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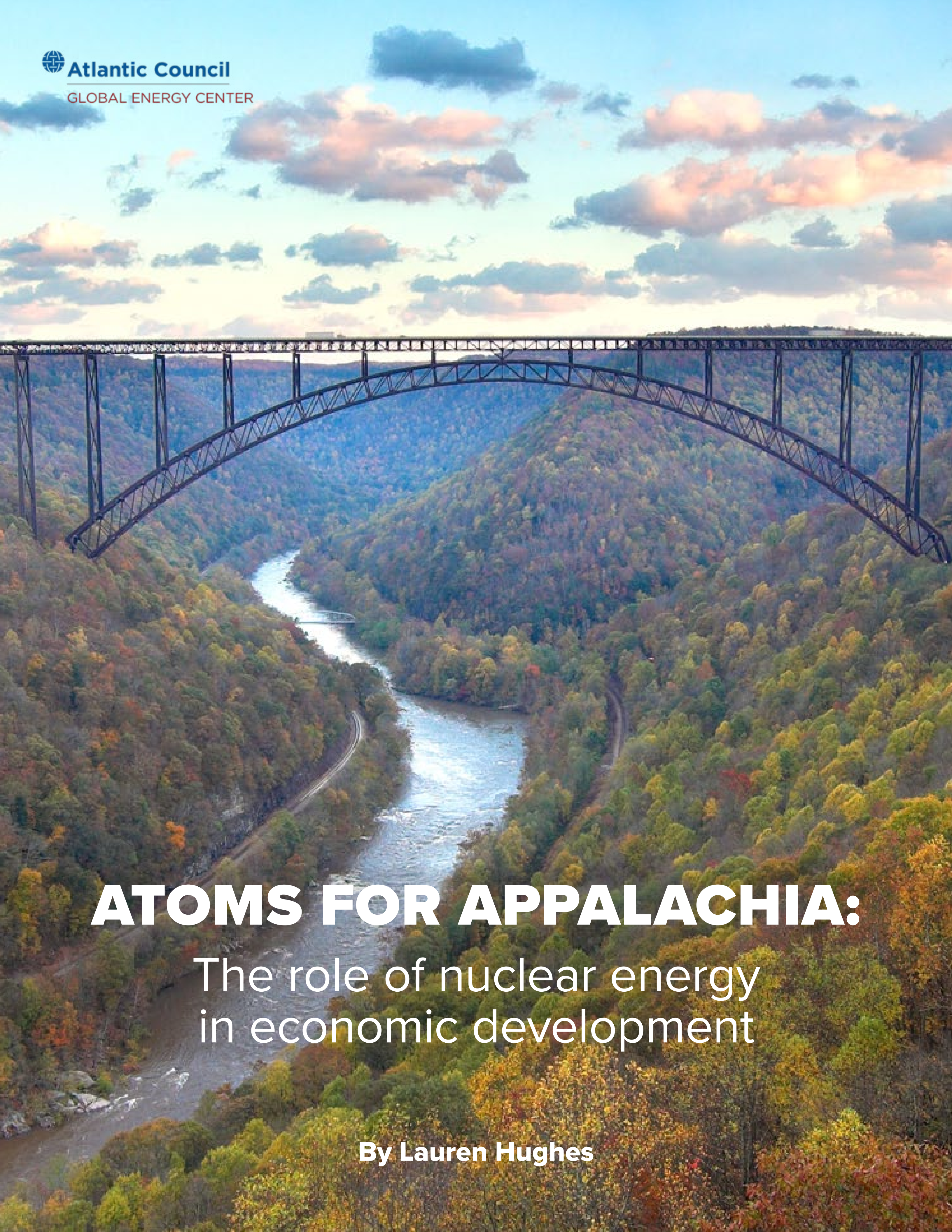

ATOMS FOR APPALACHIA:

The role of nuclear energy in economic development

By Lauren Hughes

Atlantic Council

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The Atlantic Council *Global Energy Center* develops and promotes pragmatic and nonpartisan policy solutions designed to advance global energy security, enhance economic opportunity, and accelerate pathways to net-zero emissions.

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The New River Gorge Bridge.
Source: National Park Service/Gary Hartley

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The Three Mile Island Nuclear power plant in Middletown, Pennsylvania, October 15, 2024. Source: REUTERS/Shannon Stapleton

Introduction

In 2024, the Atlantic Council's Nuclear Energy Policy Initiative hosted a series of private workshops, in partnership with Breakthrough Energy Foundation, in select Appalachian states to identify opportunities and address challenges of deploying advanced nuclear energy. The Atoms for Appalachia (A4A) workshops took place in North Carolina, Pennsylvania, Tennessee, and West Virginia. The workshops galvanized conversations at the federal, state, and local levels to highlight the potential for advanced nuclear energy to play a crucial role in the energy transition and for economic development. In the spirit of the Atlantic Council's Frontiers Project—in partnership with the Idaho National Laboratory and centered on the Mountain West, with meetings in Wyoming, Alaska, and Utah—the Atoms for Appalachia workshops strove to convene people grounded in their communities, at the state and local level, with participants from neighboring states and representatives of companies, national organizations, and the federal government.[1]

There is a connection between economic well-being and the vibrancy of US communities at the local level to the advancement of US economic security, energy security, and national security: A hearty fleet of nuclear reactors and a healthy domestic nuclear industry are essential to promoting US global leadership in nuclear energy and innovation. While the United States aspires to compete in the civil nuclear export market, US stakeholders should strive to build advanced reactors domestically because it is difficult to export a theoretical product that the United States has not yet licensed and deployed at home. First-mover states across the Mountain West, Appalachia, and beyond can advance this mission and, in so doing, further their energy security and US leadership in the energy transition.

1 For more information on the Frontiers Project, see "The Frontiers Project," Atlantic Council, https://www.atlanticcouncil.org/programs/global-energy-center/nuclear-energy-policy-initiative/the-frontiers-project.

A4A workshop discussions were state-centric but focused on a common throughline: to examine the role of advanced nuclear technologies in facilitating clean manufacturing and stimulating local and regional economic opportunities. In *Pathways to Commercial Liftoff: Advanced Nuclear*, the Department of Energy (DOE) projects that US nuclear capacity could scale to 300 gigawatts (GW) by 2050, which would necessitate "~375,000 additional workers with technical and non-technical skillsets to construct and operate 200 GW of advanced nuclear."[2] The scope and scale of this opportunity—and challenge—for states that wish to be first movers into advanced nuclear energy or play a role in the nuclear industry supply chain, is daunting and requires thoughtful, coordinated action if a state is to accelerate down a runway toward deployment of advanced reactor technologies; the workshop participants boldly welcomed the challenge.

North Carolina, Pennsylvania, and Tennessee each operate light water reactor fleets, while West Virginia only recently lifted its ban on nuclear energy in February 2022.[3] These states are at varying levels of readiness to build advanced reactors, which lends to the potential for interstate synergies and collaboration. The A4A workshops sought to reinforce stronger ties between states with experience in nuclear energy—especially by leveraging the expertise of Oak Ridge National Laboratory in Tennessee and the presence of Westinghouse in Pennsylvania—and states (e.g., West Virginia) that could deploy advanced nuclear technologies as part of their energy transition goals but do not currently operate any reactors. Even if West Virginia determines that deployment of an advanced reactor is not of interest, its companies could engage in the nuclear supply chain and enable deployments in the region and beyond.[4]

Each of these states has a legacy of innovation, early technological adoption, and energy leadership. North Carolina was home to the Nuclear Corporation of America, now known as Nucor, until the 1960s. The city of South Charleston is home to the West Virginia Regional Technology Park, an innovation and research hub established by Union Carbide in the late 1940s where an "estimated 3,000 scientists and engineers worked on campus and developed more than 30,000 patented discoveries."[5] Knoxville, Tennessee, is home to Oak Ridge National Laboratory (ORNL), a DOE national laboratory whose legacy is steeped in the Manhattan Project and today advances the frontiers of nuclear science. And in 1957, Pennsylvania pioneered operation of the first commercial nuclear power reactor, the Shippingport Atomic Power Station, in Beaver County.

States can sustain their heritage of innovation by considering advanced reactor technologies, either through physical deployments or as contributors to the nuclear supply chain; such state-led efforts can reinforce US national nuclear infrastructure, conceptualized by Lisa Marshall, American Nuclear Society president, as a delicate ecology of "people, policies, and products."[6] First-mover states can harness the power of the atom to strengthen energy security, foster local and regional economic opportunities, and bolster US global competitiveness and international civil nuclear leadership.

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2 Julie Kozeracki et al., *Pathways to Commercial Liftoff: Advanced Nuclear*, US Department of Energy, March 2023, 4, https://liftoff.energy.gov/wp-content/uploads/2023/03/20230320-Liftoff-Advanced-Nuclear-vPUB.pdf.

3 Curtis Tate, "West Virginia Senate Votes to End Ban on Nuclear Power," West Virginia Public Broadcasting, January 25, 2022, https://wvpublic.org/west-virginia-senate-votes-to-end-ban-on-nuclear-power/.

4 This is already the case with Amsted Graphite Materials, a WV-based company that will provide high quality graphite to X-Energy and Radiant. See "X-energy and Amsted Graphite Materials Establish Partnership to Strengthen Nuclear and Graphite Supply Chains," E-Energy, May 14, 2022, https://x-energy.com/media/news-releases/x-energy-and-amsted-graphite-materials-establish-partnership-to-strengthen-nuclear-and-graphite-supply-chains; and "Radiant and Amsted Graphite Materials Sign Memorandum of Understanding to Secure Critical Supplies for Advanced U.S. Nuclear Energy," Radiant blog, May 22, 2024, https://www.radiantnuclear.com/blog/agm-mou/.

5 "About," West Virginia Regional Technology Park, last updated 2024, https://www.wvtechpark.com/about/.

6 Paul LaTour, "Lisa Marshall: Leading by Example," *Nuclear News* 67 (July 12, 2024): 24, https://www.ans.org/pubs/magazines/nn/year-2024/month-7/.

Surveying the states

Energy policy is handled differently in each of the four states, but they have storied legacies in energy production (particularly in coal, oil, and dry natural-gas production) and manufacturing.[7] Each state has unique stakeholders and unique stakeholder communities, but each also shares regional similarities as part of Appalachia. The four states share geographical features such as the Appalachian Mountains and Appalachian Basin coal beds like the Pittsburgh coal seam, which spurred the growth of a coal-mining industry to export bituminous coal.[8] Ready access to high-quality coking coal encouraged the regional development of manufacturing—largely in iron and steel—and fostered a robust industrial base that grew throughout the first industrial revolution. The Marcellus and Utica shales spurred the development of the region's oil and gas industry, which is prevalent in Pennsylvania and made the state the second-largest natural gas producer after Texas in 2022.[9] Today, energy is the backbone of these states' economies and each has high levels of energy-related employment, as shown in the 2024 US Energy and Employment Report.[10]

The states take a comprehensive approach to energy policy and evaluate new nuclear generation within the context of the overall energy mix, as described below.

NORTH CAROLINA

North Carolina has an existing fleet of five reactors, which account for over 30 percent of net electricity generation, and natural gas-fired power plants contribute over 35 percent.[11] The state operates a regulated electricity market and is a net electricity importer. The North Carolina Utilities Commission (NCUC) regulates the investor-owned utilities, which aim to meet North Carolina's goal of 100 percent carbon-neutral electricity by 2050, and the NCUC and utilities work to revise the state's Carbon Plan (as required by NC House Bill 951).[12] There is no independent authority or advisory group focused solely on advanced reactors, but the North Carolina Energy Policy Council considers nuclear generation, including issues of relevance to the existing fleet, advanced reactor development, and the workforce pipeline.[13]

PENNSYLVANIA

Pennsylvania currently operates eight reactors in a deregulated electricity market, where natural gas-fired power plants and nuclear plants contributed over 55 percent and 30 percent, respectively, of electricity generation in 2022. The state is a net energy exporter of both electricity and products such as coal and natural gas.[14] In February 2024, the Joint State Government Commission released a staff study, Benefits of Nuclear Energy and Development of Small Modular Reactors, which surveyed the robust nuclear industry already present in the state and the potential for advanced reactor deployment.[15] There is no independent advisory body on advanced nuclear energy in the state; however, members of the Pennsylvania House of Representatives recently reconstituted the Nuclear Energy Caucus to "build safeguards—not barriers—to move quickly and construct SMRs."[16]

7 Corrina Ricker and Warren Wilczewski, "Shale Natural Gas Production in the Appalachian Basin Sets Records in First Half of 2021," US Energy Information Agency, September 1, 2021, https://www.eia.gov/todayinenergy/detail.php?id=49377.

8 Leslie Ruppert, Susan Tewalt, and Linda Bragg, "Coal Resources of Selected Coal Beds and Zones in the Northern and Central Appalachian Basin," US Geological Survey, last modified November 29, 2016, https://pubs.usgs.gov/fs/fs004-02/fs004-02.html.

9 "Pennsylvania State Energy Profile," US Energy Information Agency, last updated October 17, 2024, https://www.eia.gov/state/print.php?sid=PA&os=avefgi.

10 Betony Jones, Angelica Zamora-Duran, and Zoe Lipman, *United States Energy & Employment Report 2024*, US Department of Energy, October 2024, https://www.energy.gov/policy/us-energy-employment-jobs-report-useer.

11 "North Carolina State Energy Profile," US Energy Information Agency, accessed May 2024, https://www.eia.gov/state/print.php?sid=NC.

12 "North Carolina House Bill 951," North Carolina Sustainable Energy Association website, accessed November 22, 2024, https://energync.org/hb951/.

13 "Energy Policy Council," North Carolina Environmental Quality, accessed November 22, 2024, https://www.deq.nc.gov/energy-policy-council.

14 Jesse Bushman, "Pennsylvania Electricity Update," Pennsylvania Independent Fiscal Office, March 2023, http://www.ifo.state.pa.us/download.cfm?file=Resources/Documents/RB_2023_03_Electricity_Update.pdf

15 Wendy L. Baker, Bryan W. DeWalt, and Grant W. Rosul, *Benefits of Nuclear Energy and Development of Small Modular Reactors*, Staff Study, Joint State Government Commission, General Assembly of the Commonwealth of Pennsylvania, February 2024, http://jsg.legis.state.pa.us/resources/documents/ftp/publications/2024-02-08%20(HR238)%20Small%20Modular%20Power%20Final%20Report%20FEB%208%202024.pdf.

16 Robert Matzie, "PA Legislators Announced Relaunch of Bipartisan, Bicameral Nuclear Energy Caucus," News Release, PA House Democrats website, July 2, 2024, https://www.pahouse.com/InTheNews/NewsRelease/?id=134720.

TENNESSEE

Tennessee currently has four reactors that operate within a regulated electricity market.[17] Nuclear energy generates over 45 percent of the state's electricity, with natural gas and coal-fired power plants and hydroelectric power also contributing substantially to the grid. In May 2023, Governor Bill Lee established the Tennessee Nuclear Energy Advisory Council by executive order, with the remit of the twenty-two-member Advisory Council to analyze barriers to expanding the state's extant nuclear industry, funding opportunities, and technological opportunities (existing and emerging).[18] The council's subcommittees submitted a preliminary report in December 2023 and released a comprehensive Council-wide report in October 2024. The Advisory Council also has assessed projects seeking to access the $50 million Nuclear Energy Fund, approved by the Tennessee General Assembly in the Fiscal Year 2023-2024 budget and that has granted funding to two nuclear power-related business projects to date, to Type One Energy Group and Orano USA.[19]

WEST VIRGINIA

West Virginia's electricity mix does not utilize nuclear assets, historically relying on coal-fired power plants that accounted for over 85 percent of electricity generation in 2022.[20] Natural gas-fired power plants, wind, and hydroelectric generation comprise the remainder of the electricity mix. West Virginia is an interstate electricity exporter through the PJM Interconnection (a regional transmission organization) and has a regulated electricity market and deregulated gas market.[21] In 2022, the West Virginia Legislature passed Senate Bill 4 to lift the 1994 ban on new nuclear construction.[22] Then-Governor Jim Justice submitted a letter of intent to the Nuclear Regulatory Commission (NRC) in January 2023 stating that West Virginia is committed to becoming an "Agreement State," which would transfer the regulation of specific source materials from the NRC to West Virginia; this effort has been echoed in the 2024 session of the West Virginia Legislature in HB 4968.[23] In the 2023 and 2024 sessions of the House of Delegates, Delegate Kayla Young introduced legislation (HB 5150) to establish the Nuclear Reactor Pilot Program, but the bill did not advance out of committee.[24]

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17 "Nuclear Energy Fact Sheet 2024," Nuclear Energy Institute, last modified November 2024, https://www.nei.org/CorporateSite/media/filefolder/resources/fact-sheets/state-fact-sheets/Tennessee-State-Fact-Sheet.pdf.

18 Tennessee State Exec. Order No. 101 (May 16, 2023), https://publications.tnsosfiles.com/pub/execorders/exec-orders-lee101.pdf; and "Gov. Lee Names Tennessee Nuclear Energy Advisory Council Appointees," Office of the Governor, July 13, 2023, https://www.tn.gov/governor/news/2023/7/13/gov--lee-names-tennessee-nuclear-energy-advisory-council-appointees.html

19 "Nuclear Fund Project Database," Office of the Governor of Tennessee, last entry dated October 15, 2024, https://www.tn.gov/transparenttn/state-financial-overview/open-ecd/openecd/nuclear-fund-project-database0.html; and Lindsey Tipton, "Governor Lee, Commissioner McWhorter Announce Orano USA Seeks to Locate Uranium Enrichment Operations in Oak Ridge," Tennessee Department of Economic and Community Development, September 4, 2024, https://www.tn.gov/ecd/news/2024/9/4/governor-lee--commissioner-mcwhorter-announce-orano-usa-seeks-to-locate-uranium-enrichment-operations-in-oak-ridge.html.

20 "West Virginia State Energy Profile," US Energy Information Administration, last modified January 18, 2024, https://www.eia.gov/state/print.php?sid=WV.

21 "West Virginia Electricity Profile 2023," US Energy Information Administration, last modified November 6, 2024, https://www.eia.gov/electricity/state/westvirginia/.

22 Curtis Tate, "Justice Signs Bill to End Nuclear Power Ban," West Virginia Public Broadcasting, February 8, 2022, https://wvpublic.org/justice-signs-bill-to-end-nuclear-power-ban/.

23 West Virginia Gov. Jim Justice to Christopher T. Hanson, US Nuclear Regulatory Commission (NRC), Letter of Intent to Enter into an Agreement with the NRC, January 9, 2023, https://www.nrc.gov/docs/ML2303/ML23039A192.pdf; and "Bill Status–2024 Regular Session," West Virginia Legislature, https://www.wvlegislature.gov/Bill_Status/bills_history.cfm?INPUT=5150&year=2024&sessiontype=RS.

24 "Bill Status–2024 Regular Session," West Virginia Legislature; and Kayla Young, "Nuclear Power Key in West Virginia's Future," Opinion, *Charleston Gazette-Mail*, March 15, 2024, https://www.wvgazettemail.com/opinion/op_ed_commentaries/kayla-young-nuclear-power-key-in-west-virginias-future-opinion/article_a1102234-b8aa-5b35-9f14-c377f218fd0b.html.

Common themes: Localized economic opportunity and enablers of deployment

The conversations in the A4A workshops were predicated on exploring the economic opportunities—direct investment, job creation, and indirect and induced effects—for first-mover states with stakeholders interested in deploying advanced nuclear technologies. A4A participants often reiterated that energy was the driver of their states' economic engines and pivotal to economic competitiveness and energy security. Already, the existing US nuclear fleet and nuclear industry provide substantial direct and indirect economic benefits. The Southeast Nuclear Council and E4 Carolinas, an energy industry trade association, released a report that surveyed the regional and state-level economic benefits of the nuclear industry in the southeastern United States and estimated an annual economic impact of over $40 billion for the region.[25] And advanced nuclear energy could serve as an economic engine of the future.

People and policies are pivotal to any deployment. However, specific reactor technologies (the products) under development would allow for "right-sized" options for power and nonpower applications. In turn, potential end users, communities, and states have a suite of advanced reactor designs to consider and can more easily pair "attributes to needs" by contextualizing the use case(s) for potential deployments and localizing their value propositions. These advanced nuclear technologies could drive economic opportunities within these states by providing clean, firm power—aiding in the decarbonization of hard-to-abate sectors—and high-quality process heat for low-carbon manufacturing applications. Nuclear energy is often recognized for its clean and reliable attributes, as a baseload source of decarbonized electricity, as well as for its high energy density, which has inspired end users with significant energy appetites (like data centers and AI companies) to pursue co-locating next to existing nuclear reactors.[26]

Co-location also is driving novel partnership models between reactor developers, end users, and plant operators. Utilizing its existing fleet, Talen Energy Corporation leveraged its Susquehanna Steam Electric Station to build an adjacent data center and sell it to Amazon Web Services, along with contractual offtake of power supplied from the nuclear plant.[27] And in September 2024, Constellation announced the restart of Three Mile Unit 1, which had been prematurely decommissioned in 2019, after signing a twenty-year power purchase agreement with Microsoft; the restoration of service at the newly minted Crane Clean Energy Center is estimated to create thousands of new jobs and result in hundreds of millions of additional state tax revenue during operation.[28] Regarding new build, Standard Power, a data center provider, has partnered with NuScale Power to deploy reactors in Ohio and Pennsylvania.[29] Virginia is another example of where data centers may co-locate near new nuclear build. An A4A workshop participant said that their utility has been inundated with requests from data centers and manufacturers for tens or even hundreds of megawatts that then require feasibility studies and modeling, without being able to assess a company's sincerity or level of commitment to the proposed procurement; the participant emphasized that regulated utilities have a responsibility to ratepayers to not overbuild electric capacity and noted how difficult it is to evaluate the reliability of a demand signal from potential end users.

25 "New Report Details Impact of Nuclear Energy in Southeastern U.S.," Nuclear Newswire, American Nuclear Society, February 20, 2024, https://www.ans.org/news/article-5796/new-report-details-impact-of-nuclear-energy-in-southeastern-us/.

26 Carly Davenport et al., Generational Growth: AI, Data Centers and the Coming US Power Demand Surge, Report, Goldman Sachs, April 29, 2024, https://www.goldmansachs.com/insights/goldman-sachs-research/generational-growth-ai-data-centers-and-the-coming-us-power-demand-surge.

27 Dan Swinhoe, "AWS Acquires Talen's Nuclear Data Center Campus in Pennsylvania," Data Centre Dynamics, a unit of InfraXmedia, March 4, 2024, https://www.datacenterdynamics.com/en/news/aws-acquires-talens-nuclear-data-center-campus-in-pennsylvania/.

28 "Constellation to Launch Crane Clean Energy Center, Restoring Jobs and Carbon-Free Power to the Grid," News Release, Constellation, September 20, 2024, https://www.constellationenergy.com/newsroom/2024/Constellation-to-Launch-Crane-Clean-Energy-Center-Restoring-Jobs-and-Carbon-Free-Power-to-The-Grid.html; and Dean Murphy, Mark Berkman, and Wonjun Chang, "Economic Impacts of Establishing the Crane Clean Energy Center (CCEC)," Presentation to the Pennsylvania State Building & Construction Trades Council, CCEC, September 20, 2024, https://www.pabuildingtrades.org/ccec.

29 "Standard Power Chooses NuScale's Approved SMR Technology and ENTRA1 Energy to Energize Data Centers," BusinessWire, October 6, 2023, https://www.businesswire.com/news/home/20231006286295/en/Standard-Power-Chooses-NuScale%E2%80%99s-Approved-SMR-Technology-and-ENTRA1-Energy-to-Energize-Data-Centers.

Barriers to the development and deployment of new nuclear projects could also stem from fundamental realities of project feasibility, with mentions of permitting, zoning, transmission and distribution, and civil works, such as road, water, and sewer infrastructure. Data center projects, which could be co-located next to an advanced reactor, would need access to roads and water and sewer connections. A university representative highlighted work the institution is undertaking to assess the suitability of industrial sites for various types of industrial and economic development; while the project currently encompasses one state, the intention was to engage with stakeholders to expand use of a Zillow-like tool. Such efforts are examples of how innovative projects could streamline assessments and feasibility studies for brownfield sites such as Belews Creek Steam Station in North Carolina, where project developers could utilize existing transmission and distribution infrastructure.[30] Legacy electrical infrastructure and utilities may be an increasingly attractive siting proposition for proposed projects, especially when cost savings could be significant (up to 35 percent) and utilities have reported long lead times for new transmission and distribution to be approved and constructed.[31]

Beyond facilitating the decarbonization of a state's manufacturing sector, advanced nuclear capacity could enable power-sector decarbonization by repowering former coal-fired power plants. In 2022, DOE evaluated the siting characteristics of coal-fired power plants and determined that over 150 recently retired power plant sites "had the basic characteristics needed to be considered amenable to host an advanced nuclear reactor."[32] One A4A workshop participant emphasized that efforts are underway—through the Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization—to recognize human potential, making sure that coal-reliant communities are not left behind in the energy transition and being mindful of economic mobility for underserved communities.[33] The Appalachian Regional Commission has provided funding to communities affected by the decline of coal-related industries through the Partnerships for Opportunity and Workforce and Economic Revitalization (POWER) Initiative, which has invested approximately $420 million in over 500 projects focused on promoting job retraining and economic regrowth.[34] The potential of high-paying, high-quality jobs in the nuclear industry could be life-altering for a state like West Virginia, where the median household income in 2022 was approximately $55,000.[35]

Another A4A workshop participant underscored that a Wyoming coal miner is not the same as a West Virginia coal miner; they each are grounded in a unique socioeconomic fabric and their individual and cultural experiences are different, which could inform their perception and assessment of a proposed advanced nuclear project. Relatedly, managing community expectations is vital, as any coal-to-nuclear transition and job reskilling may not result in a one-to-one staffing need, since the number and type of jobs for operation and maintenance at coal-fired power plants will likely differ from the profile of a next-generation nuclear power plant. DOE recently released the Stakeholder Guidebook for Coal-to-Nuclear Conversions to assist stakeholders in evaluating such a workforce transition.[36]

The Tennessee Valley Authority (TVA) and Duke Energy are considering advanced reactors in the near term, and both have engaged in early site permitting processes. TVA, a public power corporation, submitted an early site permit application in 2016 for its Clinch River Site, which the NRC issued in 2019.

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30 Ray Gronberg, "Duke Energy Has Nuclear Plans for Stokes County Plant Site," *Business North Carolina*, August 15, 2023, https://businessnc.com/duke-energy-has-nuclear-plans-for-stokes-county-plant-site/.

31 *Coal to Nuclear Transitions: An Information Guide*, US DOE Office of Nuclear Energy, May 2024, https://www.energy.gov/sites/default/files/2024-05/Coal-to-Nuclear%20Transitions%20An%20Information%20Guide.pdf; and Hana Pampaloni, "Power Crunch to Push Data Center Connections by 1-3 Years," Loudoun Now, September 4, 2024, https://www.loudounnow.com/news/power-crunch-to-push-data-center-connections-by-1-3-years/article_e122ad16-6a5a-11ef-909c-33c14c795f00.html.

32 Jason Hansen et al., *Investigating Benefits and Challenges of Converting Retiring Coal Plants into Nuclear Plants*, Idaho National Lab, September 13, 2022, https://fuelcycleoptions.inl.gov/SiteAssets/SitePages/Home/C2N2022Report.pdf; and "DOE Report Finds Hundreds of Retiring Coal Plant Sites Could Convert to Nuclear," DOE Office of Nuclear Energy, September 13, 2022, https://www.energy.gov/ne/articles/doe-report-finds-hundreds-retiring-coal-plant-sites-could-convert-nuclear.

33 "Interagency Working Group (IWG) on Coal and Power Plant Communities and Economic Revitalization," Congressional Research Service, January 17, 2023, https://crsreports.congress.gov/product/pdf/IF/IF12238.

34 "Partnerships for Opportunity and Workforce and Economic Revitalization Initiative," Appalachian Regional Commission, n.d., https://www.arc.gov/grants-and-opportunities/power/.

35 "QuickFacts: West Virginia," United States Census Bureau, https://www.census.gov/quickfacts/fact/table/WV/INC110222#INC110222.

36 Jason Hansen et al., *Stakeholder Guidebook for Coal-to-Nuclear Conversions*, Idaho National Lab, April 2024, https://fuelcycleoptions.inl.gov/SiteAssets/SitePages/Home/C2N_Guidebook_2024.pdf.

Oak Ridge National Laboratory advances the frontiers of nuclear science. Source: US Department of Energy/ORNL

In August 2024, the TVA Board of Directors approved an additional $150 million of funding for site design work.[37] And on January 17, 2025, TVA applied for an $800 million grant from the DOE's Generation III+ Small Modular Reactor Program that, if awarded, would enable TVA and its coalition of partners to further accelerate the development of its Clinch River Project. Additionally, TVA announced a partnership with Type One and ORNL to site a pilot fusion facility, dubbed Project Infinity, at the Bull Run Fossil Plant.[38] Also in Tennessee, ORNL is supporting numerous demonstration and test reactor designs through research and development, as well as the construction of Kairos Power's Hermes Low-Power Demonstration Reactor at Oak Ridge.[39]

Duke Energy, a regulated utility, will apply for an early site permit from the NRC in 2025 for the Belews Creek site and is currently evaluating reactor designs.[40] In May 2024, at the White House Summit on Domestic Nuclear Deployment, several companies—Microsoft, Google, and Nucor—announced memorandums of understanding (MOUs) with Duke Energy to enable their investments in advanced nuclear energy through Accelerating Clean Energy (ACE) tariffs.[41] The ACE tariff framework, or voluntary rate structure, could enable commercial and industrial customers to directly invest in carbon-free assets and could include a Clean Transition Tariff (CTT)-based supply agreement to enable procurement and expand clean energy capacity. Microsoft, Google, and Nucor all have substantial commercial footprints in Duke Energy's Carolinas service area, which is an example of how novel business models could arise from industrial end users. The regulatory environment was also flagged by a workshop participant, who said the ACE tariffs must advance through the

37 Tracey Honney, "More Funding for TVA's SMR Programme," *Nuclear Engineering International*, August 27, 2024, https://www.neimagazine.com/news/more-funding-for-tvas-smr-programme/?cf-view.

38 Pamela Largue, "Tennessee's Bull Run Coal Plant Gets Second Life as Fusion Energy Pilot," *Power Engineering International*, February 23, 2024, https://www.powerengineeringint.com/nuclear/tennessees-bull-run-coal-plant-gets-second-life-as-fusion-energy-pilot/.

39 John Huotari, "Kairos Power Begins Construction on Demonstration Reactor," *Oak Ridge Today*, July 31, 2024, https://oakridgetoday.com/2024/07/31/kairos-power-begins-construction-on-demonstration-reactor/.

40 "Chapter 4: Execution Plan" in *Carolinas Research Plan: Preparing for Growth and Prosperity in a Changing Energy Landscape* (Duke Energy, November 2023), https://www.duke-energy.com/-/media/pdfs/our-company/carolinas-resource-plan/chapter-4-execution-plan.pdf?rev=ccb35fc247e54eefbdcda2499a56764b.

41 Jennifer Sharpe, "Responding to Growing Demand, Duke Energy, Amazon, Google, Microsoft and Nucor Execute Agreements to Accelerate Clean Energy Options," News Release, Duke Energy, May 29, 2024, https://news.duke-energy.com/releases/responding-to-growing-demand-duke-energy-amazon-google-microsoft-and-nucor-execute-agreements-to-accelerate-clean-energy-options.

North Carolina Utilities Commission for approval; while this development is promising, the individual said cost-recovery mechanisms, like construction work in progress (CWIP), would be enablers of reactor deployment.

There are innumerable pathways to deployment and there is no one-size-fits-all approach. When considering nuclear financing models and how commercial risk is managed, nuclear projects supported by public-private partnerships (PPPs) rely on "trusted relationships" that company employees establish with people from interested host communities. An integrated approach to a nuclear project, taking place within an ecosystem of stakeholders who are engaged in the development process, will facilitate open dialogue between parties about risk management and enable host communities to holistically discern and assess "costs" and "value," which may require trade-offs, rather than typically perceived "threats" versus "opportunities."

Cultivating trusted relationships and fostering social license requires proactive community engagement and an authentic investment in people-to-people relationships. Host communities, or even potential ones, want to be involved during the design and certification process and kept apprised of full project life cycles through decommissioning. Managing expectations will be critical to the success of any new nuclear project, and local stakeholders want companies to invest in their communities for the long term. Community members could feel abandoned if a company withdraws from a project, either proposed or operational, as has occurred in the steel mill industry; unmet expectations and unaddressed concerns can rapidly sour a host community's trust with a company.[42] An example of a community that was devastated by a business decision was South Charleston, West Virginia, when Union Carbide ceased operations. A similar story occurred in Pennsylvania in the 1960s, when the American Car and Foundry Corporation shuttered its reactor production division and industrial plant, resulting in the loss of thousands of jobs in rural Berwick.[43] Companies may ground their decisions to shutter industrial facilities and assets in financial calculus, but the aftershocks are often hard-felt and long-lived for communities that grew with an industry that suddenly uproots and evaporates.

In July 2024, before a crowd gathered at the East Tennessee Economic Council's Nuclear Opportunities Workshop, Amy Fitzgerald, a senior manager of the City of Oak Ridge, Tennessee, underscored that communities want to volunteer as hosts versus being "voluntold." Nuclear advocates should aim to identify "trusted community partners," "honest brokers," or "provers" who are from the local community and volunteer for a project because they are compelled by the economic pull, which requires sustained, sincere engagement and clearly communicating the value proposition to an audience; A4A workshop participants urged one another to communicate early and often, with each other and with community members.

42 The Roosevelt Project recently surveyed the US iron and steel industries and the impacts of decarbonization on communities and economic opportunities: See Iron and Steel Decarbonization by 2050: An Opportunity for Workers and Communities, Massachusetts Institute of Technology, 2024. The report's recommendations highlight valuable lessons that could be adapted for new nuclear projects.

43 "Our History," Berwick Industrial Development Association, accessed November 22, 2024, https://bida.com/our-history.html.

A common challenge: The future workforce

Direct investment in advanced reactors, as products, should correspond with commensurate investment in people. As articulated in the DOE Liftoff report, there is a need for recruitment of talented people for all types of careers within the nuclear industry, in nuclear engineering and beyond. A nuclear power plant requires a range of different jobs while under construction and then during operation and maintenance. There are high-value, nuclear-related jobs—as welders, machinists, tradespeople, technicians, electricians, project managers—that do not require a nuclear engineering degree. An interdisciplinary approach and framing will make opportunities accessible—and more appealing—to a broader swath of people and underserved communities. There also are opportunities for the nuclear industry to engage with veterans through programs like Helmets to Hardhats.[44] The compelling recruitment story should be framed in terms of individual benefits for people rather than a focus on technological features of various reactor designs.

Further recruitment should be leveraged by showcasing opportunities beyond four-year degrees and reenergizing the value of apprenticeships, trade schools, and community colleges, which could pilot novel programs like Roane State Community College. Roane State, with the support of UT-Battelle (a not-for-profit company that manages and operates ORNL) and the US Department of Labor, is piloting its two-year nuclear technology certificate program that will involve hands-on, project-based learning.[45] Similar programs for welders are growing at University of Pittsburgh at Bradford in Pennsylvania and Pitt Community College in North Carolina, and could be buttressed by investment from national laboratories and the government (state and federal) in affiliated trades at higher education institutions.[46] In 2023, Idaho National Laboratory (INL) awarded the University of Wyoming with funding for research on nuclear energy and environmental justice, and ORNL is playing a similar role in providing support to nearby state universities.[47]

Additionally, private companies should consider partnering with universities, community colleges, and trade schools, pairing resources with educational pipelines to satisfy future workforce needs. Oak Ridge Associated Universities (ORAU) is a nonprofit organization steeped in university programs and regional plans around capacity building that exemplifies this approach of connecting students with private-sector internships, fellowships, and careers; ORAU hosts an "opportunity catalog" of internships and apprenticeships called Zintellect, which functions as a clearinghouse and central hub for these opportunities.[48] The impact of Zintellect can be amplified if ORAU is made aware of opportunities at organizations and companies. In October 2024, ORAU published recommendations from their Partnership for Nuclear Energy effort, focused on addressing workforce needs and challenges; the report's authors emphasize the importance of "enhanced public outreach and awareness campaigns to promote nuclear education and careers."[49]

Research reactors, such as those situated at The Pennsylvania State University, North Carolina State University, and The Ohio State University (OSU), for example, serve as highly attractive recruitment tools. An A4A workshop participant shared that OSU's Nuclear Reactor Laboratory is saturated with requests for student and faculty research and cannot accommodate outside tours to maximize students' time and access to the reactor. Research reactors provide benefits beyond attracting talent to the nuclear field and the workforce pipeline, as illustrated by Penn State's existing Breazeale Nuclear Reactor, its revitalization, and the FRONTIER Program that will deploy a

44 Helmets to Hardhats, accessed November 22, 2024, https://helmetstohardhats.org/.

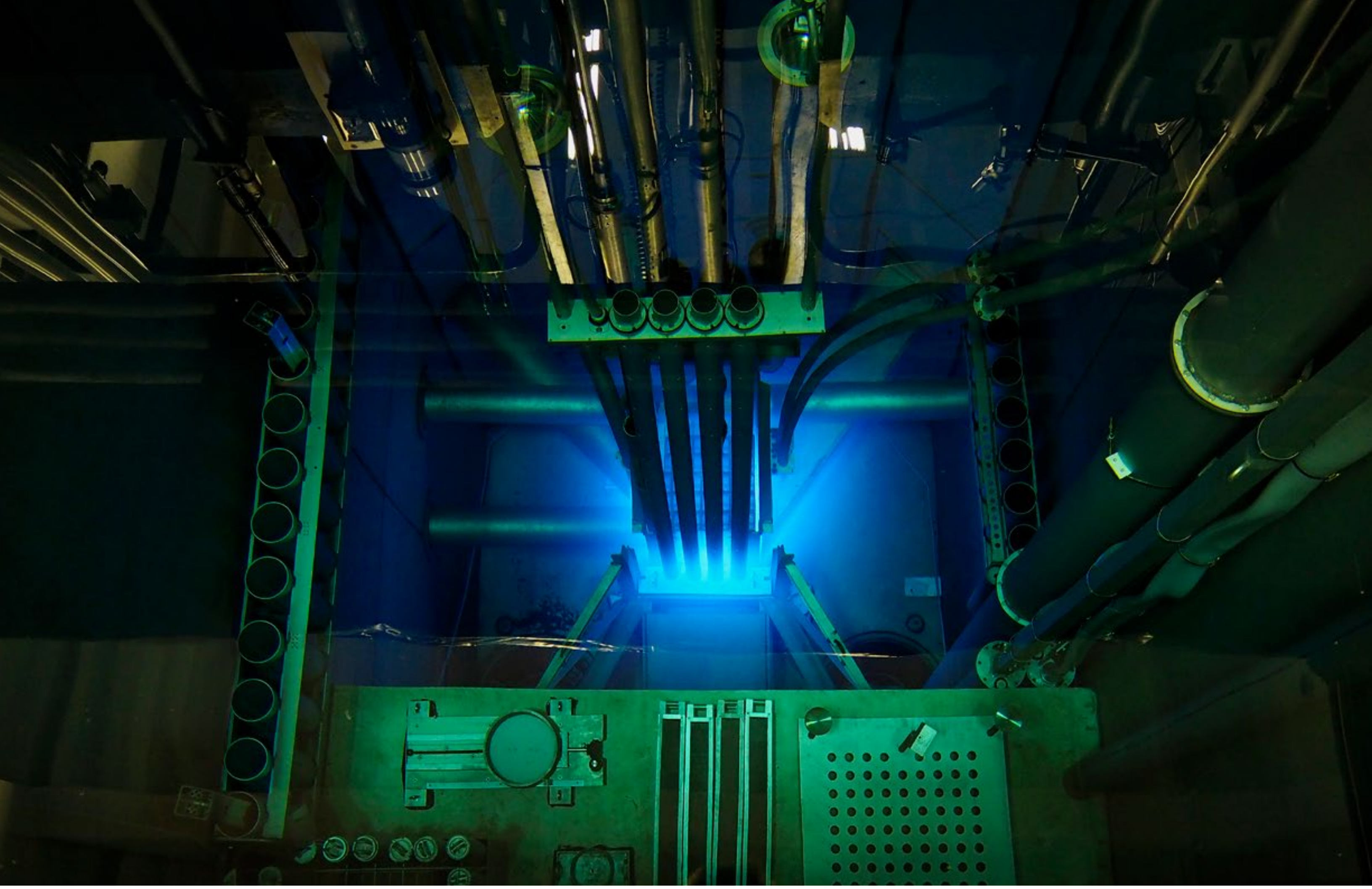
45 Daniel Dassow, "As Nuclear Workers Age, East Tennessee Adds Programs That Help You Learn to Earn $80,000," *Tennessean*, May 21, 2024, https://www.tennessean.com/story/money/business/2024/05/21/university-of-tennessee-roane-state-expand-nuclear-worker-programs/73261283007/.

46 "Mechanical Engineering Technology–BS," University of Pittsburgh, accessed November 22, 2024, https://www.upb.pitt.edu/academics/mechanical-engineering-technology-bs; and "Welding Technology Building Project Begins with Site Preparation," Pitt Community College, August 22, 2024, https://pittcc.edu/welding-technology-building-project-begins-with-site-preparation/#.

47 Cory Hatch, "National Lab Helps Wyoming Explore Nuclear Energy Frontier," Idaho National Laboratory, May 30, 2023, https://inl.gov/feature-story/national-lab-helps-wyoming-explore-nuclear-energy-frontier/; "Core Universities," Oak Ridge National Laboratory, accessed November 22, 2024, https://www.ornl.gov/content/core-universities; and "ORNL Leads Five Public-private INFUSE Projects to Advance Fusion Technologies," Oak Ridge National Laboratory, September 5, 2024, https://www.ornl.gov/news/ornl-leads-five-public-private-infuse-projects-advance-fusion-technologies.

48 "Opportunity Catalog," Zintellect website, ORAU consortium, https://www.zintellect.com/.

49 *Bridging the Gaps: Recommendations for Addressing the Needs of the U.S. Nuclear Energy Industry*, ORAU.



The research reactor at North Carolina State University. Source: Marc Hall, NC State University

Westinghouse eVinci microreactor on campus: FRONTIER can be a research platform with many research applications and serve as an avenue to build societal trust in the technology.[50] Conversely, the University of Virginia (UVA) began decommissioning its research reactor in 1998 and the decision not to replace the capability contributed to an erosion of UVA's nuclear engineering program.[51]

A focus on postsecondary education for growing the future of the nuclear energy workforce is critical, but so too is an eye toward K-12 education and the importance of encouraging an early interest in science, technology, engineering, and mathematics. The American Nuclear Society offers the Navigating Nuclear framework as a resource for educators, but the impact is on a classroom-by-classroom basis because some teachers have biases against nuclear energy and therefore may exclude it from their energy-related curricula. Furthermore, organizations such as the Center for Energy Workforce Development offer resources for educators to encourage broader energy literacy and awareness, which are fundamental to understanding how energy systems underpin our everyday lives and the value proposition of nuclear energy within a comprehensive context.[52] Katy Worrell, an A4A participant and graduate research assistant at the University of Tennessee, Knoxville, shared how her career trajectory was transformed by a BWX Technologies representative visiting her middle school classroom; the interaction and hands-on experience with the company's mission and technologies inspired her to become a nuclear engineer. Students must be aware that a career pathway exists in order to plan and pursue a future in it.

A hands-on approach to learning can pique students' interest, and many A4A workshop participants advocated

50 Sarah Small, "New Device Positions Penn State at the Forefront of University Research Reactors," The Pennsylvania State University, March 13, 2024, https://www.psu.edu/news/engineering/story/new-device-positions-penn-state-forefront-university-research-reactors/.

51 Robert Mulder, University of Virginia Nuclear Reactor Facility, to the US Nuclear Regulatory Commission, Transmittal of Master Final Status Survey Plan, UVA-FS-002, Revision 0, March 2003," April 4, 2003, https://www.nrc.gov/docs/ML0309/ML030990575.pdf.

52 "Energy Industry Fundamentals," Get into Energy, 2024, https://getintoenergy.org/eif-2-0/.

for transforming the way we teach to cultivate curiosity and pioneering classes for frontier technologies.[53] Similarly, apprenticeships are powerful ways to inspire interest in a field and its career opportunities; Mitsubishi Heavy Industries, for example, has launched a full-time apprenticeship academy at North Central West Virginia Airport that involves on-the-job training and the potential to result in full-time employment upon completion of the program.[54] A similar model could be deployed by reactor developers seeking qualified tradespeople or by other companies participating in the nuclear supply chain.

Accurately cataloging and planning for workforce needs will be essential to mitigate the risks of overtraining and hedge against any boom-and-bust cycles of employment, which occurred with the workforce that engaged in AP1000 reactor construction in Georgia; with the Vogtle units complete and no standing order book, several thousand workers have since moved on to seek other gainful employment rather than wait for the next reactor tender. This anecdote emphasizes why the cadence—when and where the jobs are coming—of nuclear projects is essential to accurately balance the forecasted workforce asks (demand) with trying to minimize training too many or too few in the workforce talent pool (supply). In October 2023, the Nuclear Energy Institute released a workforce strategic plan that assesses critical workforce issues and offers recommendations for how the nuclear industry might address future workforce challenges.[55]

Lastly, talking about "human capital" or "capacity building" can obfuscate the centrality of people: real individuals who have different motivations for taking interest in the field, joining the workforce, and seeking career advancement. Talking about "the supply chain" can also encourage this reductive tendency, thereby diminishing the critical role that people play within a supply chain's complex logistical system of components in terms of their roles and skill sets. There are also real-world, human considerations—childcare access, caretaking, transportation—that may impact whether a person or community can take advantage of a career opportunity or remain part of a workforce. Many communities in these states now struggle with the impacts of substance use disorder and its impacts on workforce availability and retention, an unexpected throughline expressed at the A4A workshops and at the Appalachian Carbon Forum, hosted by ORNL in March 2024; the regional "overdose-related mortality rate for people ages 25-54 was 72 percent higher than the rest of the country" in 2021.[56]

Individualized approaches to learning, people-to-people relationships, and the importance of mentorship for career advancement and knowledge transfer also are critical elements to consider for workforce development. The nuclear energy workforce has a higher ratio of older workers than the energy sector writ large and the national average, and with also "23% fewer workers under the age of 30 than the overall energy workforce."[57] This dynamic creates opportunities for the next generation of the workforce but underscores how the industry must grapple with bridging the gap between its retiring workforce and new members, striving to maintain competencies and retain institutional knowledge. The Regional Center for Nuclear Education and Training, a National Science Foundation Advanced Technology Education Center and consortium of academic, industry, and agency partners, recently created the Nuclear Mavericks textbook to document the hard and soft skills of retired industry experts in an autobiographical format.[58] Social media and podcasts are other avenues to capture this expertise and provide aspiring professionals with virtual role models to learn from.

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53 There is a growing recognition that educators and training professionals should modernize curricula and training programs to reflect new learning modalities and "interactive learning approaches such as e-learning, Virtual Reality (VR) and Augmented Reality (AR) simulations to AI-powered scenarios, personalized learning paths, predictive analytics, and beyond." See Olivia M. Blackmon, Charles Lease, and Billy Mack, "Modernizing Training in the Nuclear Power Industry: A White Paper," March 2024, 4, https://www.orau.org/news/releases/2024/orau-co-authored-white-paper-focuses-on-modernizing-training-for-the-nuclear-energy-industry.html).

54 Damian Phillips, "MHIRJ to Host Training Program at North Central West Virginia Airport, Hopes to Gain 160 employees," Exponent Telegram, April 27, 2024, https://www.wvnews.com/theet/news/mhirj-to-host-training-program-at-north-central-west-virginia-airport-hopes-to-gain-160/article_5b695762-0306-11ef-a667-e725739c7714.html.

55 *Nuclear Energy Industry Workforce Strategic Plan: A Long-term Plan to Address the Workforce Needs of the Nuclear Energy Industry*, Nuclear Energy Institute, October 2023, https://www.nei.org/getmedia/c0802a32-be56-4bac-b62a-81cab624fd1e/Workforce-Strategic-Plan.pdf.

56 "Appalachian Carbon Forum," West Virginia University, accessed November 22, 2024, https://acf.ornl.gov/; and "Addressing Substance Use Disorder in Appalachia," Appalachian Regional Commission, accessed November 22, 2024, https://www.arc.gov/addressing-substance-abuse-in-appalachia/.

57 "5 Workforce Trends in Nuclear Energy," DOE Office of Nuclear Energy, August 28, 2024, https://www.energy.gov/ne/articles/5-workforce-trends-nuclear-energy.

58 Regional Center for Nuclear Education and Training, *Nuclear Mavericks: A Biographical Compilation of the Men & Women Who Shaped the Nuclear Workforce*, March 30, 2016, https://9hq.ac2.myftpupload.com/nuclear-mavericks/.

A common purpose: Opportunities for interstate collaboration

Each of the four states wants to lead and succeed, domestically and beyond their borders. Representatives of state departments of commerce, departments of economic and community development, chambers of commerce, trade groups, academic institutions, and civil society organizations illuminated the landscape of economic opportunities and their potential benefits for communities. State energy offices and organizations, as well as offices of community and economic development, described their critical functions and how they are "connective tissue" between stakeholders, such as community members, potential end users of energy projects, and businesses; they provide resources for education, technical assistance, and funding.[59] Some states, like Tennessee, have governor-backed advisory bodies to grapple with their strategy to advance nuclear deployment.[60] Others, like North Carolina and its Energy Policy Council, have a standing body that addresses energy policy in a comprehensive manner and evaluates nuclear energy within this context.[61]

Even if states do not have nuclear energy advisory groups—or said groups are phased or term-limited—there are avenues to share expertise and lessons learned, build interstate ties, and coordinate in strategic areas. There are forums for interstate exchanges between state legislators, state energy officials, and public utility commission staff, such as the National Conference of State Legislatures, the National Association of State Energy Officials (NASEO), and the National Association of Regulatory Utility Commissioners (NARUC). States without advisory bodies or working groups on advanced nuclear energy can engage with the Advanced Nuclear State Collaborative (ANSC), established by NARUC and NASEO with a DOE grant in 2023; the ANSC is an avenue for interstate collaboration "to enhance collective understanding of the unique regulatory and policy questions surrounding the consideration and deployment of new nuclear generation and support peer learning across states."[62] In April 2024, NARUC, NASEO, and the National Governors Association hosted a workshop and toured ORNL, enabling a deeper appreciation of the laboratory's capabilities and workforce galvanizing the East Tennessee ecosystem around advanced nuclear development and deployment.[63]

DOE national laboratories also play an essential role in realizing advanced reactor deployment by advancing innovation, developing a workforce ecosystem, and cementing interest in nuclear deployment through feasibility studies. Oak Ridge National Laboratory, the National Energy Technology Laboratory, Idaho National Laboratory, and the Gateway for Accelerated Innovation in Nuclear (GAIN) have technical prowess to be leveraged by communities interested in advanced reactors that may need technical, regulatory, or financial support.[64] And the National Reactor Innovation Center (NRIC) provides resources for developers to test, evaluate, demonstrate, and validate their reactor designs.

59 Office of State and Community Energy Programs, "State Energy Offices and Organizations," US DOE, accessed November 22, 2024, https://www.energy.gov/scep/state-energy-offices-and-organizations.

60 "Gov. Lee Names Tennessee Nuclear Energy Advisory Council Appointees." Tennessee Office of the Governor, accessed July 13, 2023, https://www.tn.gov/governor/news/2023/7/13/gov--lee-names-tennessee-nuclear-energy-advisory-council-appointees.html.

61 "Energy Policy Council," North Carolina Department of Environmental Quality, accessed November 22, 2024, https://www.deq.nc.gov/energy-policy-council.

62 "Advanced Nuclear State Collaborative," National Association of Regulatory Utility Commissioners, 2024, https://www.naruc.org/core-sectors/electricity-energy/nuclear-energy/advanced-nuclear-state-collaborative/.

63 Kiera Zitelman, "State Officials Explore Advanced Nuclear Research and Deployment in Tennessee," National Association of State Energy Officials, April 2024, https://www.tn.gov/content/dam/tn/publicutility/documents/TN_visit_summary_Final_Article.pdf.

64 As an example from the region, the Gateway for Accelerated Innovation in Nuclear has backstopped growing interest in advanced reactors from Kentucky, and GAIN and PPL Corporation conducted a feasibility study evaluating the suitability of the Ghent site; see Donna Kemp Spangler, "GAIN Helped Kentucky Clear the Runway for Nuclear Energy. Now the Coal-dependent State Is Waiting for the Plane to Land," GAIN, n.d., https://gain.inl.gov/gain-helped-kentucky-clear-the-runway-for-nuclear-energy/.

Universities play an important regional role in readying the next generation of talent to enter the energy workforce and in investing in the people essential to staffing the scientific infrastructure at DOE national laboratories and programs like GAIN and NRIC; recognizing this, DOE has invested in this talent through the Nuclear Energy University Program, which was established in 2009.[65] Alongside DOE, universities such as North Carolina State University are also facilitating important conversations on the consent-based siting process and the management of spent nuclear fuel.[66]

The DOE Office of Nuclear Energy and the national laboratories are critical connective tissue at the federal level, bridging policy, capabilities, and people to create a longer runway for development and deployment. The DOE Loan Programs Office (LPO) aims to accelerate market uptake in an industry with long lead procurements and substantial capital outlays. Leveraging these national capabilities, programs, and support will be essential to surmounting the hurdles of first-of-a-kind deployments, bracketing risk with federal support, and building an order book. Many A4A workshop participants acknowledged that the federal government is supporting the nuclear energy innovation ecosystem and mentioned provisions of the Inflation Reduction Act (particularly the 48C tax credit or Title 17 for LPO), and the CHIPS and Science Act of 2022 as enablers of success.[67]

States and stakeholders could consider the following when navigating a path ahead in the nuclear innovation ecosystem:

- States in Appalachia could leverage existing resources and talent and band together through industry advisory councils, interstate MOUs, or regional consortia, such as the Congressional Western Caucus or the Southeast Nuclear Council. Such a structured partnership could enable sharing of lessons learned and for the coordination of strategic and infrastructure priorities.

- States with a matured interest in advanced reactors could emulate Wyoming by creating a “nuclear liaison” role, vested in state government, dedicated to working on deploying advanced reactors; Sean Schaub has taken on this mantle as the nuclear industry coordinator at the Wyoming Energy Authority.[68] A nuclear liaison would retain the knowledge and networks of any term-limited or time-bounded advisory bodies (e.g., the Tennessee Nuclear Energy Advisory Council) and serve to connect multiple local and state agencies, federal resources, and people, solely around nuclear energy development.

- States could establish advisory councils or working groups (e.g., Tennessee, Kentucky, Texas), convening experts and community and industry representatives to explore whether advanced nuclear is right for their communities and future economic development.[69] Such an approach, geared toward identifying and addressing community concerns and barriers to deployment, would lend toward a comprehensive approach to nuclear deployment. Their efforts could be informed by the

65 Office of Nuclear Energy, “Nuclear Energy University Program,” Department of Energy, accessed November 22, 2024, https://www.energy.gov/ne/nuclear-energy-university-program; https://neup.inl.gov/SitePages/Home.aspx.

66 “NC Consortium for Consent-Based Siting,” NC State Department of Nuclear Engineering, 2024, https://ne.ncsu.edu/grants/; and Office of Nuclear Energy, “Consent-Based Citing Consortia,” US Department of Education, last updated September 2024, https://www.energy.gov/ne/consent-based-siting-consortia.

67 Loan Programs Office, “Energy Infrastructure Reinvestment Financing,” Department of Energy, accessed November 22, 2024, https://www.energy.gov/lpo/energy-infrastructure-reinvestment-financing.

68 “About Us,” Wyoming Energy Authority, accessed November 22, 2024, https://wyoenergy.org/about/.

69 “Nuclear Development Workshop,” Kentucky Energy and Environment Cabinet, accessed November 22, 2024, https://eec.ky.gov/Energy/Pages/Nuclear-Development-Workgroup.aspx; and “Texas Advanced Nuclear Reactor Working Group,” Public Utility Commission of Texas, accessed November 22, 2024, https://www.puc.texas.gov/industry/nuclear/.

work of other states' organizational bodies, such as the Tennessee Nuclear Energy Advisory Council, which published its final report and recommendations in October 2024, and the Texas Advanced Nuclear Reactor Working Group, which also released a final report in November 2024.[70]

- Stakeholders could organize coalitions to create "stackable programs" that minimize duplicative efforts and prime university programs to supplement one another, which is an approach modeled by the ORAU consortium.[71] Participating in such organizations and consortia would aid in regional knowledge transfer.[72]

- Other states could adapt an approach taken by Virginia, where the Virginia Department of Education added a seventeenth career cluster (focused on energy) to its curriculum, which has opened up opportunities for students and primed them for university programs in the industry.[73]

It is imperative that actors across the nuclear innovation ecosystem—at all levels—appreciate the conditional limitations and enabling factors to deployment that may be specific to a community and place.[74] One workshop participant made an analogy and underscored that even with a winning hand of enabling factors, someone must be willing to stand up and play their hand at the community level and within state government; willing communities must be identified and compelled by the value proposition to stand up and volunteer, and state representatives should be willing to stand up and declare that they value nuclear generation and want advanced reactor(s) deployed in their state. States can leverage their legacies of innovation and energy leadership to reimagine their economic futures and seize on opportunities to lead in next-generation nuclear energy technologies. State industries will compete, but stakeholders can develop a regional strategy for deployment with longevity that emboldens states where they are best suited to lead. Together, they can harness the atom for economic development and advance behind a common cause: to innovate a path forward.

70 "TN Nuclear Energy Advisory Council Final Report & Recommendations," Tennessee Department of Environment and Conservation, October 31, 2024, https://www.tn.gov/environment/program-areas/energy/tneac.html; and "Governor Abbott, PUCT Release Texas Advanced Nuclear Reactor Working Group Report," Office of the Governor of Texas, November 18, 2024, https://gov.texas.gov/news/post/governor-abbott-puct-release-texas-advanced-nuclear-reactor-working-group-report.

71 See ORAU's membership directory, https://orau.org/partnerships/consortium-members.html.

72 The NASEO-NARUC Advanced Nuclear State Collaborative (ANSC) is another example of an organization that bridges regional perspectives and knowledge. In October 2024, NARUC, in partnership with NASEO, released a report surveying the use cases for advanced nuclear reactors that provides considerations for state-level discussions: https://pubs.naruc.org/pub/09F52BB1-D92E-9CB4-C9E8-172331A1A9A5?_gl=1*1u27wy8*_ga*NDY1OTExMzI3LjE3MzY1MTcxMDI.*_ga_QLH1N3Q1NF*MTczNjUzMDUxOC4yLjAuMTczNjUzMDUxOC4wLjAuMA..

73 "Energy: Virginia's 17th Career Cluster," Office of the Secretary of Commerce and Trade, Commonwealth of Virginia, 2019, https://www.commerce.virginia.gov/media/governorvirginiagov/secretary-of-commerce-and-trade/va-nuclear/va-nuclear-pdf/VA-17th-Energy-Cluster-Pathways.pdf.

74 The Kentucky Nuclear Energy Working Group issued a report that valuably discusses gated opportunities, and whether the pacing and sequencing of key initiating events could unlock further opportunities. A "gated opportunity" was defined as a potential opportunity where "a preceding event must occur to initiate progress in that area." See Kentucky Office of Energy Policy, *Report to the Kentucky Legislative Research Commission Pursuant to 2023RS SJR 79*, November 17, 2023, 7, https://eec.ky.gov/Energy/Documents/Final%20Report%20SJR79_11.17.23.pdf.

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