PUBLIC HEARING:

THE PEOPLE'S VOICE ON TVA'S ENERGY PLAN

In Re:	)	
Tennessee Valley Authority 2024	)	**Docket No. PPLPWR-11-2023**[1]
Integrated Resource Plan and	)	
Environmental Impact Statement	)	

Direct Testimony of

Peter Hubbard, Georgia Center for Energy Solutions

On Behalf of the Petitioners:

Energy Alabama, Appalachian Voices, Southern Alliance for Clean Energy,

Center for Biological Diversity, Vote Solar, Green Workers Alliance

January 25, 2024

[1] Illustrative docket number

Direct Testimony of Peter Hubbard, Georgia Center for Energy Solutions, on the Tennessee Valley Authority 2024 Integrated Resource Plan

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Q. PLEASE STATE YOUR NAME, TITLE, AND ORGANIZATION.

A. My name is Peter Hubbard. I am a Clean Energy Advocate with the nonprofit Georgia Center for Energy Solutions (GCES) located in Atlanta, Georgia. GCES seeks to develop an economic and regulatory framework to transition the electric, transportation, buildings, and agriculture sectors in the US Southeast to a 100% clean energy (zero-carbon) future in an equitable, reliable, resilient, sustainable, rapid, and economically efficient manner and in furtherance of the public benefit.

Q. PLEASE SUMMARIZE YOUR EDUCATION AND EXPERIENCE.

A. I hold two Bachelor of Science degrees in Physics and Mathematics and one Bachelor of Arts degree in French from the University of Memphis. I also hold one Master of Arts degree from the Johns Hopkins University School of Advanced International Studies in International Affairs with two Concentrations in International Economics and Energy, Resources, and Environment and one Specialization in Quantitative Methods and Economic Theory. My professional experience is in solar and storage project development as well as energy management consulting (previously at Siemens Energy Business Advisory and AFRY Management Consulting) focused on US and global gas market analysis, electric utility Integrated Resource Plan (IRP) projects, power market analysis in North America, commodity price projections, probabilistic risk analysis, future scenario development, strategic management consulting, capacity expansion modeling, production cost modeling, new technology assessment, and transaction due diligence. I have 14 years of professional experience in the energy sector.

Q. **ON WHOSE BEHALF ARE YOU TESTIFYING?**

A. I am testifying on behalf of the Petitioners: Energy Alabama, Appalachian Voices, Southern Alliance for Clean Energy, Center for Biological Diversity, Vote Solar, and Green Workers Alliance.

Q. WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY IN THIS PROCEEDING?

A. The purpose of my direct testimony is to present to the Tennessee Valley Authority (TVA) Board of Directors and Tennessee Valley customers the growing body of evidence that building new gas-fired generation resources in lieu of renewables and battery storage would increase system costs and risks for TVA and its customers in terms of reliability, resiliency, affordability, and sustainability. Specifically, this testimony will begin with TVA's stated plan in the 2019 IRP, its subsequent decisions ahead of this 2024 IRP, and the process failures that led to TVA's embrace of building new natural gas-fired capacity. This testimony will then address the many risks associated with gas-fired capacity including stranded asset risk, rising fuel cost and price volatility risk, risk to TVA from an over-reliance on gas technology, reliability risks with gas-fired generation, the cost risk of gas versus solar and battery storage, risk to gas-fired units from competition in the interconnection queue, and risk to TVA's customers from a new methane emissions charge. This testimony will also look at several credible analyses to support TVA's clean energy transition, federal government climate action and partnering opportunities, observations and signposts from the 2019 IRP particularly with respect to Distributed Energy Resources (DER), and comments on the 2024 IRP and Environmental Impact Statement (EIS) process for new gas-fired capacity.

Q. PLEASE DESRIBE TVA'S PLAN FOR NEW GAS-FIRED CAPACITY.

A. In the 2019 IRP, TVA announced firm plans to build 2 gigawatts (GW) of new gas-fired combined cycle (CC) capacity and 1.5 GW of new combustion turbine (CT) capacity by 2028, while also letting approximately 2 GW CC and 2 GW CT capacity retire or PPA contracts expire by 2028. Subsequent to the 2019 IRP, but prior to the upcoming 2024 IRP, TVA made its final decision to build 3.5 GW of new gas-fired power plants at its Johnsonville, Paradise, Colbert, and Cumberland Fossil Plant (CUF) sites. TVA is also: (a) nearing a final decision to build a new 1.5 GW gas-fired CC plant at its Kingston Fossil Plant (KIF) site; (b) is proposing to build a new 0.5 GW gas-fired CT plant at its New Caledonia site; and (c) is proposing to build a new 0.8 GW gas-fired CT plant in Cheatham County, Tennessee, for a total of 6.3 GW of new gas-fired capacity.

This is significantly more gas-fired capacity than was contemplated to be online by 2028 in the 2019 IRP Current Outlook. Yet these recent decisions are not informed by the updated analysis of the 2024 IRP and in particular do not consider the dramatically lower costs for solar, wind, and battery storage that result from the Inflation Reduction Act of 2022 (IRA). These decisions could lock TVA into building costly-to-unwind, long-term generation resources that will be pushed early into retirement for economic and regulatory reasons well before the end of their useful life.

Q. PLEASE DESCRIBE THE PROCESS FAILURES THAT LED TO TVA'S EMBRACE OF BUILDING NEW GAS-FIRED POWER PLANTS.

A. The 2019 IRP process led TVA to identify an overly broad range of potential additions to its fleet by 2038, including 18.4 GW of new-build gas-fired power plants, 18.2 GW of solar and wind, and 5.3 GW of battery storage. For context, that level of gas-fired capacity (or renewables capacity) is nearly half of TVA's current system capacity of 38 GW. Because the 2019 IRP contemplated such a wide set of potential additions, TVA can effectively swap half its fleet with gas, or with solar and wind, or both, in the next two decades. This broad ambiguity and lack of a clearly recommended portfolio allows TVA to select conventional resources that are convenient to build but not necessarily the best resources for TVA to meet its obligation to develop an affordable, reliable, and sustainable energy plan.

In this current 2024 IRP, TVA is falling short of its obligation to hear all voices and, importantly, to subject its analysis to objective third-party analysis in order to better meet TVA's planning objectives and avoid a broadly ambiguous IRP result. In other jurisdictions, a regulated utility would present its IRP to the state public utility commission and that plan would be scrutinized by intervenors and commission staff in terms of assumptions, methodologies, preferred portfolios, and alternatives. For example, Georgia Power Company recently submitted its 2023 IRP Update to the Georgia Public Service Commission for them to assess whether their plan as proposed is prudent, reasonable, and likely to meet its objectives, and then provide approval or propose alternatives. In this 2024 IRP, TVA must adopt a more open and transparent integrated resource planning process to ensure that the proposed portfolio for TVA is the most affordable, reliable, and sustainable portfolio possible, and that there is a clearly delineated pathway to decarbonization.

Q. PLEASE DESCRIBE THE RISK TO TVA FROM NEW GAS-FIRED GENERATION SUPPLY, INCLUDING STRANDED ASSET RISK, AND PROVIDE EXAMPLES.

A. TVA's current plan to add 6.3 GW of new-build gas-fired generation capacity creates a broad range of risks of financial impairment for these assets in the near-term and long-term, likely shortening their useful life and putting the assets at risk to retire before project debt is fully amortized. The multiple financial risks to gas-fired resources are derivative of the regulatory risk, climate risk, fuel price volatility risk, and correlated fuel scarcity risk that all fossil gas resources face today, all of which are risks that are increasing over time. Moreover, these are risks that battery storage and hybrid solar+storage resources do not face at all or in equal measure.

At its CUF site and elsewhere, TVA acknowledges they are evaluating emissions abatement technologies for gas-fired CC and CT units such as Carbon Capture and Sequestration (CCS) and hydrogen in order to preserve the future optionality of new gas-fired generation in the face of increasing regulatory and economic pressure. However, it is likely that any retrofitting of gas-fired generating units with carbon emissions control technology like CCS or to co-fire hydrogen will be prohibitively costly to implement, leading to assets at risk of becoming financially stranded and forced to cease operations while still holding debt. This is because CCS is pre-commercial, risky, and a poor choice for abatement technology for the foreseeable future. TVA has commented in US Environmental Protection Agency

(EPA) proposed rulemaking[2] that proposed future standards for natural gas-based units that would impose emission reduction requirements based on utilization of CCS blending with low-GHG hydrogen are not currently available and are not projected to be "adequately demonstrated" and available until as far in the future as 2038. TVA must account for the remarkably poor track record of failure for CCS projects such as Southern Company's failed Kemper project in Mississippi and NRG's failed Petra Nova project in Texas in its IRP process, when accounting for the possibility that this troubled technology could work for TVA.

Several new-build gas-fired generation projects that have been cancelled in favor of battery storage help to further exemplify the risk to TVA. As early as 2017, the 262 megawatt (MW) gas CT Puente Power Project in Oxnard, California was cancelled by Southern California Edison who instead procured a 100 MW 4-hour battery. More recently in Q4 2023, Competitive Power Ventures cancelled plans for its 657 MW gas-fired Keasley project in New Jersey[3], and Invenergy cancelled its 639 MW gas-fired Allegheny project in Pennsylvania[4], citing unfavorable economics compared to alternatives like battery storage. Global Energy Monitor reported[5] that in the first half of 2023, plans for 68 gas-fired power projects around the world were cancelled in favor of battery storage, due to unfavorable economics, uncertainty over revenues, fewer expected run hours, etc. These investment decisions align with analysis published by the Rocky Mountain Institute in December 2022[6] showing that more than 90% of proposed gas plants are outcompeted by cheaper renewable energy, thanks in large part to the IRA.

[2] https://www.regulations.gov/comment/EPA-HQ-OAR-2023-0072-0511

[3] https://www.spglobal.com/marketintelligence/en/news-insights/latest-news-headlines/competitive-power-ventures-pulls-plug-on-657-mw-gas-plant-in-new-jersey-77841585

[4] https://webcache.googleusercontent.com/search?q=cache:iZai_Cx0ETMJ:https://www.post-gazette.com/business/powersource/2023/11/14/invenergy-natural-gas-powerplant-allegheny-energy-center-cancelled/stories/202311130131&hl=en&gl=us

[5] https://www.reuters.com/business/energy/giant-batteries-drain-economics-gas-power-plants-2023-11-21/

[6] https://rmi.org/business-case-for-new-gas-is-shrinking/

Neighboring grid operator PJM issued a report in February 2023 entitled, "Energy Transition in PJM," that exemplifies the headwinds for new gas builds in the region. PJM reports that from 2020 to 2022, only 4.1 GW of new gas-fired generation projects entered their interconnection queue, while 15.1 GW of existing gas projects withdrew from the queue. Meanwhile, 199 GW of proposed renewable projects entered the PJM queue since 2018. PJM assumed that of the 17.6 GW of natural gas generation in the queue at that time, only those projects that were uprates or that were under construction would be completed. PJM's report acknowledged that uncertainty lingers over new-build gas-fired generation projects, even those with signed interconnection agreements and despite their proximity to Marcellus and Utica shale gas supply. Using an economic capacity expansion planning model, PJM determined that virtually all (>95%) new economically-driven generation additions in their market region would be renewables and storage, adding between 56 and 107 GW of new nameplate renewable generation capacity by 2030 as compared to 5 GW of gas capacity.

Given the premature nature of abatement technologies like CCS, the robust economics favoring battery storage over gas-fired power plants, and the headwinds against new-build gas in PJM, it is imperative that TVA account for the high likelihood of financial impairment and stranding of gas-fired generation assets.

Q. PLEASE DESCRIBE THE RISK TO TVA FROM RISING FUEL COSTS AND PRICE VOLATILITY.

A. The US natural gas market is experiencing a long-term structural shift towards increased linkage to global markets due primarily to Liquefied Natural Gas (LNG) exports. The US became the top LNG exporting country last year[7] and as much as 30% of US natural gas production will be exported to markets primarily in Asia and Europe by 2030[8], doubling the percentage of current exports. These LNG

[7] https://www.eia.gov/todayinenergy/detail.php?id=60582

[8] https://www.eia.gov/todayinenergy/detail.php?id=60944 and other sources

exports together with rising pipeline exports to Mexico and Canada will put upward pressure on the cost of natural gas that TVA must purchase for its gas-fired generation fleet. Increasing LNG and pipeline exports will more closely bind the US to the whiplash fluctuations of global markets and extreme weather events, adding to the inherent price volatility of commodities like natural gas. Indeed, TVA stated in an August 2022 Board of Directors meeting that the volatility of natural gas prices becomes a greater risk as gas-fired generation becomes a larger portion of its portfolio. This risk takes a back seat to TVA's current aim to build 6.3 GW or more of new gas-fired capacity, which will certainly result in greater gas reliance and vulnerability to volatile fossil gas prices. Since TVA passes its fuel costs directly to customers, it is TVA's customers who are forced to bear this unlimited upside risk. This risk was borne out in 2022 when the annual average wholesale natural gas price in the United States was $6.45/MMBtu—or more than double the annual average of the prior 12 years—and TVA fuel costs skyrocketed as a result. Moreover, passing fuel costs onto customers invites moral hazard, which is discussed at length by expert witness Ron Binz before the South Carolina Public Service Commission, "From the utility's perspective, operating a natural gas plant is not risky because there is no way the utility will collect less than its reasonable and prudently incurred cost for fuel, no matter how much the price changes." [9]

Q. PLEASE DESCRIBE THE RISK TO TVA FROM AN OVER-RELIANCE ON GAS-FIRED GENERATION TECHNOLOGIES.

A. In the 2019 IRP, TVA concluded that CUF and KIF would both continue operations through 2038. Following a 2021 Ageing Coal Fleet Evaluation, TVA then pre-determined the outcome of its 2024 IRP by making the decision in January 2023 to retire one CUF unit by the end of 2026 and the second unit by the end of 2028. Coal plant retirements are welcome and they have the benefit of unlocking additional tax credits for renewables and battery storage. However, TVA concluded that it would

[9] https://cleanenergy.org/wp-content/uploads/South-Carolina-Fuel-Cost-Proceeding-Testimony-for-SACE-Upstate-Forever-SC-Coastal-Conservation-League.pdf

replace the retiring CUF capacity by building a 1.45 GW gas-fired CC plant on site by 2026, including a new 30 mile gas lateral pipeline, as well as a new 0.9 GW gas-fired CT in Cheatham County, Tennessee.

Although TVA considered solar+storage as replacement capacity at CUF, primarily at alternative locations, their now-outdated analysis fell short in numerous ways and must be updated, including that TVA: (a) used very large estimates for land use; (b) used a range of battery storage costs whose low end benchmark doesn't capture today's cost of battery storage as of the June 2023 NREL Annual Technology Baseline (ATB); (c) added transmission upgrade costs to solar and storage, even though sufficient batteries and a significant amount of solar power can be built on-site at CUF to take advantage of existing transmission interconnection capacity; (d) did not account for the stranded asset costs of a gas-fired CC that will likely only operate for half its useful life; (e) did not account for existing or future environmental compliance costs such as the new methane emissions charge; (f) is underestimating the potential for deficiencies related to climate change accounting and an over-dependence on underperforming gas-fired capacity in its EIS reports for proposed new build gas-fired generation; (g) is overestimating the commercial readiness of CCS technologies and alternative fuels used to abate gas-fired power plant emissions; and (h) did not account for the 50% or more cost reduction of solar and storage projects as provided by the IRA.

When including the impact of the IRA, which TVA and its Local Power Company (LPC) customers can take advantage of through direct payments from the US Treasury, the levelized cost of a firm dispatchable battery system capable of providing a full 24 hours of energy at 1.45 GW power is less than that of the capital cost using ATB 2023 figures plus fuel costs over the next 20 years for TVA's preferred gas-fired CC option at the CUF site. Moreover, TVA locked itself into avoidable costs prematurely by contracting for a new-build lateral gas pipeline at CUF, but without the benefit of an updated economic and environmental analysis as evaluated in the 2024 IRP.

The story is similar at KIF with a 1.5 GW new-build gas-fired CC plant that is under consideration but with worse economics due to a proposed 122 mile gas lateral pipeline. At KIF, the EPA commented that, "The EPA remains concerned that the analysis does not fully account for expected cost decreases of renewable energy and higher future natural gas prices. The costs of renewable energy production and battery storage will continue to fall along the timeline of this project due to subsidies from the IRA."

The risk to TVA from an over-reliance on gas-fired generation is naturally larger than the risk to a well-balanced fleet. The lack of fuel or technology diversity would be risky for any generation portfolio. TVA runs significant risk by shifting its fleet too heavily toward gas-fired technology and should examine much more closely the benefits of decreased reliance on gas-fired power generation.

Q. PLEASE DESCRIBE THE RELIABILITY RISKS ASSOCIATED WITH GAS-FIRED GENERATION.

A. Winter Storm Elliot (WS Elliot) struck in December 2022 and was both an unprecedented event for TVA and a strong signal to the Board of Directors that the 2019 IRP and subsequent analyses of capacity expansion alternatives are underestimating the reliability risks of gas-fired power plants. During WS Elliott, roughly 30% of TVA's gas-fired units experienced correlated outages due to freezing equipment as indicated in TVA's After Action Report. Neighboring Balancing Authorities (BA) were experiencing their own difficulties including natural gas fuel shortages, which resulted in PJM and others curtailing their exports to TVA. There is already a large and growing reliability risk to TVA in the winter on cold mornings and evenings when natural gas demand among residential customers is very high and fuel deliveries are curtailed to interruptible customers like gas-fired power plants, limiting them to on-site fuels like diesel as an alternative, if available. The addition of the planned 6.3 GW of gas-fired generation capacity will exacerbate the risk of correlated forced outages due to fuel supply issues, extreme weather, and other issues that negatively impact the reliability of ageing fossil units.

In a joint report from the Federal Energy Regulatory Commission (FERC), North American Electric Reliability Corporation (NERC), and Regional Entity Staff issued October 2023, "Inquiry into Bulk-Power System Operations During December 2022 Winter Storm Elliott," it was noted that the TVA system saw extreme temperature changes including a drop of 46 degrees in five hours. As a result, TVA experienced well over 6 GW of forced outages and had no choice but to order firm load shed, at one point totaling over 3 GW. In the case of WS Elliott, just as it was in the four prior major national events that required load shed, natural gas fuel issues were core to the problem and called into question the reliability of gas-fired power resources.

These natural gas fuel issues include significant production decreases due to freeze-offs at the wellhead and processing plants that limit supply, the freezing of natural gas transportation and generation infrastructure, gas quality issues and low pipeline pressure, the lack of harmonization between natural gas and electricity markets to ensure fuel supplies can use timely available pipeline capacity, contractual curtailments to interruptible customers in order to meet residential and commercial demand for gas on local distribution systems, shippers' inability to procure natural gas on secondary markets due to tight supply, and very high scarcity-induced market prices. Altogether, these risks combine to increase the risk to reliability of gas-fired resources and the reliability of the TVA system.

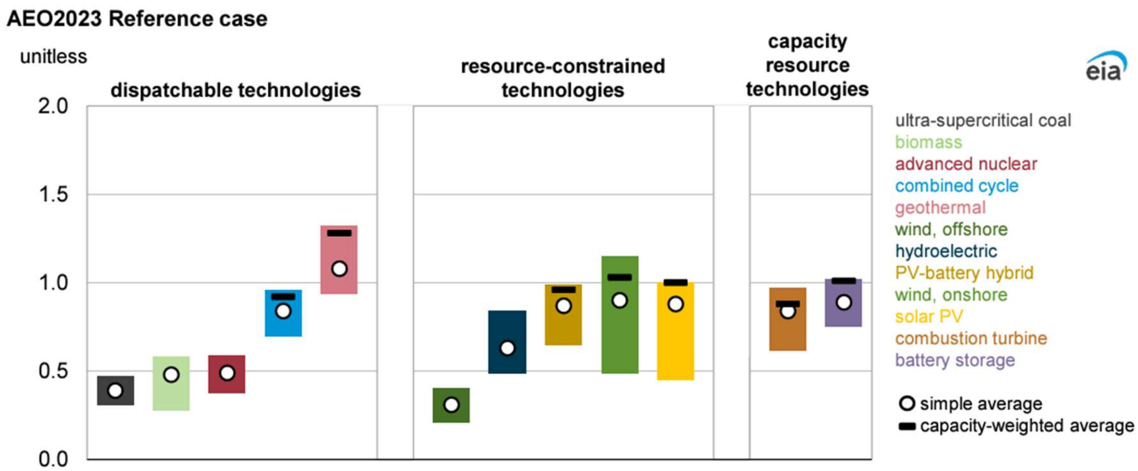
Q. PLEASE DESCRIBE THE RELATIVE COST RISK OF GAS-FIRED GENERATION VERSUS SOLAR AND BATTERY STORAGE.

A. In the latest EIA Annual Energy Outlook released in March 2023, a comparison of the Reference Case levelized costs and the value/cost ratio of new generation resources provides useful insights. The Levelized Cost of Electricity (LCOE) and Levelized Cost of Storage (LCOS) represent the cost to build and operate a generator and diurnal storage, respectively, over a specified cost recovery period (in this case, 30 years). The Levelized Avoided Cost of Electricity (LACE) is the revenue available to that generator over the same 30 years. On its own, an LCOE or LCOS figure only reflects the cost to build and operate a resource but not the value of the resource to the grid. When used together with LACE as a Value-Cost Ratio (VCR), where LACE is the numerator and LCOE or LCOS is the denominator, they provide a comparison of first-order economic competitiveness among technologies and of the cost risk of gas-fired generation vs. alternatives.

Focusing first on the capacity resource technologies in the AEO 2023, the capacity-weighted average LCOE of a gas-fired CT is $122.36 per megawatt-hour (MWh) compared to the capacity-weighted average LCOS of battery storage is $129.37/MWh, a difference of +5.7%. However, the AEO 2023 captured some but not all of the tax credits available to batteries and solar, for example it did not account for the 10% bonus credit for Energy Community status, due to a lack of clear guidance at that time. Including the full IRA tax credits would reduce the LCOS of battery storage below the LCOE of a gas CT. Next, the capacity-weighted average LACE is $110/MWh for a gas-fired CT and $130/MWh for battery storage. Accordingly, the VCR of a gas-fired CT is 0.9 and for battery storage the VCR is just over 1.0, where higher is better. The conclusion is that battery storage is already more valuable to the grid today as a capacity resource, compared to a gas-fired CT, and the relative value of battery storage will only increase with updated tax credit assumptions and as battery storage costs continue to decline.

Focusing next on a comparison of levelized costs for a dispatchable technology like a gas-fired CC ($39.37/MWh) versus energy-limited technologies like solar photovoltaic ($18.95/MWh) and hybrid solar+storage ($31.75/MWh) resources, we see that solar is beneficial as a low-cost energy resource. While LCOE does not capture all of the factors that contribute to actual investment decisions, we then include the LACE figures ($35/MWh, $19/MWh, and $30/MWh, respectively) to arrive at VCR figures of 0.89 for a gas-fired CC, 1.00 for solar, and 0.94 for hybrid solar+storage, as shown in Exhibit 1. The conclusion once again is that solar and hybrid solar+storage are already more valuable to the grid today than is a gas CC. Moreover, the relative value of solar and hybrid solar+storage resources compared to gas-fired units will increase with updated tax credit assumptions and as solar and storage production costs continue to decline.

Exhibit 1: Value/Cost Ratio of New Generation Resources.[10]



Data source: U.S. Energy Information Administration, Annual Energy Outlook 2023
Note: PV = photovoltaic; technologies in which capacity additions are not expected in 2028 do not have a capacity-weighted average.

Q. PLEASE DESCRIBE THE OPPORTUNITY AND RISK TO TVA THROUGH THE LENS OF ITS INTERCONNECTION QUEUE.

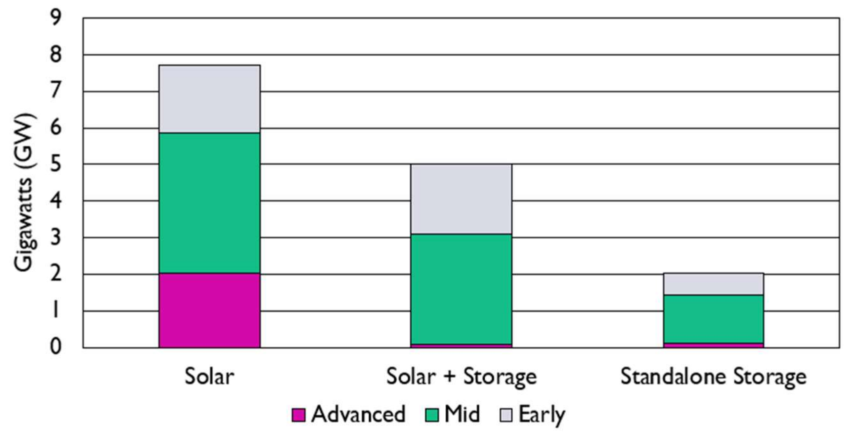
A. A recent review of the website for TVA interconnection requests[11] shows that currently there is more than 5 GW of firm, dispatchable, hybrid solar+storage capacity in the TVA interconnection queue, most of which can be characterized as mid-development (completed System Impact Study) to advanced development (executed Interconnection Agreement). There is a further 2 GW of firm and dispatchable standalone battery storage capacity in the queue, again mostly in mid- to advanced development. And there is over 7.7 GW of utility-scale solar generation in the queue, all of which have expected in-service dates by 2028 or

[10] www.eia.gov/outlooks/aeo/electricity_generation/pdf/AEO2023_LCOE_report.pdf

[11] https://demo.oasis.oati.com/tva/

earlier. At the same time, there is also 9.4 GW of gas-fired capacity in the queue. These figures are summarized below.

Exhibit 2: TVA Interconnection Queue by Technology and Development Status (MW nameplate capacity)



	Early	Mid	Adv	Total	TN	AL	MS	KY	GA	NC	VA
Solar	1,862	3,822	2,042	7,726	2,933	1,232	2,519	1,142	0	0	0
Solar + Storage	1,925	3,016	74	5,015	1,899	830	1,936	350	0	0	0
Standalone Storage	600	1,327	100	2,027	1,152	200	650	25	0	0	0
Gas	3,020	4,481	1,932	9,433	7,277	814	622	720	0	0	0
Total	7,407	12,646	4,148	24,201	13,261	3,076	5,727	2,237	0	0	0

While not all of this capacity will be built, particularly the early-development projects, there remains more than 10 GW of potential new solar, battery storage, and hybrid solar+storage project capacity in the mid- to late-development stage in the queue that can be brought online to help TVA meet its requirements for load growth, reliability, affordability, and decarbonization. Tens of GWs more renewable and battery storage capacity will be added to the TVA queue this decade. Independent power producers and others are sending a strong signal via interconnection queue requests that the case for new-build gas-fired capacity—whether based on economics or resource adequacy or a combination of these and other reasons—is losing ground to renewable and battery storage projects in the open market.

Q. PLEASE DESCRIBE THE RISK TO TVA FROM THE METHANE EMISSIONS CHARGE AND OTHER ENVIRONMENTAL COMPLIANCE COSTS.

A. One component of the IRA that has received little attention is the new methane emissions charge. The emissions charge applies primarily to upstream production and midstream natural gas transportation facilities that are required to report their greenhouse gas (GHG) emissions to the EPA. However, the methane emissions charge will result in higher fuel costs that will be passed directly onto TVA and its customers via the Fuel Cost Adjustment. The charge starts in FY2026 at $900 per metric ton of methane, increasing to $1,500 after two years.[12]

For TVA's fleet of gas-fired CTs and CCs, each more than 7.3 GW, the annual methane emissions charge is estimated to add $60-100 million in fuel cost adjustments by 2030. This is in addition to the cost to purchase and transport the natural gas, which for TVA was $1.9 billion for the year of 2022[13]. TVA would also incur higher natural gas costs if it chose to procure costlier certified natural gas—which has verifiably lower leakage[14]. While this new emissions charge is the first time the federal government has directly imposed a charge, fee, or tax on GHG emissions, other new costs will be imposed explicitly or implicitly as the US economy decarbonizes. TVA must plan for a future in which the fuel for its expansive gas-fired generation fleet grows increasingly more expensive, driving up system costs and reducing the affordability of electrical service to its customers.

Q. PLEASE SUMMARIZE THE ANALYSIS THAT SUPPORTS A CLEAN ENERGY TRANSITION FOR TVA.

A. There is a growing body of evidence, backed by rigorous and credible analysis, that supports a well-managed and rapid transition to clean energy for TVA and its

[12] Congressional Research Service, "Inflation Reduction Act Methane Emissions Charge: In Brief"

[13] Source: S&P Global Market Intelligence

[14] Source: https://www.bloomenergy.com/applications/certified-gas/

customers. A Synapse Energy Economics report prepared in 2023 for GridLab and the Center for Biological Diversity (CBD) demonstrated (using the same capacity expansion and production cost model that is used by TVA, Encompass) that a TVA fleet with 100% clean energy resources—particularly when coupled with DERs—can meet all energy and capacity needs, provide electricity reliably, and generate hundreds of billions of dollars of economic development, public health, and energy justice benefits to Tennessee Valley consumers.

An Applied Economics Clinic report prepared in 2023 for CBD, Appalachian Voices, et al. highlights several key points. In particular, the TVA decision to retire CUF was made outside of the 2019 IRP process. In addition, a consultant to TVA incorrectly asserted that the IRA would not change the conclusions of the 2019 IRP and that TVA would face extreme complexity in the near future by integrating renewables. In truth, no IRP scenario-strategy combination results in more than 8% wind and solar by 2028 (17% by 2038) on the TVA system. Adding solar+storage as proposed for Cumberland Alternative C raises the renewable share to 17% in 2028 (26% in 2038) on the TVA system. However, the integration challenges that can be expected at 30% wind and solar penetration, based on experience and analysis in markets like PJM, are not expected to occur in the TVA region in the next 20 years.

A 2021 report from the Southern Alliance for Clean Energy, "Achieving 100% Clean Electricity in the Southeast," noted that TVA is strategically located in and near areas (e.g., the Midcontinent ISO market) of high wind and solar resources and has a high amount of traditional and pumped hydro resources that can help it integrate high levels of renewables, allowing TVA to achieve 100% clean electricity many years earlier than the rest of the utility sector. In particular, DERs like energy efficiency (EE), demand response (DR), and distributed solar as well as large-scale solar are all critical components for TVA to meet its clean electricity goals as efficiently and affordably as possible.

A CBD et al. issued in June 2022 a report, "From Climate Laggard to Climate Leader," charting a roadmap for TVA to achieve 100% by maximizing DERs, integrating the reliability risks of continued fossil gas and coal operations and partnering with the DOE national laboratories. These and other reports serve to show that there are opportunities for TVA to better meet its energy, environment, and economic development goals using renewables, storage, and DERs as opposed to adding gas-fired capacity with its many costs and risks.

Q. PLEASE DESCRIBE FEDERAL CLIMATE ACTION AND PARTNERING OPPORTUNITIES FOR TVA.

A. The federal government of the United States is making efforts to move rapidly toward decarbonization, as directed by the current administration in several Executive Orders (EO) including EO 14008: *Tackling the Climate Crisis at Home and Abroad*; EO 14057: *Catalyzing Clean Energy Industries Through Federal Sustainability*; EO 14082: *Implementation of the Energy and Infrastructure Provisions of the Inflation Reduction Act of 2022*; and EO 13990: *Protecting Public Health and the Environment and Restoring Science to Tackle the Climate Crisis*. Each of these EOs align with TVA's mission to affordably serve the electricity needs of the Tennessee Valley and create economic development opportunities while doing so in a sustainable way.

The US Department of Defense (DOD), a massive consumer of energy, intends to transition its electricity use to 100% carbon-pollution free energy (CFE) on an annual basis by 2030, with at least 50% matched to a CFE regional supply on an hourly basis.[15] In this area of energy and national security, TVA can be a strong partner to the DOD.

[15] https://media.defense.gov/2023/Jun/16/2003243454/-1/-1/1/2023-DOD-PLAN-TO-REDUCE-GREENHOUSE-GAS-EMISSIONS.PDF

The US Department of Energy (DOE), through its national laboratories, is currently a partner to TVA and can be further leaned upon to develop deep decarbonization pathways. The Oak Ridge National Laboratory (ORNL) is a partner to TVA, as is the National Renewable Energy Laboratory (NREL) in providing assistance during TVA's 2024 IRP. In particular, NREL provides technical assistance to analyze, plan for, and manage all the technical concerns that utility management and system operators have regarding reliability, dispatchability, grid stability, contingencies, etc. An area of particular focus and collaboration between NREL and TVA should be to develop and integrate a Distribution Resource Plan as part of the IRP process.

As a partner to TVA, the EPA can offer rigorous analysis to support safe and reliable decarbonization pathways for the TVA generation fleet and its customers. With the expectation that regulations covering GHGs will become more comprehensive over time, TVA would be well-served to integrate proposed rulemaking into its IRP process. In May 2023, the EPA proposed new source performance standards on fossil fuel-fired electric generating units that would require large gas plants to capture 90% of their carbon emissions, have 30% hydrogen use by 2035, or close early.[16] If this proposed rule were to be implemented, it would have serious implications for TVA's proposed plan to add 6.3 GW of gas-fired power.

It is vital that TVA work closely with partner federal agencies to plan for the most reliable, affordable, and sustainable electric grid as it drives toward its stated decarbonization goals. TVA is already close partners with other federal agencies such as the close collaboration it has with the US Army Corps of Engineers at Kentucky Dam, and TVA should expand these partnerships. TVA should align with federal agencies working toward a well-managed yet rapid clean energy future. Certainly, TVA must set more ambitious targets than its current target of achieving

[16] https://www.federalregister.gov/documents/2023/05/23/2023-10141/new-source-performance-standards-for-greenhouse-gas-emissions-from-new-modified-and-reconstructed

a 70% reduction in carbon emissions by 2030, with a plan to achieve an 80% reduction by 2035 and an aspirational goal to achieve net-zero emissions by 2050.

Q. PLEASE COMMENT ON ANY SIGNPOSTS FROM THE 2019 IRP THAT CAN INFORM THE 2024 IRP.

A. The TVA 2019 IRP provided several key observations with respect to the scenarios, strategies, and sensitivities that are applicable to this 2024 IRP. TVA found that the scenario in which it is operating has more impact on overall results than the strategy or strategies that are implemented. Nevertheless, all scenarios showed a need for new capacity with solar expansion playing a substantial role in all futures.

Of the six scenarios evaluated in 2019, three demonstrate continued relevance to the present TVA 2024 IRP, namely the Valley Load Growth scenario, Decarbonization scenario, and Rapid DER Adoption scenario. The Tennessee Valley and surrounding regions are, in fact, experiencing significant load growth, increasing regulatory pressure to decarbonize, and rising customer demand for rapid DER adoption. Overall, the 2019 IRP found that three variables represent the fundamental drivers of variation among scenarios; these include changing market conditions, more stringent regulations, and technology advancements. In the intervening years since the 2019 IRP, an increasing number of signposts are pointing away from new gas-fired generation and toward renewables and storage.

Five strategies were evaluated in the TVA 2019 IRP, namely the Base Case, Promote DER, Promote Resiliency, Promote Efficient Load Shape, and Promote Renewables strategies. Table 8-2 of the IRP noted that among all five strategies, the Promote DER strategy demonstrated low risk exposure, moderate risk/benefit profile, lowest land use, high flexibility performance, low system average cost, low present value of revenue requirements, and low total resource cost after netting out participant cost. The Promote DER strategy allows TVA to lower its load growth outlook at no cost to its balance sheet, as the cost is shifted (voluntarily) onto the participant installing a DER. The Promote Renewables strategy also showed favorable results including low environmental impact and moderate risk, moderate flexibility, and moderate cost, and would no doubt show even more favorable results in 2024 with lower costs for solar and storage as well as improved flexibility and firm dispatchability with solar+storage hybrid projects.

Several sensitivities were performed and are summarized in Figure 8-18 of the IRP. One observes an increased deployment of solar, wind, EE, and DR in most sensitivities, apart from the sensitivity with lower natural gas prices. However, natural gas prices can and do spike upward for extended periods of time, as they did throughout 2022 and will again as the US gas market is increasingly linked to global gas markets via LNG. In fact, the sensitivity focused on Valley Load Growth demonstrated the economic advantage to TVA of an incremental 6 GW of solar beyond the 9 GW of solar by 2038 in the 2019 IRP Current Outlook.

TVA has also identified several key signposts that can guide decisions in the longer term. These signposts include: (a) higher than anticipated demand for electricity; (b) natural gas prices that are trending higher over time with large spikes as in 2022; (c) rising customer expectations for carbon-free energy; (d) more stringent regulatory requirements like the IRA methane emissions charge and proposed EPA rulemaking; (e) rising operating costs for existing thermal units; (f) strong economic incentives for ageing coal to retire and create new qualifying Energy Communities; and (g) solar, wind, and battery storage costs that continue to decline. Other signposts are centered around technologies such as dynamic line ratings, grid-enhancing technologies, virtual power plants, and DER management systems.

Q. PLEASE DESCRIBE HOW DISTRIBUTED ENERGY RESOURCES (DER) SHOULD PLAY A KEY ROLE IN THE 2024 IRP.

A. A policy of enabling DERs will help TVA to lessen the cost and burden of rapid load growth in the Tennessee Valley by allowing TVA's customers and ratepayers to invest their own money in local, distributed generation that reduces system requirements for both capacity and energy. There is now a large body of evidence to support the safe and reliable operation of bulk electric systems with a large penetration of renewables, including at the distribution level as in California. Any technical reservations can be addressed in partnership with the US Department of Energy and its national laboratories.

DERs are a critical component to economic development in the Tennessee Valley and will enable TVA to reach its strategic goals at lower cost and more quickly than using only utility-scale resources. In the 2019 IRP, Scenario No. 5 for Rapid DER Adoption was the least cost and best performing portfolio across all five strategies in terms of Present Value of Revenue Requirements (PVRR), lowest total resource cost, least risk-benefit ratio, least risk exposure, lowest CO_2 emissions, lowest CO_2 intensity, lowest water consumption, lowest waste, and lowest land use, with a favorable flexibility turn down factor and with positive contributions to local employment. It is clear from TVA's analysis that the Rapid DER Adoption scenario offers significant benefit to TVA and its customers.

In the 2019 TVA IRP, Section 7.4 focused on the observations from modeling results. Significantly, TVA states that, "Solar expansion plays a substantial role in all futures, driven by its attractive energy value beginning in the mid-2020 time frame." Importantly, Strategy B: Promote DER included customer-driven capital investments, which are not costs incurred by TVA and can be excluded from the total resource cost assessment. Further along on page 10-1, TVA states that, "Implementing the recommendations from the IRP will require close cooperation between TVA and local stakeholders, LPC partners, and Valley electric customers, particularly around deployment of DERs. TVA will need to partner with LPCs and other stakeholders in the region to better understand the potential for distributed resources in the Valley and their locational value to inform resource decisions."

Q. PLEASE DESCRIBE WHAT LED TO UNIDENTIFIED RISK FOR GAS-FIRED POWER PLANTS, UNDERACCOUNTING FOR RISK OF CLIMATE CHANGE IMPACTS, AND UNRECOGNIZED VALUE FOR SOLAR AND BATTERIES.

A. Electric utilities are risk-averse by nature and have traditionally relied on firm generation that can be dispatched to meet load in every moment. TVA rightfully puts reliability as a top metric of its performance, where it is critical to identify and quantify all risks to reliability. Currently, TVA relies heavily on thermal power plants for 76% of its installed capacity or more than 30 GWs. Portfolio diversity has been an explicit main focus area for TVA since at least the 2011 IRP. However, more needs to be done to diversify the TVA fleet and balance the heavy dependence on vulnerable gas- and coal-fired power plants.

During extreme weather events, which are becoming more common, thermal power plants can see their summer net dependable capacity reduced by 7% or more during period of high summer heat (not to mention hydroelectric plants that are more than 14% of TVA capacity and can also be heavily impacted by summer drought). Or thermal plants may experience coal stack freeze-offs, frozen equipment, involuntary interruptions to natural gas transport, and other winter-related causes for failure to dispatch reliably. During WS Elliott, more than 15% (6 GW) of TVA's total capacity was offline due to unplanned forced outages at gas and coal plants. This led TVA to declare an Energy Emergency Alert 3 and order customer shutoffs—for the first time in its history—equivalent to 10% of system peak load shed (3 GW) for a duration of seven hours. In fact, natural gas fuel supply issues are implicated in each of the last five major North American load shed events 2011-2022. Significant natural gas production freeze-offs and significant natural gas local distribution company outages were also implicated in three and two of these major events, respectively.

Any further reliance on natural gas capacity for reliability in a world of increasing extreme weather events is misguided and a recipe for future failures. TVA would be well-served by shifting rapidly toward fuel-saving, reliable and dispatchable generation including hybrid solar+storage and standalone battery storage projects. TVA must improve its process in the 2024 IRP and in its EIS documents in order to capture these risks to gas and benefits to renewables and storage.

Q. PLEASE PROVIDE A CONCLUDING SUMMARY OF YOUR DIRECT TESTIMONY.

A. A well-managed yet rapid buildout of solar, wind, battery storage, transmission, and DER resources is needed to replace TVA's retiring fossil capacity and meet strong load growth in the Tennessee Valley. There are numerous credible analyses that clearly demonstrate the substantial economic, environmental, and public health benefits to TVA customers from a 100% clean energy transition. TVA can best fulfill its mission to serve its customers through the Three Es of Energy, Environment, and Economic Development by directing its new-build efforts toward renewables, storage, DERs, and transmission ties with neighboring markets.

Q. DOES THIS CONCLUDE YOUR DIRECT TESTIMONY?

A. Yes, at this time.