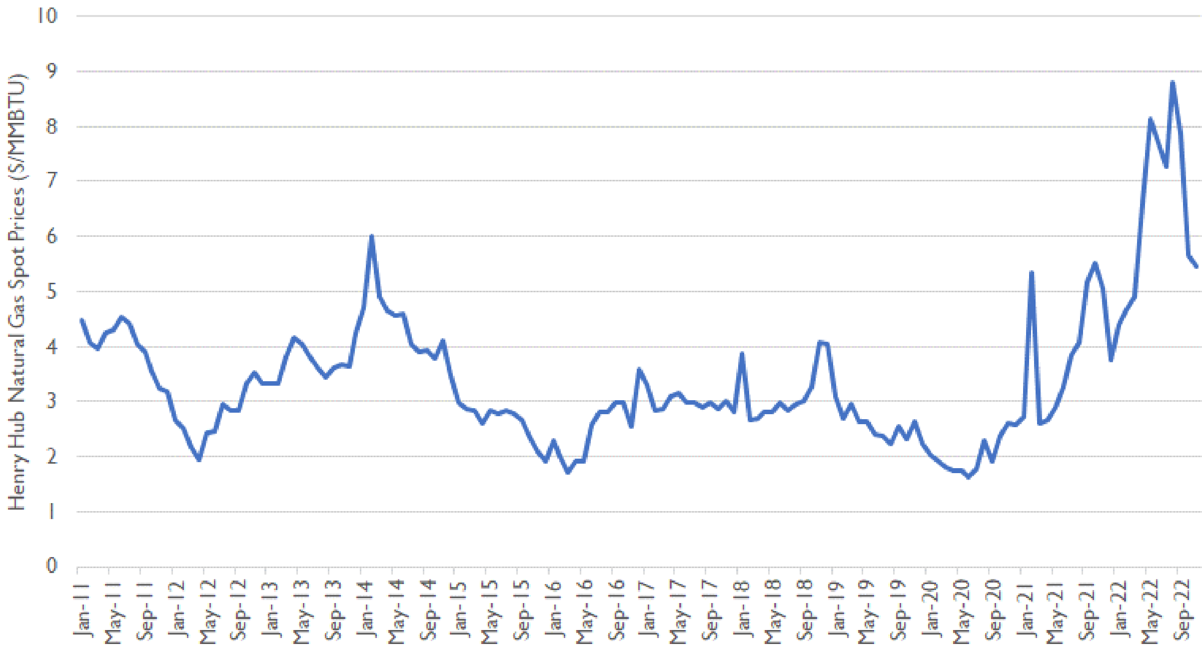
TVA should recognize that recent market and legislative changes should fundamentally shift how it thinks about resource planning. First, recent market volatility and record high gas prices show the cost and risk inherent in a resource planning model that pivots from coal to gas. Figure 1 below presents the weekly natural gas spot prices, demonstrating the volatility of gas prices and recent record highs. TVA needs to understand and quantify this risk and take it into account when evaluating resource options. Second, coal price spikes[9] show the risk in continued reliance on coal and highlight the need for TVA to plan for a speedy retirement of all its coal assets. Figure 2 below features weekly coal spot prices over time, highlighting the recent spikes in coal prices in the Central Appalachia and Northern Appalachia regions. Third, as we discuss in Section 2 below, extreme weather events are showing the flaws in conventional wisdom that fossil plants provide robust firm capacity year-round in ways that dispatchable renewables cannot. Fourth, transmission reforms at the federal and regional level are addressing barriers to transmission build-out and socializing the cost across larger groups of customers, rather than concentrating those costs on new projects seeking interconnection. Finally, inflation and

[9] U.S. Energy Information Administration, Coal Markets. Accessible at https://www.eia.gov/coal/markets/.

supply chain challenges are driving up the cost to maintain existing fossil resources and delaying the deployment of new resources.

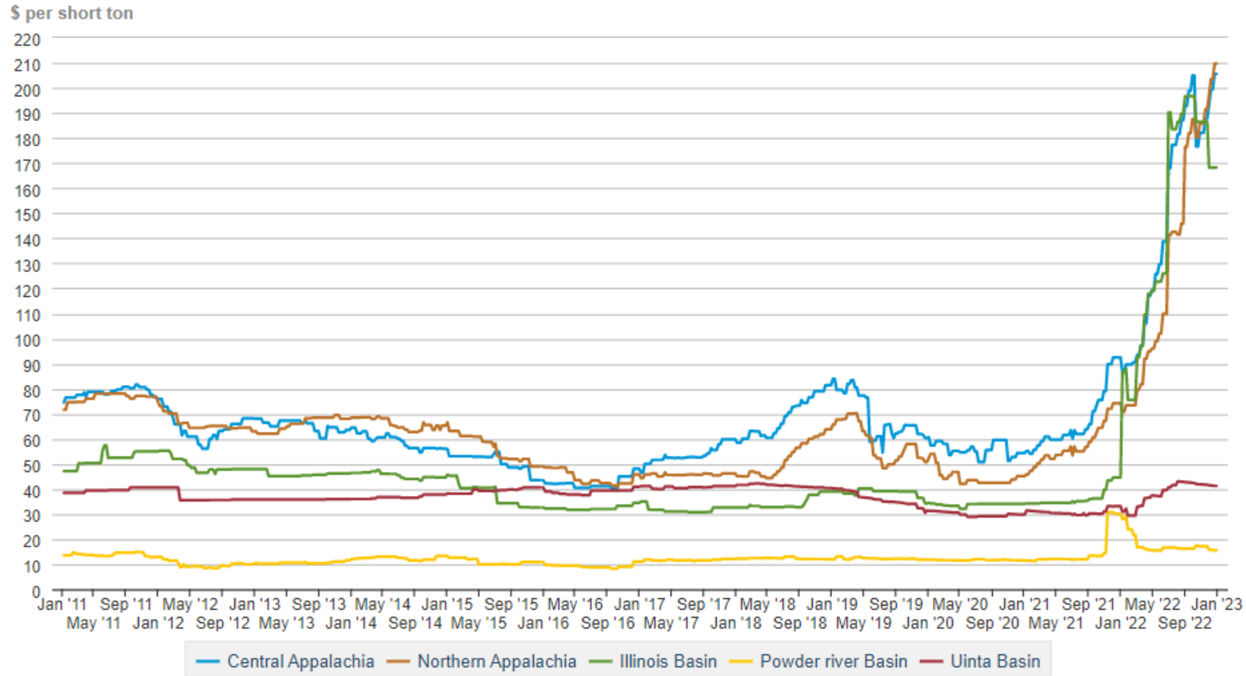
As a broader point, Synapse emphasizes that the conventional utility approach of waiting to procure new resources until an existing resource is uneconomic or broken is not well suited for the clean energy transition. Instead, we recommend that TVA and other utilities more broadly evaluate how it currently meets demand using existing resources, and whether more economic, non-carbon emitting alternatives exist.

Figure 1. Weekly natural gas spot prices



Source: U.S. Energy Information Administration. 2021. Natural Gas Weekly Update. Available at: https://www.eia.gov/naturalgas/data.php#prices .

Figure 2. Weekly coal spot price by region



Source:U.S.EIA, Coal Markets – Average Weekly Coal Commodity Spot Prices. 2021. Available at: https://www.eia.gov/naturalgas/data.php#prices.

Passage of the Inflation Reduction Act

In Appendix Q of the Cumberland EIS, Concentric includes a single-page supplemental section on the impacts of the IRA on the TVA IRP. In it, Concentric assumes it is too soon to assess the impacts of the IRA but nonetheless concludes that those impacts are within the ranges of the IRP.[10] This assessment is overly simplistic and skews the results against clean energy resources. The IRA is the most significant piece of climate legislation in U.S. history. It represents around $369 billion worth of investment over the next 10 years[11] and includes unprecedented incentives for renewable energy, energy storage, electric vehicles and charging infrastructure, energy efficiency, nuclear, and other clean energy investments. The incentives available shift the baseline in favor of clean energy resources, and therefore the results of all scenario and sensitivities shift in that direction as well.

Unlike other environmental regulations, which often penalize inaction, the IRA is a collection of positive financial tax credits and funding incentives that together make a clean pathway more economic. But utility action and investment are required to achieve the emissions savings that the legislation aims to provide. Utilities have a responsibility to provide the lowest cost and most reliable mix possible to their

[10] Appendix Q – Concentric Report – Response to Synapse and Goggin Reports. Pg 2.

[11] IEA (International Energy Agency). 2022. “Inflation Reduction Act of 2022.” Available at: https://www.iea.org/policies/16156-inflation-reduction-act-of-2022.

ratepayers, and that includes taking advantage of the incentives available to them. TVA's failure to incorporate meaningful quantitative analysis of the IRA into this replacement resource decision process is contrary to its customers' interests.

Concentric makes the following claims in support of TVA's decision not to update its analysis and to ignore the impacts of the IRA:

1) The comprehensive impacts of the IRA are uncertain and will take time to fully understand.
2) TVA's previous analyses explored a wide enough range of future possible outcomes such that questions about the IRA's effects can be qualitatively assessed by considering whether the potential impacts would trend resources higher or lower within the 2019 IRP ranges.
3) Fundamental concepts and conclusions remain unchanged, namely: (1) the complexity of adding renewables; (2) the need for broad and rigorous analyses; (3) the need for dispatchable generation; and (4) the near-term practicality of A (natural gas) over C (solar + storage) is unchanged. The IRA would improve economics for C, but cost improvements would not eliminate implementation barriers.

In this section, we address the first two claims, highlight the provisions that will have the greatest impact in TVA's territory, and demonstrate why it is essential for TVA to consider the IRA here and in any future resource planning decisions and exercises. We will address the third set of claims in Section 2.

Concentric/TVA Claim 1: The comprehensive impacts of the IRA are uncertain and will take time to fully understand

There are already well-defined provisions of the IRA that are, or will soon be, available for utilities and consumers. TVA does not need to know with certainty how every one of the IRA provisions will evolve over the next 10 years to understand the impacts of, or begin utilizing, specific provisions. TVA already has access to key information on the new IRA tax credits, for instance: the IRS has been working to guide the development and implementation of these credits. Specifically, the IRS hired 4,000 additional employees for the 2023 tax season, sought comments on upcoming energy guidance, and recently released the wage and apprenticeship requirements.[12] In addition, specific guidance for many of the new programs created under the IRA is currently under development. For example, the Biden-Harris Administration recently announced state allocations for the home energy rebate programs, with funding expected to be available by Spring 2023 and rebates expected to be available to the public later in 2023.[13]

[12] U.S. Internal Revenue Service (IRS). 2022. "News on the Inflation Reduction Act of 2022. Available at: https://www.irs.gov/newsroom/latest-news-on-the-inflation-reduction-act-of-2022.

[13] U.S. Department of Energy (DOE). 2022. "Biden-Harris Administration Announces State and Tribe Allocations for Home Energy Rebate Program." November 2. Available at: https://www.energy.gov/articles/biden-harris-administration-announces-state-and-tribe-allocations-home-energy-rebate.

Indeed, other utilities have begun to incorporate the IRA in their resource planning processes. In November of 2022, DTE performed a full analysis of the IRA's expanded tax credits and more than tripled the capacity of proposed renewable energy in its current IRP relative to its prior IRP.[14] Minnesota Power filed a settlement agreement in November 2022 with state regulators regarding its pending IRP that would double the amount of planned wind power by 2030, increase solar installations by 50 percent, and add up to 500 MWh of battery storage demonstration projects. The chief operating officer of Minnesota Power stated that one of the driving reasons behind this decision was the financial impact of the IRA.[15] This shows that other utilities have found there is sufficient certainty regarding implementation of the IRA for them to incorporate these provisions into their resource planning processes. TVA should follow suit.

Concentric/TVA Claim 2: TVA's previous analyses explored a wide enough range of possible future outcomes, such that questions about the IRA's effects can be qualitatively assessed by considering whether the potential impacts would trend resources higher or lower within the 2019 IRP ranges

The 2019 IRP ranges represent a stale snapshot of the past and is not representative of the current energy landscape. Specifically, the "Current Outlook" that TVA designed while developing the 2019 IRP is over three years old and is no longer accurate, especially given the passage of the IRA, and should not be the case that the EIS recommendations are centered upon. At best, the "Decarbonization" scenario that TVA defines as "a strong push to curb greenhouse gas emissions . . . resulting in incentives for non-emitting technologies" is now the most accurate characterization of the current energy landscape among the various scenarios evaluated. Given the IRA impacts, it is unreasonable to assume that resource costs would remain within the ranges of the now-stale "Current Outlook" scenarios. At a minimum, the IRA shifts the Target Power Supply Mix from the Current Outlook Scenario, Base case strategy (Case 1A) to something closer to the Decarbonization Scenario, Base case strategy (Case 4A).[16]

The new clean energy tax credits will be transformative for TVA both in changing the credit monetization provisions and extending and expanding specific provisions. As a public entity, TVA was historically excluded from taking direct advantage of clean energy tax credits and could only benefit indirectly by negotiating PPAs with developers who themselves could take advantage of the tax credits. Now, TVA is eligible to receive the clean energy credits through direct refunds, enabling it to take advantage of the

[14] Wamsted, Dennis. 2022. "Utility resource plans reveal impact of IRA incentives in Midwest." *Solar Builder.* December 15. Available at: https://solarbuildermag.com/news/utility-resource-plans-reveal-impacts-of-ira-incentives-in-midwest/

[15] Ibid.

[16] The 2019 TVA IRP describes the current outlook scenario as "TVA's current forecast for key uncertainties that reflects modest economic growth offset by impact of increasing efficiencies resulting in a flat load outlook" while the decarbonization scenario "Represents a strong push to curb GHG emissions due to concern over climate change, resulting in high CO2 emission penalties and incentives for non-emitting technologies"

credits itself.[17] The IRA extended both the investment tax credit (ITC) and production tax credit (PTC) through 2032, marking a sharp change from the previous one- to two-year extensions of the past. This generous timeline provides more certainty to developers and will disrupt the industry's previous boom and bust cycle. In the long run, these updated tax credits will significantly improve the relative economics of clean energy resources compared with fossil fuel resources, as DTE's IRP process revealed. Under this regime, the benefits of Option C or a clean energy portfolio compared to Option A will become even greater. Table 1 below summarizes several of the most relevant updates to the federal tax credits.

Table 1. Comparing 2019 IRP assumptions with updated IRA tax credits

Resource		TVA's 2019 IRP Assumptions	IRA Tax Credits
Wind	PTC	Phases down from 2019–2021, and expires for projects beginning construction after 2021[18]	Increased to $26/MWh credit through 2032
	ITC	Ineligible[19]	**Newly eligible** for 30% credit through 2032
Utility-Scale Solar	PTC	Ineligible	**Newly eligible** for $26/MWh credit through 2032
	ITC	Phase down to 10% from 2024 onwards.[20]	Increased to 30% credit through 2032
Storage	ITC	Standalone storage not eligible; storage paired with solar eligible for 10% credit	Standalone storage **newly eligible** for a 30% ITC, meaning it doesn't necessarily need to be co-located with solar

*Notes: * Assumes prevailing wage and apprenticeship requirements are satisfied. 10% adders for domestic content and serving energy communities are also available for all of the above credits.*

[17] McCormick, Durham et al. 2022. "Inflation Reduction Act Extends and Modifies Tax Credits for Wind Projects." McGuireWoods. August 24. Available at: https://www.mcguirewoods.com/client-resources/Alerts/2022/8/inflation-reduction-act-tax-credits-for-wind-projects.

[18] Ibid.

[19] Frazier, Allister, Marcy, Cara, and Cole, Wesley J. 2019. "Wind and solar PV deployment after tax credits expire: A view from the standard scenarios and the annual energy outlook." Available at: https://www.osti.gov/servlets/purl/1548263.

[20] Solar Energy Industries Association (SEIA). 2022. "Inflation Reduction Act: Solar Energy and Energy Storage Provisions Summary." Available at: https://www.seia.org/sites/default/files/2022-08/Inflation%20Reduction%20Act%20Summary%20PDF%20FINAL.pdf.

In addition to the expanded clean energy tax credits, the IRA contains many other sources of funding that could have profound effects within the Valley, as described in Table 2. Examples of IRA funding that TVA should evaluate in its planning process

Funding for refinancing undepreciated assets and reinvesting in renewables	
Sec. 50141. Funding for DOE Loan Programs Office	Loans to retool, repower, repurpose, or replace energy infrastructure that has retired or to improve efficiency and reliability of existing resources ($40 billion of authority through FY2026)
Sec. 50144. Energy Infrastructure Reinvestment Financing	Loans to retool, repower, repurpose, or replace energy infrastructure no longer in operation or enable operating energy infrastructure to avoid greenhouse gas emissions ($5 billion to guarantee up to $250 billion in loans through FY2026)
Sec. 60103. Greenhouse Gas Reduction Fund	Financial assistance for projects that reduce greenhouse gas emissions or deploy zero-emission technology ($27 billion available through FY2024)
Support for renewable energy in rural areas	
Sec 22001. Additional Funding for Electric Loans for Renewable Energy	Loans and forgivable loans available to nonprofits, government entities and commercial utilities for renewable energy and storage facilities serving a public purpose in rural areas ($1 billion available through FY 2031)
Transmission development	
Sec. 50151. Transmission facility financing	Loans supporting the construction and modification of national interest electric transmission facilities ($2 billion through FY 2030)
Sec 50152. Grants to Facilitate the Siting of Interstate Electricity Transmission Lines	Grants to study impacts of transmission projects, hosting negotiations, participating in regulatory proceedings and economic development for communities affected by construction and operation ($760 million)
Building electrification and energy efficiency	
Sec. 13301-13304. Building improvement credits	Existing residential and commercial tax credits for building energy improvements such as heat pump installations and weatherization are expanded and extended through December 2032
Sec. 50121 & 50122. Rebate programs	Two new rebate programs are created to support home energy efficiency and electrification retrofits ($8.8 billion total through FY2031)
Electric vehicle deployment acceleration	
Sec. 13401-13403. Clean vehicle credits	Existing credits for individuals and businesses that purchase new or used qualified clean vehicles are expanded and extended through December 2032

Source: Congress.gov. "Text - H.R.5376 - 117th Congress (2021-2022): Inflation Reduction Act of 2022." August 16, 2022. Available at: https://www.congress.gov/bill/117th-congress/house-bill/5376/text.

. TVA should perform a comprehensive review of all available funding in its resource planning process. It is noteworthy that in the EIS Appendix Q, Concentric suggests that there are fewer opportunities for utility demand-side management programs given the influx of federal funding. Instead of taking this passive approach, TVA should consider how utility programs can complement and to the extent possible, utilize, federal funding for demand-side management programs.

Some of this direct funding targets external entities, such as state energy offices or manufacturers, but should spill over to TVA's load and customers. TVA should understand and evaluate the impact of these programs in its resource planning process. Some of the areas that TVA needs to update to account for IRA funding include load projections, new resource cost estimates, and resource retirement costs. Table 2. Examples of IRA funding that TVA should evaluate in its planning process

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includes a non-comprehensive list of funding that TVA should evaluate in its planning process.

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2. CONCENTRIC'S CLAIMS ABOUT SYNAPSE'S ANALYSIS REFLECT AN INCOMPLETE AND OUT-OF-DATE VIEW OF RESOURCE PLANNING

2.1. Current events are reinforcing that clean energy portfolios can be reliable, and that fossil resources can fail when needed most

Concentric claims that Synapse's analysis did not account for the complexity of adding renewables and the need for dispatchable resources. Specifically, while the Synapse report states that electric systems can absorb large quantities of renewables without negative impacts on reliability and resilience, Concentric argues that "increasing the amount of intermittent generation will require dispatchable generation to ensure that customer energy and capacity needs are met around the clock."[21] But this claim completely mischaracterizes Synapse's modeling and conclusions and is at odds with recent utility experience—including TVA's own.

First, Synapse relied on production cost modeling to show that a portfolio of clean energy resources could replace coal-fired generation and meet system energy, capacity, and reliability needs just as well as a gas plant; the modeling further showed that such a portfolio would result in customer savings even before the IRA's passage. Second, Synapse agrees that dispatchable resources should be deployed along-side renewable resources. This is why Synapse's results include a substantial quantity of dispatchable battery storage. Third, as discussed above, the output of renewables can be forecasted and predicted, even if they are not dispatchable. Fourth, the expansion of area transmission can increase the diversity and geographic scope of renewables serving TVA load. Diversity in the type and geographic distribution of resources can reduce the quantity of dispatchable resources needed.

Finally, the implication that a dispatchable fossil plant will "ensure that customer energy and capacity needs are met around the clock" is wrong, as recent events have made clear. During Winter Storm Uri in 2021, many coal and gas plants failed and thereby caused grid-wide disruptions.[22] Just before Christmas a few weeks ago (December 23, 2022), winter storm Elliott brought record cold temperatures to the Southeast region. Regional utilities were able to avert a total power failure, but some customers were hit with rolling blackouts. Once again, this grid failure occurred because many coal- and gas-burning plants went offline or could not perform as expected. Within TVA, Cumberland went offline when critical instrumentation froze; Bull Run, another coal plant, also went offline; and TVA admitted it "had issues at some of our natural gas units." [23] TVA was not alone—other utilities in the region, including Duke Energy in North Carolina, experienced blackouts resulting from outages at coal and gas facilities. Duke Energy admitted that its outages resulted when multiple generators did not respond to calls to increase output. This was after the company promised regulators last summer that its generating units were ready for the extreme cold.[24]

These events emphasize that fossil plants are far more fallible and less reliable than TVA and others purport. Notably, this was the first time in TVA's 89-year history that the company had to order rolling

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[21] Appendix Q, page 6.

[22] University of Houston. 2021. "Reliability & the Texas Power Grid in the Aftermath of Winter Storm Uri." Hobby School of Public Affairs. Available at: https://uh.edu/hobby/electricgrid/tegs_report_june_25_2021.pdf.

[23] Mattise, Jonathan and Travis Loller. 2022. "Power failures amplify calls for utility to rethink gas." *Associated Press*. December 31. Available at https://news.yahoo.com/power-failures-amplify-calls-utility-155623475.html.

[24] Leslie, Laura. 2022. "Duke Energy acknowledges multiple generators failed, despite promise they were fully prepared for extreme cold." *WRAL News*, December 28. Available at: https://www.wral.com/duke-energy-acknowledges-multiple-generators-failed-despite-promise-they-were-fully-prepared-for-extreme-cold/20646932/.

blackouts.[25] This demonstrates that, contrary to what Concentric and TVA claim, continued reliance on fossil generation does not ensure TVA can continue to provide reliable electricity service to its customers.

2.2. Synapse's analysis was sufficiently expansive and up-to-date, and TVA's was not

Concentric claims that the Synapse analysis was insufficient because Synapse only modeled two scenarios. First, more scenarios and sensitivities are not necessarily better if the assumptions and methodology underlying the analysis are insufficient or outdated. Second, the goal of Synapse's analysis was not to conduct a comprehensive and optimized IRP exercise. That is TVA's job. Rather, Synapse sought to evaluate if a clean energy portfolio could meet TVA's system needs at a lower cost and lower environmental impact than the proposed gas projects. And we found that it could.

Additionally, Concentric is ignoring its own stated wisdom about the importance of broad and rigorous analyses by continuing to rely on a narrow and outdated study. Robust analyses should quantitatively reflect all relevant cost drivers (including major federal legislation). The IRP explicitly states that TVA will closely monitor key drivers relating to changing market conditions such as natural gas prices, emerging technologies, and solar and wind costs to inform appropriate actions and guide decisions in the longer term.[26] Concentric's report is silent on this commitment and makes no mention of any plans by TVA to reevaluate its long-term decisions in light of the changing market conditions.

2.3. Synapse's capital cost projections for wind are well supported by industry-standard sources while TVA relied on dated sources that neglect capital cost dynamics

Concentric claims that Synapse relied on "overly optimistic and strategically adjusted input assumptions" that supported the adoption of large amounts of renewable resources. These critiques are unfounded.

Concentric leveled particularly strong critiques at Synapse's wind cost assumptions. Far from being overly optimistic, Synapse's wind cost assumptions relied on the industry-standard 2021 National Renewable Energy Laboratory (NREL), Annual Technology Baseline (ATB). The NREL ATB was the most

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[25] Timms, Mariah and Friedman, Adam. 2022. "TVA ordered rolling blackouts for the first time in 90 years amid freezing temps." *The Tennessean.* December 23. Available at: https://www.tennessean.com/story/news/local/2022/12/23/why-tennessee-valley-authority-ordered-rolling-blackouts-in-nashville/69754538007/.

[26] TVA IRP, page ES-6.

current, transparent source at the time we conducted our modeling, with projections through 2050.[27] It is particularly useful in capturing future technological innovation and its impact on capital costs. For this reason, many utilities rely on it benchmark resource costs projections as the basis for future cost projections. We used the moderate case, which reflects the midpoint between optimistic (advanced) and the pessimistic (conservative) scenarios.

By comparison, Concentric supports the outdated capital costs used by TVA in its 2019 IRP, which are based on a static, dated figure from a 2016 DOE report on installed wind costs. Our first concern with TVA's wind capital cost projection is TVA's 2019 capital cost figure of $1,615 per kW (pre-interconnection), which it used as a starting point for wind costs in 2019. We find this starting value to be conservative, given it is greater than the $1,560 per kW figure used in the 2021 IEA World Energy Outlook Mid Stable Policies case—the highest-cost case in the literature compiled by the NREL ATB.

Second, independent of the starting capital cost, (i) TVA did not appear to assume a decreasing technology cost curve[28] and (ii) TVA assumed that the PTC would expire.[29] TVA's assumption that the cost of renewables would not decrease over time is inconsistent with nearly all industry projections. Even the origin of TVA's capital costs for wind, the 2016 DOE report, showed that capital costs have decreased every year from 2010 to 2016: year on year, the data showed an average decrease of 6 percent, a minimum decrease of 4 percent, and a maximum decrease of 10 percent. This indicates that year-on-year cost declines are the norm even in actual installed cost data. Therefore, using a single year of installed cost data from three years prior to the IRP and assuming those levels remain constant will not project the true costs of adopting wind and is inconsistent with IRP best practices. Figure 3 below shows a clear declining trend for average levelized wind prices in MISO and SPP (the "Central Region") beginning in 2009. The is region we identified for TVA wind resource imports in the prior study.

[27] NREL (National Renewable Energy Laboratory). 2021. "2021 Annual Technology Baseline." Golden, CO: National Renewable Energy Laboratory. https://atb.nrel.gov/.

[28] Page 8–14 of the TVA IRP.

[29] Appendix A of the 2019 TVA IRP states that, "Additionally, the production tax credit is set to expire which will increase costs for all wind options, and IRP costs assume no decreasing technology curve."

Figure 3. Generation-weighted average levelized wind PPA prices by execution date and region (2021 $/MWh)

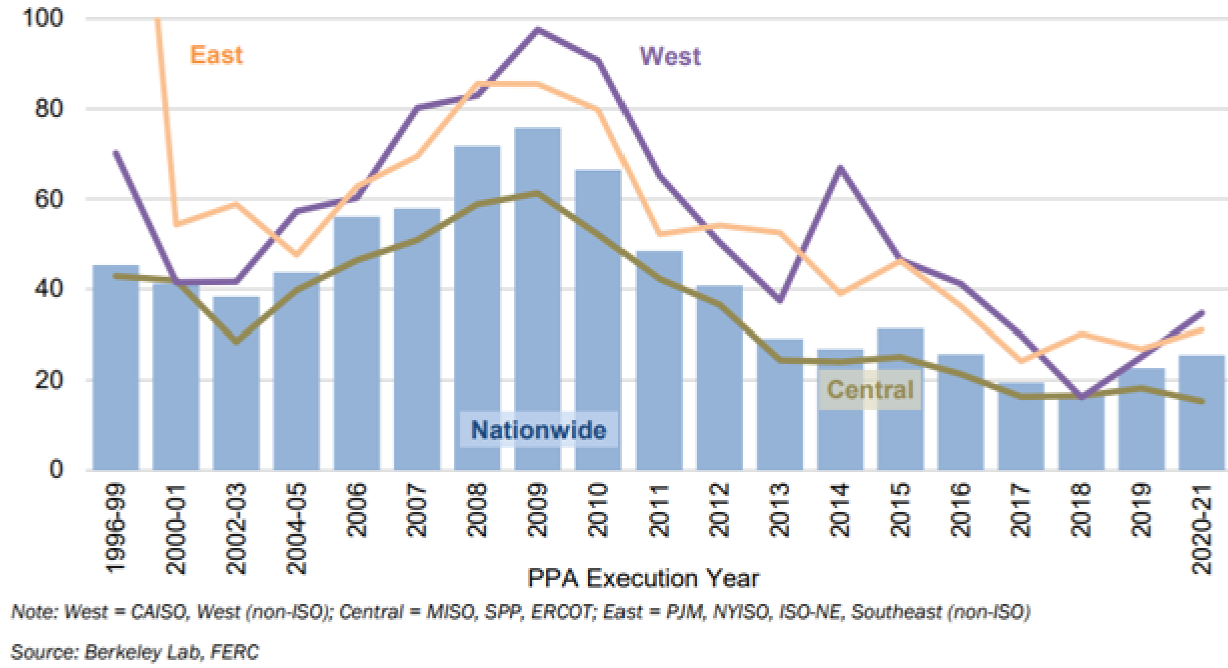

Figure Source: Department of Energy Land Based Wind Market Report: 2022 Edition.

Third, the three-year-old data point on wind cost fails to capture the trend of increasing hub heights and power ratings in newer wind installations. In 2016, EIA data showed that 45 wind projects were installed in the interior region (SPP, MISO, ERCOT); each wind project typically[30] added 150 MW of capacity and featured 2 MW turbines at a hub height of 275 feet.[31] In 2021, the same EIA data source shows 39 wind projects added in the region which each project adding 209 MW of capacity and featuring turbines with a power rating of 3 MW.[32] This trend is important because these changes in the scale of individual projects, power ratings, and hub heights contribute to declining capital costs and levelized prices for wind.[33] Although 2 MW and 3 MW turbines have been the standard, we also note that developers are

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[30] "Typically" is used here to designate the median value.

[31] U.S. EIA. "Annual Electric Generator Report." Release date: September 22, 2022, Final 2021 data Available at: https://www.eia.gov/electricity/data/eia860/

[32] Ibid.

[33] U.S. Department of Energy. 2022. "Wind Turbines: the Bigger, the Better." *Office of Energy Efficiency & Renewable Energy*. Available at: https://www.energy.gov/eere/articles/wind-turbines-bigger-better.

currently offering models twice that size, including GE's 6.0 MW 164 Cypress model[34] and Vestas' V162 6.0 MW turbine.[35]

Overall, Synapse's reliance on an industry-standard source provides a much more reasonable proxy to actual market data. Nonetheless, Synapse believes that the best way to approximate the true capital costs is through real market data obtained through regular all-source request for proposals (RFP). TVA recently issued an RFP for 5 GW of carbon-free capacity and we look forward to seeing the results of this procurement effort.[36] Such results should have been folded into the Cumberland EIS.

2.4. Historical precedent should not disqualify or undermine the candidacy of economic, out-of-region, wind resources in TVA's analysis

Contrary to Concentric's claims, Synapse recognizes several *historical* barriers to the creation of interregional transmission that have limited transmission expansion to only a few interregional transmission projects in the last few decades.[37] Nevertheless, this reasoning is insufficient to disqualify or undermine the candidacy of MISO and SPP PPA resources, especially given the rapid pace at which the United States is changing the transmission landscape to accommodate the expansion of renewables on the U.S. electricity grid.

Large interregional transmission projects are already in development near TVA, and federal funding support is increasing

There are positive signs that at least some of the barriers to interregional transmission construction are being eased. First, and most simply, transmission projects are currently in-development, with several permitting milestones being achieved in the Southern and Midwestern regions. Figure 4 below shows a map of proposed transmission projects as of 2021 (before the IRA passed).

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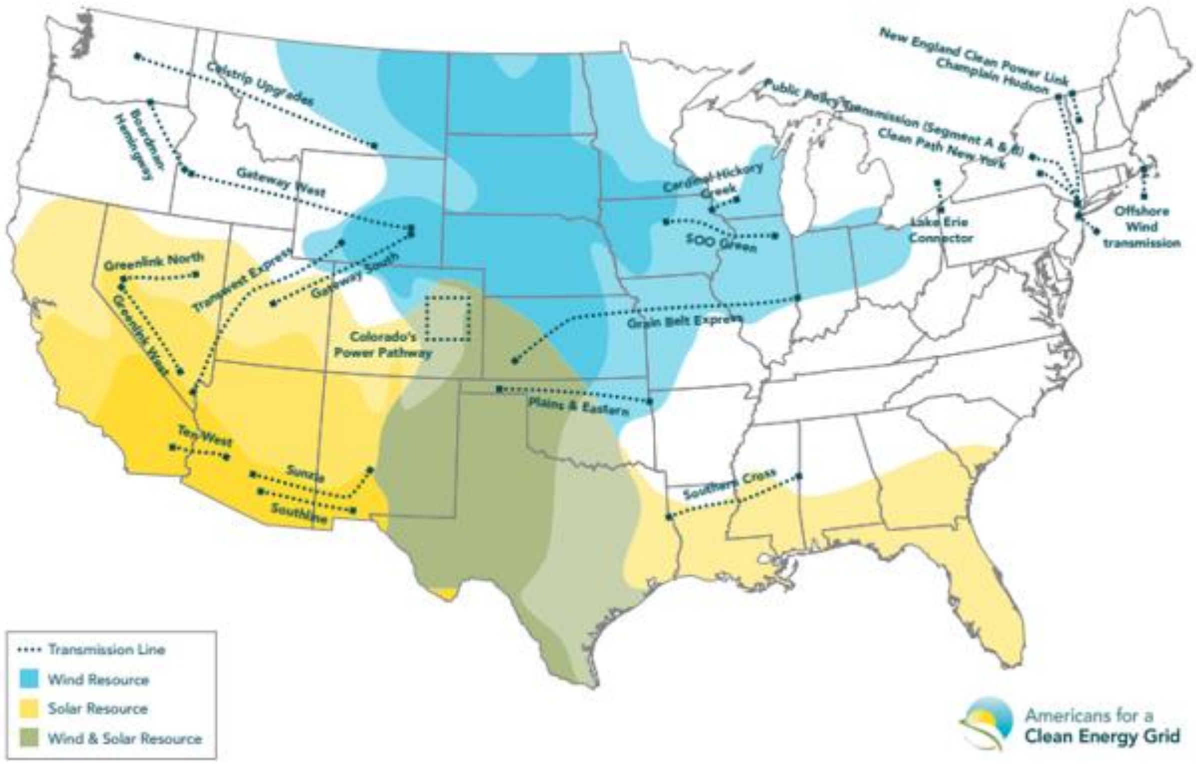
[34] S&P Global Market Intelligence. 2020. "GE launches new 6-MW onshore wind turbine." Available at: https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/ge-launches-new-6-mw-onshore-wind-turbine-61509713.

[35] *Wind Power Monthly*. "Vestas receives first 6MW turbine order." Available at: https://www.windpowermonthly.com/article/1702113/vestas-receives-first-6mw-turbine-order.

[36] Tennessee Valley Authority. 2021. "TVA Issues One of the Nation's Largest Requests for Carbon Free-Energy." Available at: https://www.tva.com/newsroom/press-releases/tva-issues-one-of-the-nation-s-largest-requests-for-carbon-free-energy.

[37] Pfeifenberger, Spokas, Hagerty, Tsoukalis. 2021. "A Roadmap to Improved Interregional Transmission Planning." The Brattle Group. Available at: https://www.brattle.com/wp-content/uploads/2021/11/A-Roadmap-to-Improved-Interregional-Transmission-Planning_V4.pdf.

Figure 4. Map of proposed transmission projects nationwide



Source: Goggin, Gramlich, Skelly. 2021. "Transmission Projects Ready to Go: Plugging into America's Untapped Renewable Resources." Grid Strategies LLC. Available at: https://cleanenergygrid.org/wp-content/uploads/2019/04/Transmission-Projects-Ready-to-Go-Final.pdf.

Second, federal financial support is being offered in novel ways to address some of the difficulties present in building transmission and in recognition of the importance of transmission to a cleaner grid. For example, DOE announced on December 16, 2022, that it is considering providing a loan guarantee for the Grain Belt Express Transmission project. This project would entail building 800 miles of transmission lines to connect four power markets including, principally, SPP and MISO. This would allow bilateral transfer of 4.5 GW. If finalized, this would be the first loan guarantee the DOE makes to a high voltage DC transmission line.[38] Additionally, the IIJA allocated $1.2 trillion for infrastructure upgrades across multiple industries, which specifically includes the Building a Better Grid Initiative using funds

[38] Federal Energy Regulatory Commission (FERC). 2022. "Notice of Intent to Prepare an Environmental Impact Statement for the Grain Belt Express Transmission Line Project, DOE/EIS-0554." Available at: https://www.federalregister.gov/documents/2022/12/16/2022-27099/notice-of-intent-to-prepare-an-environmental-impact-statement-for-the-grain-belt-express.

from the IIJA for grid reliability.[39] Finally, the IRA also provides loans that are now available for supporting construction and modification of national interest electric transmission facilities.[40]

Third, there is near-consensus among studies from industry participants such as SPP, MISO, and NREL that transmission expansion projects have a high net benefit-to-cost ratio.[41] There are challenges inherent in every capital project and Concentric fails to distinguish, using any real study, why interregional transmission should be any riskier than building a combined-cycle gas plant and a pipeline, both of which would risk becoming stranded assets in a few years.

Prior challenges with building out transmission projects are not indicative of the current context

Concentric claims that the Southern Cross Transmission Project is "an excellent example of the challenges and high cost of building interregional transmission." Concentric further explains that the challenges consist of a lengthy timeline from conception to completion and the high costs being $1,000 per kW for the cost of transmission. Concentric then uses this project cost as the basis for its transmission cost estimates.

First, we reject the assertion that this anecdote can be used as the single basis for transmission costs. We note, for example, that NREL's Regional Energy Deployment System (ReEDS) model, projects long-range transmission costs in Tennessee at $901 to $1,200 per MW-mile.[42] The Southern Cross Transmission Project cited by Concentric represents, on a rough approximation, double the costs projected by NREL for the TVA service area.

Second, Concentric's discussion ignores the benefits of transmission. MISO's recent assessment of a tranche of transmission projects in its territory found that $10.3 billion in costs would yield a minimum of $37.3 billion in benefits, or a 3.6:1 benefit-cost ratio.[43] By providing the costs of the projects without

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[39] S&P Global Market Intelligence. 2022. "As IRA drives renewables investment attention turns to transmission upgrades." Available at: https://www.spglobal.com/marketintelligence/en/news-insights/research/as-ira-drives-renewables-investment-attention-turns-to-transmission-upgrades.

[40] U.S. Department of Energy – Grid Deployment Office. 2022. "Grid & Transmission Programs Conductor Guide." Available at: https://www.energy.gov/sites/default/files/2022-10/FINAL_GDO_Grid%20and%20Transmission%20Program%20Guide_091522%5B19%5D.pdf.

[41] Goggin, Gramlich, Skelly. 2021. "Transmission Projects Ready to Go: Plugging into America's Untapped Renewable Resources." Grid Strategies LLC. Available at: https://cleanenergygrid.org/wp-content/uploads/2019/04/Transmission-Projects-Ready-to-Go-Final.pdf.

[42] Ho et al. National Renewable Energy Laboratory. Regional Energy Deployment System (ReEDS) Model Documentation: Version 2020. Available at: https://www.nrel.gov/docs/fy21osti/78195.pdf, p. 62.

[43] MISO Board of Directors. 2022. "Reliability Imperative: Long Range Transmission Planning." Available at: https://cdn.misoenergy.org/20220725%20Board%20of%20Directors%20Item%2002a%20Reliability%20Imperative%20LRTP625714.pdf.

estimating the benefits, Concentric's transmission discussion does more to obscure the value of these resources than clarify them.

Third, TVA is not a passive entity in the expansion of interregional transmission. The company can and should take an active role in spearheading, evaluating, and championing transmission projects that may be beneficial to the region. As part of its charter to deliver least-cost electricity to its customers and its commitment to reaching net-zero by 2050, TVA should actively coordinate with SPP and MISO to better vet options to build out inter-regional transmission capacity. This becomes increasingly important given the 237 GW and 25 GW of wind awaiting interconnection in SPP and MISO, respectively. The approximately 4.7 GW and 2 GW of wind in interconnection queues in SPP and MISO, respectively, are located in Oklahoma and a mix of Arkansas and Kentucky. These resources could serve TVA with proper build-out of interregional transmission.

TVA has at least twice received interconnection study requests from large interregional transmission providers, demonstrating the availability of interregional transmission. These comprehensive and time-intensive processes deflect the critique that Synapse optimistically assumed the availability of interregional transmission.

For example, testimony from the developers and owners of Southern Cross Transmission Project before the Mississippi Public Service Commission suggested that the project's Eastern Converter Station was strategically located between Alabama Power Co and TVA, making it an efficient solution to access both Southern Company and potentially TVA.[44] In the same testimony, Pattern Energy Company also reveals it had requested an interconnection study with TVA.

Likewise, owners of the Clean Line Eastern Transmission Project approached TVA nearly a decade ago looking to build a 720-mile HDVC transmission line to bring wind power from Oklahoma to consumers in the Southeast and MidAtlantic, allowing for 4 GW of energy to be transferred.[45] The Clean Line Eastern Transmission project went through a multi-year rigorous process involving the requests of interconnection studies from TVA,[46] receiving a FERC final EIS,[47] and even getting financial support from

[44] Mississippi Public Service Commission. 2017. "Direct Testimony of David Parquet On Behalf of Southern Cross Transmission LLC. Petition by Southern Cross Transmission LLC for a CPCN for Southern Cross Project." Available at: https://www.psc.state.ms.us/InSiteConnect/InSiteView.aspx?model=INSITE_CONNECT&queue=CTS_ARCHIVEQ&docid=385777.

[45] Smith, S. 2016. "Department of Energy Green Lights Wind Power Transmission LLC." Southern Alliance for Clean Energy. Available at: https://cleanenergy.org/blog/cleanlinehvdc/.

[46] Tennessee Valley Authority. "Interconnection System Impact Study: Shelby Option" 2014. Available at: https://www.energy.gov/sites/prod/files/2015/04/f22/CleanLinePt2-Appendix-10-C.pdf.

[47] U.S. Department of Energy. 2015. "Plains & Eastern Clean Line Transmission Project: Environmental Impact Statement Summary." Available at: https://www.energy.gov/sites/default/files/2015/11/f27/EIS-0486_FEIS_Summary_0.pdf.

DOE.[48] Despite these accomplishments, TVA still did not agree to purchase the 500 MW to 1 GW minimum capacity needed to bring the project to fruition. TVA cited the lack of economic sense given that it already had the capability to meet future projected flat or declining demand using its existing resources.[49] In the same article, the Southern Alliance for Clean Energy (SACE) correctly pointed out that the decision contradicted TVA's own 2015 IRP, which suggested the need to purchase 1.75 GW of low-cost HDVC wind. Furthermore, TVA also cited its reluctance to sign long-term PPAs given the variation in electricity demand. We note that this logic is overall inconsistent with TVA's recent decision to build a new gas pipeline and gas power plant to replace its Cumberland Coal Plant.[50] Synapse recommends TVA revisit this option or explore similar opportunities.

Transmission and Interconnection Policy Reform

In addition to new avenues for funding, interregional transmission is also being supported by reforms at the FERC, SPP, and MISO, and other regulatory venues. FERC recently released a proposal that will support long-range transmission planning by requiring public utility transmission providers to, among many other things, (1) conduct long-term regional transmission planning, and (2) seek the agreement of relevant state entities within the transmission planning region on cost allocation methodologies.[51]

FERC is also investigating establishing a minimum interregional transfer capacity requirement to increase reliability and reduce power prices.[52] Additionally, FERC is attempting to reform interconnection procedures and agreements through various dockets. FERC Docket RM 22-14-000 for instance attempts to alleviate current interconnection queues through, among other measures, revising

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[48] U.S. Department of Energy- Office of Electricity. No date. "Plains and Eastern Clean Line Transmission Line." Available at: https://www.energy.gov/oe/services/electricity-policy-coordination-and-implementation/transmission-planning/section-1222-0.

[49] Smith, S. 2018. Southern Alliance for Clean Energy. "Clean Line: A TVA Failure of Clean Energy and Environmental Leadership." January 8. Accessible at: https://cleanenergy.org/blog/tvacleanline/.

[50] Shober, M. Southern Alliance for Clean Energy. 2022. "TVA Nears Decision to Build New Gas Pipeline and Plant in Middle Tennessee." December 12. Accessible at: https://cleanenergy.org/blog/tva-nears-decision-to-build-new-gas-plant-and-pipeline-in-middle-tennessee/ .

[51] FERC. 2022. Docket RM21-17-000. "Building for the Future Through Electric Regional Transmission Planning and Cost Allocation and Generator Interconnection." Available at: https://www.ferc.gov/media/rm21-17-000.

[51] FERC. 2022. "Establishing Interregional Transfer Capability Transmission Planning and Cost Allocation Requirements; Supplemental Notice of Staff-Led Workshop." Available at: https://www.ferc.gov/media/rm21-17-000.

[52] FERC. 2022. "Establishing Interregional Transfer Capability Transmission Planning and Cost Allocation Requirements; Supplemental Notice of Staff-Led Workshop." Available at: https://www.federalregister.gov/documents/2022/12/06/2022-26474/establishing-interregional-transfer-capability-transmission-planning-and-cost-allocation.

the allocation of costs for (1) shared network upgrades and (2) cluster network upgrade costs. These measures target some of the key barriers identified in the previously cited Brattle report.[53]

2.5. Synapse's energy efficiency assumptions are reasonable, and robust against changes in energy efficiency cost estimates

Contrary to Concentric's characterization, Synapse's energy efficiency forecast is conservative and developed using a methodology consistent with utility industry practices. In fact, the Synapse forecast was comparable to the forecast TVA relied on in one of its IRP scenarios for the Rapid DER and Decarbonization pathways.[54]

Concentric nonetheless criticizes Synapse for using "broad expectations based on backward-looking data references" to determine the level of energy efficiency potential. However, Concentric did not develop its own energy efficiency forecast, and moreover ignores the reality that TVA has yet to publish a current energy efficiency potential study, despite it being listed a "near-term action" in the 2019 IRP four years ago (TVA claims it currently underway).[55]

Additionally, it is consistent with industry-standard to set a high-level energy savings target in long-term planning processes like these rather than forecast energy efficiency on a measure-level basis as Concentric appears to suggest. In the 2019 IRP TVA itself did not include a projection for programmatic energy efficiency. Synapse recommends that TVA undertake an EE potential study and integrate these projections in its own planning processes, consistent under its obligations under NEPA.

Synapse agrees with Concentric that when lighting efficiency measures are exhausted, future utility-sponsored energy savings may to be more expensive to capture. But TVA is far from exhausting its energy efficiency savings potential from lighting.[56] Tennessee only has about 55 percent residential penetration of LEDs, and it lags in energy efficiency adoption more broadly. Indeed, Tennessee consistently ranks in the bottom half of all states in the American Council for an Energy-Efficient Economy's (ACEEE) *State Energy Efficiency Scorecard*, with an average ranking of 33 in the past 15

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[53] Pfeifenberger, Spokas, Hagerty, Tsoukalis. 2021. "A Roadmap to Improved Interregional Transmission Planning." The Brattle Group. Available at: https://www.brattle.com/wp-content/uploads/2021/11/A-Roadmap-to-Improved-Interregional-Transmission-Planning_V4.pdf.

[54] Synapse Report at p. 28, Figure 16.

[55] TVA 2019 IRP at p. ES-5.

[56] U.S. Energy Information Administration. 2022. *2020 RECS Survey Data.* "Highlights for electronics and lighting in U.S. homes by state, 2020." Available at: https://www.eia.gov/consumption/residential/data/2020/index.php?view=state.

years.[57] Concentric offers no evidence that Tennessee is approaching any point of diminishing returns when it comes to energy efficiency investment in lighting, or more broadly.

Concentric cites $1 billion in IRA funding available to strengthen energy codes as an obstacle to utilities achieving high future levels of energy efficiency savings. However, Concentric does not state how TVA used this information to inform its analysis. And indeed, since the TVA IRP predated the IRA, TVA could not have accounted for the impact of IRA funding on federal efficiency standards in the load forecast. It is important to remember that the goal of energy efficiency investment is not to build a large energy efficiency program, but rather to produce a lower net load. If the Federal government deploys stricter building energy codes, energy savings will still materialize—they will just show up as lower load rather than as part of the utility's energy efficiency program. The only difference is now the savings will occur at zero cost to the utility.

Concentric cherry-picked data from Connecticut and made sweeping assumptions to inflate the cost of the Synapse Clean Energy Portfolio.

Concentric makes an inexplicable comparison between energy efficiency potential in the TVA service area and the state of Connecticut. Concentric's claim is that since a recent energy efficiency plan was approved in Connecticut at a first-year cost of $1.05 per kWh to achieve a 0.7 percent reduction in load, it will cost TVA $1.05 per kWh to achieve the same savings rate in 2032. This argument ignores the history of energy efficiency in each state as well as the many differences between the two states.

On this topic, there is no equivalence between Connecticut, a state which has long invested in energy efficiency—and therefore whose incremental energy savings are necessarily harder to achieve—and TVA, which is a laggard among its regional utility peers.[58] Concentric correctly states that Connecticut is a leader in energy efficiency, having been rated in the top 10 on the ACEEE Scorecard for over a decade.[59] By contrast, in 2022, Tennessee placed 28th by the same metric.[60] Connecticut is a small, northeastern state with a different population, geography, climate, and building stock that are not obviously well-suited for comparison to Tennessee. Connecticut is served by two investor-owned utilities, while Tennessee is served almost exclusively by TVA.

Importantly, Concentric's claim ignores the history of energy efficiency in each state. Figure 5 shows that Connecticut has long achieved efficiency savings in considerable excess of 1 percent of total load, while Tennessee has seen decreases approaching zero in recent years.

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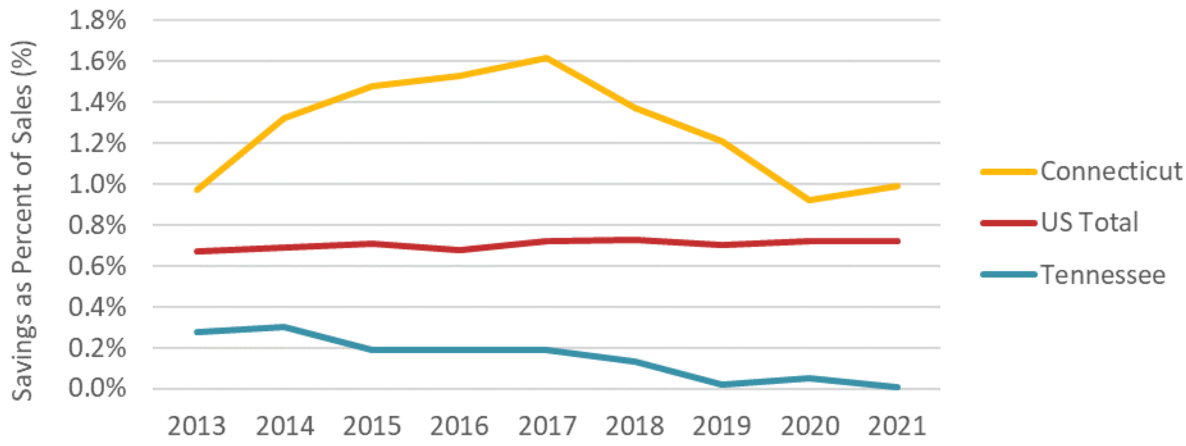
[57] Synapse analysis of previous 15 ACEEE State Energy Efficiency Scorecards. Available at: https://www.aceee.org/state-policy/scorecard.

[58] Southern Alliance for Clean Energy. 2022. *Energy Efficiency in the Southeast, Annual Report.*

[59] Concentric Report at p. 11.

[60] American Council for an Energy-Efficient Economy. 2022. *2022 State Energy Efficiency Scorecard.* Available at: https://www.aceee.org/research-report/u2206.

Figure 5. Comparison of energy efficiency savings as a percent of sales



Source: Synapse analysis of ACEEE State Energy Efficiency Scorecards.

Considering the success Connecticut has seen over the past decade of efficiency investments, it is no surprise that the cost of saved energy is higher now; however, there is no reason to expect Tennessee would see the same costs for energy efficiency , as Concentric suggests. Had Concentric presented a national or regional average cost per kilowatt-hour saved, or the energy efficiency costs for multiple states, it could have drawn a logical conclusion about forward-looking energy efficiency costs. Instead, Concentric cherrypicked an unrepresentative state and did not provide a fair comparison. Thus, its claim that Synapse understates the cost of the Clean Replacement Portfolio by over $8 billion is unsupported.

Energy efficiency covering 1 percent of total load is achievable, and TVA must reverse course and once again invest in saving energy

Concentric attempts to argue that the level of energy efficiency in Synapse's proposed Clean Replacement Portfolio is too costly to be achieved. This is not true. An analysis of the 2022 ACEEE State Scorecard shows that 16 states achieved energy efficiency saving totaling 1 percent of load, at a median cost of saved energy of $0.2787 per kWh.[61, 62] A number of these states have long achieved energy efficiency savings of over 1 percent of total load, without reaching the point of diminishing returns as Concentric presumes. For example, Michigan has an average annual energy efficiency savings of 1.42 percent of sales over the past decade at an average cost of $0.16 per kWh.[63] Over that same timeframe,

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[61] Those states are Arizona, California, Connecticut, Hawaii, Illinois, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Rhode Island, Utah, and Vermont.

[62] 2022 ACEEE State Energy Efficiency Scorecard.

[63] Synapse analysis of ACEEE Scorecards.

Maryland has achieved an average annual energy efficiency savings of 1.38 percent of sales at an average cost of $0.30 per kWh.[64]

For a local example of a utility investing in EE , TVA should look to Duke Energy Carolinas, which has had energy efficiency programs that have achieved about 1 percent of sales.[65] As noted in the comments of SELC et al. on TVA's 2019 Draft IRP, Duke Energy Carolinas offers a full suite of energy efficiency programs that capture energy savings from the residential and non-residential sectors.[66] SELC points out that Duke Energy Carolinas achieves this level of savings not only because of the programs it offers but because of its commitment to them.[67] In contrast, TVA has gutted funding for energy efficiency in recent years, and in fact eliminated all direct financial incentive programs for energy efficiency upgrades in 2019.[68] This has led to TVA severely under-performing in energy efficiency; TVA accounted for 19 percent of sales in the Southeast and only 5 percent of the total energy efficiency savings in 2020.[69]

Overall, Synapse developed a reasonable energy efficiency forecast to reflect a level of savings that is achievable for many utilities at a cost-effective rate. In 2021, 16 states achieved a level of energy efficiency of at least 1 percent of total load.[70] Their median cost of saved energy was $0.2787 per kWh. Continued investment in energy efficiency is critical for TVA and will make its system lower-cost and more resilient. It could also help mitigate the impacts of high load events in the future, such as the rolling blackouts that 320,000 TVA customers experienced in December 2022.[71] These events are becoming more common and disruptive, and increased energy efficiency and demand response investments, as part of a clean energy portfolio, can help TVA mitigate or even avoid these types of grid disruptions and rolling blackouts in the future.

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[64] *Ibid*.

[65] American Council for an Energy Efficient Economy. 2020. *2020 Utility Energy Efficiency Scorecard.* Available at: https://www.aceee.org/research-report/u2004.

[66] SELC et al. 2019. *Comments on Draft Integrate Resource Plan.* at p. 22.

[67] *Id.* at p. 23.

[68] Bradley Wright, F., H. Pohnan, M. Shober. 2022. "Fourth Annual Report: Energy Efficiency in the Southeast." available at: https://cleanenergy.org/wp-content/uploads/Energy-Efficiency-in-the-Southeast-Fourth-Annual-Report.pdf.

[69] *Id.* at Appendix B, attachment "Energy-Efficiency-Report-Program-Year-2020-Appendix-B.xlsx"

[70] Those states are Arizona, California, Connecticut, Hawaii, Illinois, Maine, Maryland, Massachusetts, Michigan, Minnesota, New Hampshire, New Jersey, New York, Rhode Island, Utah, and Vermont.

[71] Eggers, Caroline. 2022. "TVA bet on gas for Arctic storms. It backfired." *90.3 WPLN News.* December 29. Available at: https://wpln.org/post/tva-bet-on-gas-for-arctic-storms-it-backfired/.

2.6. Synapse finds that Concentrics's analysis of storage resources relies on an incomplete and outdated view of storage technologies

A substantive portion of Concentric's critique of Synapse's treatment of battery storage focuses on Synapse's Solar and Storage Scenario, which relies heavily on deployment of battery storage. But Synapse also modeled a Clean Portfolio that relies on less deployment of battery storage and a more diverse mix of resources. This portfolio has the type of diversity TVA promoted in its IRP. We address Concentric's critiques on our modeling of battery storage in detail in this section.

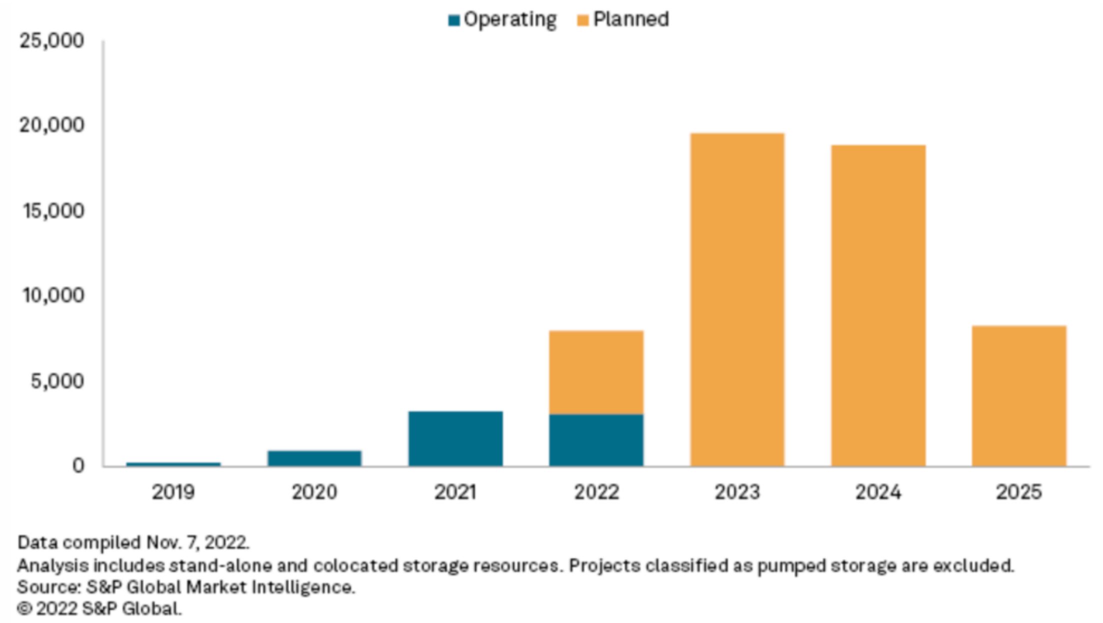
Concentrics's arbitrary use of the 2020 calendar year as a benchmark for storage deployment is misleading and outdated.

In its report, Concentric contrasts anticipated storage deployment in TVA over the next 5 years with total U.S. deployment of energy storage in 2020. Concentric's comparison correctly points out that the deployment of energy storage is exponentially accelerating across the country. Over the last several years, this has led to single-year deployments that exceeded the total cumulative storage deployment of previous years. For example, *cumulative* energy storage capacity deployment tripled in 2021 from 1,500 MW to 4,500 MW.[72] Storage deployments maintained momentum in 2022 despite widely discussed supply-chain issues, and short-term projections through 2025 contemplate deployment levels that are, approximating conservatively, a factor of 50 greater than total deployments seen in 2020.[73] Figure 6 shows S&P Global's November 2022 projections of U.S. utility-scale energy storage projects through 2025. In 2023 and 2024, S&P Global anticipates just under 20 gigawatts of new deployments of energy storage per year.

[72] Hering, G., & Duquiatan, A. 2022. "US energy storage wave builds strength amid delays." *S&P Global.* Retrieved at: https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/us-energy-storage-wave-builds-strength-amid-delays-72885152.

[73] Ibid.

Figure 6. Utility-scale storage deployment by anticipated year in service (MW)



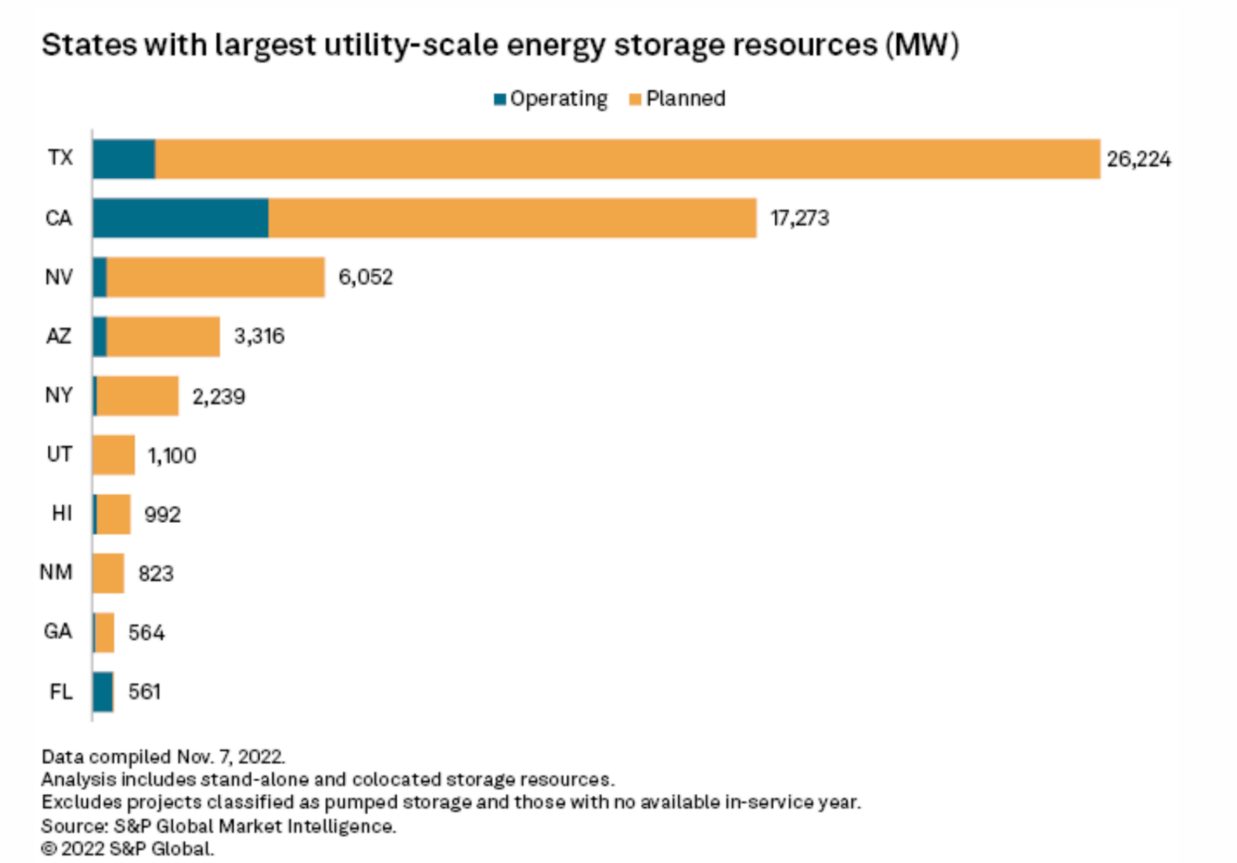
Source: Hering & Duquiatan.2022. "US energy storage wave builds strength amid delays". S&P Global Market Intelligence .Available at https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/us-energy-storage-wave-builds-strength-amid-delays-72885152:

Over the next decade, Bloomberg New Energy Finance expects the global storage market to reach 15 times its 2022 level by 2030.[74] While 2020 cumulative deployment provides a helpful indicator for the exponential growth of energy storage in recent years, it is not an accurate benchmark of the current state of energy storage deployment.

Deployment over the last few years has been led by forward-thinking states and utilities—especially those integrating battery storage into resource planning and state energy and climate planning. Figure 7 shows operating and planned energy storage deployments by state as of November 2022.

[74] Bloomberg New Energy Finance. 2022. "Global Energy Storage Market to Grow 15-Fold by 2030". Available at: https://about.bnef.com/blog/global-energy-storage-market-to-grow-15-fold-by-2030/

Figure 7. Cumulative operating and planned energy storage by state



Source: Hering & Duquiatan.2022. "US energy storage wave builds strength amid delays". S&P Global Market Intelligence .Available at https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/us-energy-storage-wave-builds-strength-amid-delays-72885152:

Nevada's population, for example, is just one-third of that served by TVA, yet Nevada plans to install 6 GW of energy storage through 2028 to integrate low-cost renewable energy sources. Meanwhile, Arizona Public Service plans to procure more than 5 GW of energy storage through 2035, with 1 GW coming online by 2025.[75] Duke Energy Carolinas and Duke Energy Progress' resource planning contemplates deploying 2.1 GW of storage by 2030 to meet their carbon commitment.[76] And, driven by

[75] Miller, C., Twitchell, J., & Schwartz, L. 2021. State of the Art Practices for Modeling Storage in Integrated Resource Planning. *U.S. Department of Energy Grid Modernization Laboratory Consortium.* Retrieved at: https://eta-publications.lbl.gov/sites/default/files/idsp_2021_storageirps_20211005.pdf.

[76] Duke Energy. 2020. Carolinas Carbon Plan. Retrieved at: https://desitecore10prod-cd.azureedge.net/-/media/pdfs/our-company/carolinas-carbon-plan/executive-summary.pdf?rev=489fd2ab6211481484eb4beb9b62a25a.

Virginia's *Clean Economy Act*, Dominion Virginia's IRP anticipates 2.6 GW or more of energy storage over the next 15 years.[77]

Increased reliance on battery storage expands to grid operators as well as they gain operational experience with the resource. During the summer of 2022, for example, California's grid operators dispatched more than 3 GW of storage to meet summer peak demand, "orders of magnitude" more than the California grid had online in 2020.[78] Battery storage resources are meeting grid needs at scale today, and they are projected to play an even greater role in the coming years.

Even with the growing momentum around battery storage deployment, the IRA has upended utility resource planning expectations—especially for battery storage resources, which previously were not eligible for clean energy tax credits.[79] Princeton University's REPEAT project estimates that, due to the IRA, storage deployment in the United States will grow almost two orders of magnitude this decade to 90 GW by 2030.[80] Credit Suisse concludes that the IRA "definitively shifts the narrative from risk mitigation to opportunity capture."[81] In the context of new subsidies and low-cost renewables, the most salient constraint is the physical pace at which new projects can be constructed and interconnected.

Energy storage deployment is moving astonishingly quickly, rendering deployment numbers from just a few years ago obsolete as a measure of the role of these resources on our energy grid. Recent events portend to further accelerate storage deployment. Synapse's modeling projects this emerging reality, rather than re-producing the status quo.

Concentric mischaracterizes NREL ATB's fixed operations and maintenance cost assumptions, which are appropriate for planning purposes

Concentric articulates concerns about the NREL ATB fixed operations and maintenance (FOM) costs on which Synapse relied. Specifically, Concentric anchors its assessment[82] with high-level claims about the variability of storage degradation, unjustified assertions on the performance of storage resources in the

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[77] Dominion Virginia (2022). 2022 Update to 2020 Integrated Resources Plan. Retrieved at: https://cdn-dominionenergy-prd-001.azureedge.net/-/media/pdfs/global/company/2022-va-integrated-resource-plan.pdf?la=en&rev=4549a78d3a3a49fdb4850432fbdc9492.

[78] Colthorpe, A. (2022, September). "California's fleet of battery storage working to avert energy crisis." *Energy Storage News.* Retrieved at: https://www.energy-storage.news/californias-fleet-of-battery-storage-working-to-avert-energy-crisis/.

[79] Howland, E. (2022, November). "Inflation Reduction Act upends utility resource planning tenets: NARUC panelists." *UtiityDive.* Retrieved at: https://www.utilitydive.com/news/inflation-reduction-act-ira-resource-planning-irp-naruc-nextera/636801/.

[80] Ibid.

[81] Meyer, R. (2022). The Climate Economy Is About to Explode. *The Atlantic.* Retrieved at: https://www.theatlantic.com/science/archive/2022/10/inflation-reduction-act-climate-economy/671659/.

[82] EIS Appendix Q, p. 13.

Synapse scenarios, and a quotation from an NREL cost projection report: "If the battery is operating at a much higher rate of cycling, then this FOM value might not be sufficient to counteract degradation."[83] Concentric appears to ignore that NREL's cost approach was, in fact, designed to accommodate these uncertainties by using conservative assumptions. Indeed, Concentric ignores the NREL material immediately preceding the sentence it quotes:

> Lower FOM numbers typically include only simple maintenance while higher FOM numbers include some capacity additions or replacements to deal with degradation. We have adopted a FOM value from the high end and assume that the FOM cost will counteract degradation such that the system will be able to perform at rated capacity throughout its lifetime. The FOM value selected is 2.5% of the $/kW capacity cost for a 4-hour battery. We assume that this FOM is consistent with providing approximately one cycle per day. If the battery is operating at a much higher rate of cycling, then this FOM value might not be sufficient to counteract degradation.[84]

The sentences immediately preceding the quote taken by Concentric show that NREL ATB cost assumptions already use conservative, high-end FOM cost assumptions and account for energy storage resources cycling once per day. This approach is consistent with the use of energy storage in the Synapse scenarios, which are discharged to meet peak load, net of energy efficiency and variable renewable energy generation, then recharge during low net load times. Concentric's misunderstanding of NREL's cost and degradation assessments apparently relies on a misused quote and misinterpretation of how storage operates in the Synapse portfolio. Puzzlingly, Concentric also highlights recommendations that the American Automobile Association supplies for an entirely different use case than utility-scale energy storage. None of these arguments merit reconsideration of NREL cost estimates.

Concentric's view of renewable portfolio procurement is outdated and not in the best interest of customers

Concentric correctly identifies that the Synapse scenarios both envision rapid deployment of low-cost, zero-fuel and zero-emission resources to meet TVA's needs. Notably, the Synapse scenarios procure these resources because high-renewables, high-storage portfolios represent the best value for TVA customers and deliver power at a substantial discount (roughly $7–10 billion on a net-present-value basis by 2042) compared to the business-as-usual portfolio. Even if, as Concentric contemplates, FOM costs were more expensive than expected or storage deployment was implemented more slowly than anticipated, Synapse's portfolios with varying levels of energy storage show that renewable and storage procurement would still be likely to benefit ratepayers. In sum, Concentric is correct that the Synapse

[83] Cole, W., Frazier, A., Augustine. 2021. Cost Projections for Utility-Scale Battery Storage: 2021 Update. NREL. Retrieved at: https://www.nrel.gov/docs/fy21osti/79236.pdf.

[84] Ibid.

portfolios offer a different approach to energy storage resources. Critically, Synapse's approach is better for TVA's customers than the status quo.