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Opportunities for Coal Communities Through Nuclear Energy: An Early Look

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Good Energy Collective is a policy research organization building the progressive case for nuclear energy as an essential part of the broader climate change agenda. We develop smart policies at every scale to accelerate the just and equitable deployment of advanced nuclear technologies.

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Introduction

Ever since inventor Nikola Tesla's vision for free electricity gave way to the natural monopolies of the electricity industry, a progressive vision of energy as a public good has often been at odds with pure economics. Cheap and abundant fossil fuels powered economic growth, but they also left a swath of environmental injustices in their wake. In addition to the global impact of greenhouse gas emissions, fossil fuels have disproportionately impacted many communities—what some call "environmental justice communities"—locally for decades. These communities are predominantly poor communities and communities of color whose residents have worked at or lived near mines and fossil fuel-fired power plants. These environmental justice communities may have benefited from energy sector jobs but also bore an undue burden, breathing dirty air, inhaling coal dust, and drinking water with toxic runoff.

Now, as the U.S. electricity sector begins to wean off carbon-intensive energy sources and infrastructure, the everyday people that made modern electricity access possible—the coal miners, the steelworkers, the pipefitters, and the communities that sustained all of them—are increasingly getting left behind with little assistance from the companies that long relied on them to turn a profit.

As utilities have shifted to cleaner energy sources, the nation's coal workforce in particular has shrunk, negatively impacting communities. From 2010–2020, more than 600 coal-fired units generating nearly 100 gigawatts-electric (GWe) of electricity went offline.[1] Some coal plant shutdowns happened naturally as the generators reached the end of their usable lives. Others closed because they became uneconomical as natural gas and renewable energy grew cheaper over this period. As plants closed and coal demand fell, the number of coal

[1] Data drawn from: "Form EIA-860 Detailed Data with Previous Form Data (EIA-860A/860B)," U.S. Energy Information Administration, last modified September 9, 2021, https://www.eia.gov/electricity/data/eia860/.

industry jobs plummeted: The 89,400-odd coal mining jobs held at the end of 2011 fell to around 42,200 jobs at the end of 2020.[2] In just one year, coal fuel jobs fell by about 15,000 positions to around 60,400 jobs in 2020, marking a loss of almost 20 percent.[3] Meanwhile, coal jobs in electric power generation fell by 8,300 positions to about 71,400 jobs in 2020—a drop of 10.4%, the highest rate of decline among energy sources. Coal plant closures hurt local economies, as coal plant workers either move away or take jobs in different sectors that may pay less.[4] When local renewable energy jobs spring up in and around coal communities, they rarely offer the same salaries or an option to join a union.

The Biden-Harris administration has highlighted the challenges facing these communities that are both burdened by legacy pollution and concerned that a transition to cleaner forms of energy will leave them behind. In interim guidance released in July 2021, two White House offices called on federal departments and agencies to identify programs that make investments in addressing climate change, cleaning up legacy pollution, providing clean water and transportation, and supporting workforce development—including in energy communities, which explicitly "include coal, oil, and gas and power plant communities."[5] The guidance further tasked agencies with determining how to direct at least 40 percent of those programmatic investments to underserved areas, including environmental justice communities and those who have lost jobs due to the energy transition.[6]

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[2] "Employment, Hours, and Earnings from the Current Employment Statistics survey (National)," U.S. Bureau of Labor Statistics, Series ID CES1021210001, https://data.bls.gov/timeseries/CES1021210001.
[3] U.S. Department of Energy, *United States Energy & Employment Report 2021*, https://www.energy.gov/sites/default/files/2021-07/USEER%202021%20Main%20Body.pdf, 4, 17.
[4] Brady Dennis and Steven Mufson, "In Small Towns across the Nation, the Death of a Coal Plant Leaves an Unmistakable Void," *The Washington Post*, March 28, 2019, https://www.washingtonpost.com/national/health-science/thats-what-happens-when-a-big-plant-shuts-down-in-a-small-town/2019/03/28/57d62700-4a57-11e9-9663-00ac73f49662_story.html; David Ferris, "Why Coal Plant Workers Aren't Going Green," *E&E News*, June 22, 2021, https://www.eenews.net/articles/why-coal-plant-workers-arent-going-green/.
[5] Office of Management and Budget, "Memorandum for the Heads of Departments and Agencies," July 20, 2021, https://www.whitehouse.gov/wp-content/uploads/2021/07/M-21-28.pdf, 3.
[6] Ibid., 2–3.

However, this administrative effort to support environmental justice communities is still nascent. While the United States needs to reduce its power sector emissions, doing so without a clear plan in place to help coal communities risks leaving them with little to no recourse to sustain their local economies or continue to contribute toward the U.S. energy system. Although some city- and state-based initiatives and federal programs do already exist to help workers and communities in coal-closure communities, the benefits of these programs do not extend to everyone who has experienced coal plant shutdowns or mine closures. Meanwhile, the decline continues: Another 25 GWe of coal-fired power is slated to go offline in the next four years, including 2.7 GWe in 2021 alone.[7]

A progressive energy system in the United States needs to include and uplift, as frontline communities, the coal-closure communities that are struggling economically from the imperative national shift toward cleaner energy. However, policies that can facilitate this support will need to take the local communities' interests and concerns into account. For example, coal communities may prefer support for investments in energy infrastructure that more closely mirrors the size and workforce opportunities of the coal plants that closed. A successful and equitable transition to clean energy will require working with local communities to determine what would best facilitate their economic and personal health within the bounds of their values.

One option for recourse to support struggling coal communities could be the local deployment of advanced nuclear energy—specifically, small modular reactors (SMRs). Discussions over how and where nuclear energy could help provide new energy jobs in coal communities are increasingly entering the public sphere.[8]

[7] "Nuclear and Coal Will Account for Majority of U.S. Generating Capacity Retirements in 2021," U.S. Energy Information Administration, January 12, 2021, https://www.eia.gov/todayinenergy/detail.php?id=46436.
[8] Paul Day, "Retired Coal Sites Seen as Prime Location for SMRs," *Reuters Events*, June 15, 2021, https://www.reutersevents.com/nuclear/retired-coal-sites-seen-prime-location-smrs; Lisa Martine Jenkins, "A New Frontier for Nuclear: Partnering With Utilities on Decommissioned Coal Sites," *Morning Consult*, August 30, 2021, https://morningconsult.com/2021/08/30/nuclear-brownfields-coal-sites-utilities/.

Several analogs between coal and nuclear power plants make the technology a potentially attractive energy option for coal-closure communities. Nuclear jobs are as well or better-paying than coal jobs, and certain designs may offer more jobs than the retiring coal plant. Like coal-burning facilities, nuclear plants support the local economy through tax revenue. Many advanced nuclear designs will also be able to produce a comparable amount of power to coal plants and take up significantly less space than wind and solar to generate similar amounts of energy.[9] Similarly attractive is advanced nuclear's ability to locate within existing coal plant sites and take advantage of the existing water, transportation, and transmission infrastructure.[10] Critically, nuclear energy has zero operating emissions and very low carbon intensity over its lifetime, on par with that of offshore wind, mitigating the environmental and public health impacts for the local community.[11]

Advanced nuclear energy could make a significant contribution toward the United States' transition to clean power, but today's advanced nuclear developers will first need to have successful demonstrations of their reactors if these technologies are eventually to diffuse across the United States. Important to successful demonstrations will be developers' ability to find and site their reactors in places that broadly support their construction. Many coal communities are located in states that trend Republican or independent and may want to see different investment options and solution sets than those in Democratic-majority areas. Notably, nuclear energy remains more favorable among Republicans than Democrats, making nuclear energy a possible clean energy solution for places that might de-prioritize climate action but still want

[9] "NuScale SMR Technology: An Ideal Solution for Repurposing U.S. Coal Plant Infrastructure and Revitalizing Communities," NuScale Power, 2021, https://mc-67443a0a-0a3b-4888-8568-874354-cdn-endpoint.azureedge.net/-/media/Nuscale/Files/Technology/Technical-Publications/nuscale-smr-technology-an-ideal-solution.ashx.
[10] Day, "Retired Coal Sites."
[11] "Climate Change 2014: Mitigation of Climate Change—Working Group III Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change," ed. Ottmar Edenhofer et al. (New York: Cambridge University Press, 2014), https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_full.pdf, 1335.

clean energy and employment opportunities.[12] This facet uniquely distinguishes nuclear energy as an important technology that could support the decarbonization of the entire country. While Democratic-majority states have been the first to set deep decarbonization targets, U.S. emissions will not meaningfully decline without the decarbonization of every part of the country—in blue, red, and purple states alike.

This report addresses the potential for advanced nuclear energy to contribute toward a more equitable energy transition that supports coal communities by repowering coal-fired power plants in or near the communities where coal plants are shuttering. Section 1 takes stock of the federal and state policies that are already in place to help coal closure communities readapt and rebound. Section 2 provides an early look at the potential workforce planning required to support local coal-to-nuclear transitions, elaborating on some of the key workforce considerations that are likely to confront SMR developers, owners of retiring coal plants, and the federal government. Section 3 explores which retired and retiring coal sites might be best suited for repowering with SMR technology, based on available data on geography, plant size, state incentives and restrictions, with additional social and health benchmarks provided to assist policymakers and communities. The report concludes with policy implications, detailing suggestions on a proactive approach that would benefit workers, communities, and employers.

[12] Alec Tyson and Brian Kennedy, "Two-Thirds of Americans Think Government Should Do More on Climate," Pew Research Center, June 23, 2020, https://www.pewresearch.org/science/2020/06/23/two-thirds-of-americans-think-government-should-do-more-on-climate/.

Abbreviations

CRO	=	Community Reuse Organization
DOE	=	U.S. Department of Energy
DOL	=	U.S. Department of Labor
GWe	=	Gigawatts-electric
MWe	=	Megawatts-electric
NRC	=	U.S. Nuclear Regulatory Commission
SMR	=	Small modular reactor
SRSCRO	=	Savannah River Site Community Reuse Organization

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Section 1: Programs and Policies Supporting Coal Communities

The closure of coal plants has created a stark need for workforce development programs for the communities that depended on the plants for their livelihoods and the local tax revenue that helped to pay for regional education systems and civil services.

As the country shifts to cleaner forms of electricity in the face of climate change and shifting energy economics, the federal government has multiple avenues to support communities like these that have relied on the energy sector for direct and indirect employment to transition to a successful alternative. These options include straightforward, federally-led programs specifically geared toward providing this assistance, many of which are currently active and listed later in this section.

Another opportunity for positive federal intervention is to help communities determine a path forward by facilitating help from a local organization with an understanding of and ties to the region's employers and universities. For example, the U.S. Department of Energy (DOE) developed a community transition program after receiving direction from Congress in the 1993 National Defense Authorization Act to help employees at defense nuclear facilities land on their feet as workforce changes compounded following the end of the Cold War.[13] In practice, "[t]he program encouraged affected

[13] *To Authorize Appropriations for Fiscal Year 1993 for Military Activities of the Department of Defense, for Military Construction, and for Defense Activities of the Department of Energy, to Prescribe Personnel*

communities to chart their own economic development future by establishing a Community Reuse Organization (CRO) that was recognized by DOE to receive grants for programs to alleviate the impacts of workforce restructuring at DOE facilities."[14]

These CROs, which were structured either as governmental or non-governmental organizations,[15] have used DOE grants for everything from seed grants to start-ups and worker training initiatives. Some of these organizations existed prior to receiving an official CRO designation, such as the Savannah River Site Community Reuse Organization (SRSCRO), which was formally designated the region's CRO in 1996.[16]

The Obama-Biden administration also recognized that coal plant and mine shutterings represent a key workforce and economic problem and sought to assist impacted communities. In 2015, the White House announced the POWER+ Plan. Through POWER+, the administration launched the Partnerships for Opportunity and Workforce and Economic Revitalization (POWER) initiative to leverage workforce development support for affected regions, including up to $38 million in already-available federal grant funding from across the government in the form of both planning and implementation grants.[17] As envisioned, the program was to help not only create jobs and

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Strengths for Such Fiscal Year for the Armed Forces, to Provide for Defense Conversion, and for Other Purposes, Public Law 102, U.S. Statutes at Large 484 (1992), https://www.congress.gov/102/statute/STATUTE-106/STATUTE-106-Pg2315.pdf.

[14] "Summary of Community Reuse Organizations Fiscal Years 1993 Through 2015," U.S. Department of Energy Office of Legacy Management Community Transition Program (September 2016): https://www.energy.gov/sites/default/files/2021-05/Final_Reports_on_Community_Reuse_Organization_Grants.pdf, v.

[15] What Definitions Are Used in This Part?, U.S. Code 10 (2013), § 770.4, https://www.law.cornell.edu/cfr/text/10/770.4.

[16] Rick McLeod, "Almost 30 Years of CRO Success," Savannah River Site Community Reuse Organization, September 11, 2019, https://www.energy.gov/sites/default/files/2019/09/f67/Rick-McLeod-30-Years-of-EM-Cleanup.pdf.

[17] "Fact Sheet: The Partnerships for Opportunity and Workforce and Economic Revitalization (POWER) Initiative," The White House Office of the Press Secretary, March 27, 2015, https://obamawhitehouse.archives.gov/the-press-office/2015/03/27/fact-sheet-partnerships-opportunity-and-workforce-and-economic-revitaliz.

support workforce development, but also to secure health care and pensions for affected families.[18] By mid-October 2015, the administration had announced 36 awards of over $14.5 million across 12 states and tribal nations under the POWER initiative.[19] However, Congress only appropriated some of the funding that the administration requested for POWER; while a handful of the programs still exist today,[20] the amount of available funding through POWER was insufficient to meet the scale of the problem.[21]

The Biden-Harris administration has committed specifically to supporting coal-closure communities. On Jan. 27, 2021, Executive Order 14008 called for the creation of an Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization within the DOE, tasked with identifying and providing federal support to coal, oil, gas, and power plant communities and protection for affected workers.[22] In April, the working group, led by DOE National Energy Technology Laboratory Director Brian Anderson, released a report detailing existing ways to provide grants, loans, technical assistance, and other sources of funding to these areas informed by advocacy organizations, academia, and representatives from the communities to be served.[23] Working group participants also spoke with labor unions, local and tribal governments, private companies, philanthropies, and other stakeholders.

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[18] "Investing in Coal Communities, Workers, and Technology: The POWER+ Plan," The President's Budget Fiscal Year 2016, https://obamawhitehouse.archives.gov/sites/default/files/omb/budget/fy2016/assets/fact_sheets/investing-in-coal-communities-workers-and-technology-the-power-plan.pdf.

[19] "Fact Sheet: Administration Announces New Workforce and Economic Revitalization Resources for Communities through POWER Initiative," The White House Office of the Press Secretary, October 15, 2015, https://obamawhitehouse.archives.gov/the-press-office/2015/10/15/fact-sheet-administration-announces-new-workforce-and-economic.

[20] Michael H. Cecire, *The POWER Initiative: Energy Transition as Economic Development* (Washington, DC: Congressional Research Service, November 20, 2019), https://sgp.fas.org/crs/misc/R46015.pdf.

[21] "Thousands of Coal Workers Lost Jobs. Where Will They Go?" *E&E News* via *Energy News Network*, June 25, 2020, https://energynews.us/2020/06/25/thousands-of-coal-workers-lost-jobs-where-will-they-go/.

[22] Executive Office of the President, "Executive Order 14008: Tackling the Climate Crisis at Home and Abroad," *Federal Register* 86, no. 7619, (February 1, 2021): 7619-33, https://www.federalregister.gov/documents/2021/02/01/2021-02177/tackling-the-climate-crisis-at-home-and-abroad.

[23] Initial Report to the President on Empowering Workers through Revitalizing Energy Communities," National Energy Technology Laboratory, https://netl.doe.gov/IWGInitialReport.

Ultimately, the interagency working group has now identified over $45 billion currently available through existing federal programs to support these struggling communities through infrastructure improvements, low-carbon deployments, abandoned and orphaned mines and well remediation, local economic redevelopment funding, and workforce development support.[24] Because of the swift retirement of coal plants over the last decade and the expected retirement of tens of additional plants in the next few years, the working group has explicitly recommended that early federal investments go toward six large regions it identifies as having recently supported or continuing to support large proportions of the country's coal-dependent laborers.[25] Tellingly, these regions are widely dispersed and touch nearly half of U.S. states. Drilling down further, most of the 25 "coal-dependent areas" the working group identified are located in rural areas with fewer options for other employment.[26] The working group recommended support for fenceline communities that live near energy and industrial infrastructure and are disproportionately communities of color, and for tribal communities.

Passage of federal legislation in the last year has set this work on a strong footing, and many projects that will benefit struggling coal communities have been chosen for support. The working group's recent one-year report highlighted how the Infrastructure Investment and Jobs Act (PL 117-58), paired with the American Rescue Plan (PL 117-2), will promote new opportunities "in communities where coal mines or power plants have been shut down."[27] Working group leaders and other stakeholders met recently to announce the names of 60 finalist projects that the U.S. Economic Development Administration (EDA) has selected to receive about $500,000 each and compete

[24] Interagency Working Group on Coal & Power Plant Communities & Economic Revitalization, *The Bipartisan Infrastructure Law Tops Off a Banner Year of Investment in Energy Communities*, December 2021, https://energycommunities.gov/the-bipartisan-infrastructure-law-tops-off-a-banner-year-of-investment-in-energy-communities/.

[25] Initial Report to the President on Empowering Workers through Revitalizing Energy Communities, National Energy Technology Laboratory, April 2021, https://netl.doe.gov/sites/default/files/2021-04/Initial%20Report%20on%20Energy%20Communities_Apr2021.pdf, 8-9.

[26] Ibid., 10.

[27] Interagency Working Group, *The Bipartisan Infrastructure Law*.

to receive even more through the administration's Build Back Better Regional Challenge.[28] This pool of finalists include 12 projects in coal communities, as part of a $300 million total that the EDA has committed to direct toward supporting job growth and industrial development in these communities.[29]

The working group also announced a new online resource compiling federal support programs for energy communities.[30] As the interagency working group identified, numerous programs across the federal government directly or tangentially support coal communities to train into or obtain new jobs, expand workforce opportunities, and assist in community development. Table 1 lists a selection of these programs.

Table 1. Select Federal Programs Supporting Coal Workforces.

Department	Agency/Program	Program
Commerce	Economic Development Administration	Assistance to Coal Communities
Treasury		State Small Business Credit Initiative
Treasury		Emergency Capital Investment Program
Interior	Office of Surface Mining Reclamation and Enforcement	Abandoned Mine Lands grants and the Abandoned Mine Lands Economic Revitalization grant program
Interior	Bureau of Land Management	Well remediation on public lands
Agriculture		Rural Innovation Stronger Economy program
Labor		Workforce Opportunity for Rural Communities demonstration grant initiative

[28] "U.S. Secretary of Commerce Gina M. Raimondo Annoucnes Finalists for $1 Billion 'Build Back Better Regional Challenge'," U.S. Economic Development Administration, December 13, 2021, https://eda.gov/news/press-releases/2021/12/13/build-back-better-regional-challenge-finalists.htm.

[29] "Readout of the Interagency Working Group on Coal and Power Plant Communities Meeting for Economic Growth That Benefits Everybody," The White House Briefing Room, September 27, 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/27/readout-of-the-interagency-working-group-on-coal-and-power-plan-communities-meeting-for-economic-growth-that-benefits-everybody/; https://eda.gov/news/press-releases/2021/07/22/american-rescue-plan-programs.htm.

[30] Readout of Investment Roundtable Hosted by the Interagency Working Group on Coal and Power Plant Communities and Economic Revitalization," The White House Briefing Room, December 15, 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/12/15/readout-of-investment-roundtable-hosted-by-the-interagency-working-group-on-coal-and-power-plant-communities-and-economic-revitalization/.

Health and Human Services		Community Economic Development discretionary grants program
Transportation		Rebuilding American Infrastructure with Sustainability and Equity program
Appalachian Regional Commission		Partnership for Opportunity and Workforce and Economic Revitalization initiative
Note. Adapted from *Initial Report to the President on Empowering Workers through Revitalizing Energy Communities*, National Energy Technology Laboratory, April 2021, https://netl.doe.gov/sites/default/files/2021-04/Initial%20Report%20on%20Energy%20Communities_Apr2021.pdf.		

A handful of U.S. states have also developed initiatives specifically geared toward helping utility and coal workers affected by plant or mine closures. For example, in 2019, Colorado established an Office of Just Transition specifically to help coal communities move into new, well-paid jobs. The office is tasked with determining when and where facilities close and staff will be let go and making recommendations on how to implement the rest of the state's just transition law.[31]

Also in 2019, New Mexico enacted provisions that established three new funds for coal community assistance and allowed coal plant abandonment costs that certain utilities bear to include costs going toward "severance and job training costs for displaced workers."[32] Under the law, the utilities can ask the state's Public Regulation Commission to recover these and other costs by issuing bonds.[33]

However, because coal communities exist throughout the country, more comprehensive federal support is needed to help more coal workers, their families, and the hundreds of small, local economies for which plant closures have dealt a severe blow.

[31] "About the Office of Just Transition," Colorado Department of Labor and Employment, https://cdle.colorado.gov/offices/the-office-of-just-transition/about-the-office-of-just-transition; *Concerning a Just Transition From a Coal-Based Electrical Energy Economy, and, in Connection Therewith, Making an Appropriation*, Colorado House Bill 19-1314, https://leg.colorado.gov/sites/default/files/2019a_1314_signed.pdf.
[32] Iglesias, *Fiscal Impact Report: Energy Transition Act* (New Mexico Legislative Finance Committee, March 7, 2019): 3, https://www.nmlegis.gov/Sessions/19%20Regular/firs/SB0489.PDF.
[33] New Mexico, Senate, SB 489: An Act Relating to Public Utilities..., March 22, 2019, https://www.nmlegis.gov/Sessions/19%20Regular/final/SB0489.pdf.

Section 2: Local Workforce Development and Potential Opportunities for a Coal-to-Nuclear Worker Transition

For coal communities that have relied or continue to rely on a local coal-fired power plant for employment, the closure of these plants often leaves a vacuum for the local economy with nothing in its place. Advanced nuclear plants, which are likely to offer similarly sized workplaces, good pay, and many analogous employment opportunities, could help fill the void left by shuttered coal plants.

An environmentally just approach to siting small modular reactors (SMRs)—one that engages with and involves the community early on, prepares them ahead of operation, and ensures that the community benefits from the presence of the SMR—will necessarily work to employ local workers for the operation and, wherever possible, the construction of the nuclear plant to the maximum feasible extent. The long, multi-year lead times ahead of an anticipated plant closure, which can surpass those of other industries, give power plant owners comparatively more time to develop strategies on providing alternatives for their workforces. One option coal companies have implemented is to offer workers at retiring coal plants a position at one of the

company's other, still-operating plants.[34] However, these and other job alternatives may offer lower salaries or require longer commutes.[35]

It is in SMR developers' explicit interest to start performing the upfront work necessary before deployment to understand the local workforces and identify the jobs that workers in the surrounding community could fill with existing skills or through participation in training programs. National workforce shortages make these local, active, and what are likely to be willing workers attractive for hire: Eighty-nine percent of nuclear electric power generation companies told researchers that in 2020, they had trouble with hiring.[36] In addition, employing locally may open opportunities for federal support for the developer. Fossil fuel workers in many instances have skills and training that overlaps with work at nuclear facilities. Already, some of these workers have experience with nuclear facilities, most notably by helping during nuclear plant refueling.[37]

It is likewise in coal plant owners and operators' interest to learn about and start communicating with SMR developers as one means of potentially providing for coal plant workers who will soon be out of a job. For example, the plant owner may either have agreements in place through which it must identify or develop opportunities for worker placement into employment alternatives at or around the company, or it may want to preserve a good relationship with the local region that might still host many of their electricity customers.

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[34] Lee Buchsbaum, "Supporting Coal Power Plant Workers Through Plant Closures," *POWER Magazine*, June 1, 2016, https://www.powermag.com/supporting-coal-power-plant-workers-plant-closures/.
[35] David Ferris, "Why Coal Plant Workers."
[36] U.S. Department of Energy, *United States Energy & Employment Report 2021*, https://www.energy.gov/sites/default/files/2021-07/USEER%202021%20Main%20Body.pdf, 70.
[37] "Maria Korsnick's Remarks at the State of the Nuclear Energy Industry Event," Nuclear Energy Institute, March 23, 2021, https://nei.org/news/2021/nei-korsnick-remarks-state-of-industry-event; Maria Korsnick, "Nuclear energy is the key to our energy transition," *Washington Examiner*, May 6, 2021, https://www.washingtonexaminer.com/opinion/op-eds/nuclear-energy-is-the-key-to-our-energy-transition.

The local workforce development parameters of siting an SMR in a coal community will vary depending on several factors. The activities that a utility or reactor developer will undertake will differ based on elements such as:

- The timing of the coal plant retirement (i.e., whether the plant closed 15 years ago or one year ago or is scheduled to close in the future)
- The availability of an active comparable workforce (likely dependent on the timing of the coal plant's closure)
- The novelty of the SMR design
- The length of time until the reactor developer is licensed and its workforce and training needs are established

While potential symbiotic benefits exist for all stakeholders, several unknowns complicate stakeholders and policymakers' ability to project the extent of achievable workforce and technical overlap between coal and nuclear plants. As one example, SMRs are still many years from deployment. For this reason, uncertainty remains regarding the level of staffing that the U.S. Nuclear Regulatory Commission (NRC) will require to be present onsite at these reactors, and what kinds of training plant employees will need to work at power plants deploying novel reactor concepts. While all stakeholders should start engaging early to be prepared for when advanced nuclear developers are ready to demonstrate and deploy their reactors, this uncertainty will complicate the ability of the owners of retiring coal plants to secure a path for their employees to work at an SMR at the site. Likewise, the uncertainty will complicate the ability of SMR developers to provide hard figures on their ultimate training and employment needs.

A second caveat is that today, communities across the country, including coal communities, have no real avenues to engage with SMR developers or determine if an SMR might be right for them. The federal government, however, can and should play a unique role in developing and funding new engagement processes that help communities lead their own exploration into available options for advanced nuclear. Whether through feasibility studies,

direct consultation, database development and instruction, or another mechanism, the federal government could help field a potential domestic market for SMRs while giving coal communities or other regions a possible means of preserving and attracting workers and tax revenue.

Strategies for SMR Developers

In some coal communities, local workforce development will start from scratch. In these instances, the local coal plant may have closed a decade ago, and the workforce will no longer be located in the community. For coal plants with at least one unit still operating, the opportunity still exists to achieve a seamless transition for its workers into comparable nuclear power jobs. As the University of Michigan Fastest Path to Zero initiative identified in 2019, coal plant sites that undergo a unit-by-unit phased closure (as opposed to a synchronous closure of all units) are likely to have a longer window of opportunity to support SMR repowering and the retraining of the existing coal plant workforce.[38]

There are several steps SMR vendors can take to understand the local workforce dynamic in a coal closure community and help the developer determine a path forward toward a successful local coal-to-nuclear transition. These include:

1. **Starting early**. A strong local workforce development plan will take a significant amount of time to develop and execute. Rick McLeod, president and CEO of the SRSCRO, says that in his experience, it can take three or more years of localized work to stand up training programs at community colleges and universities and graduate students before anyone exits the pipeline into the workforce.

[38] Suzanne Hobbs Baker, "Innovating New Nuclear Site Selection & Engagement Approaches," University of Michigan Fastest Path to Zero, 2019, https://uploads-ssl.webflow.com/5f05cd440196dc2be1636955/615e1a1ddaee716c57553ec0_Fastest%20Path%20Overview.pdf.

2. **Continuing to engage with the NRC to determine what training qualifications will be required.** New, advanced nuclear designs may have different training requirements than reactors in operation in the United States today.
3. **Engaging with the utility, municipality, or other owner or operator of the closed or closing coal facility.** Their interest in participating and helping to coordinate a workforce transition for coal workers to the nuclear facility will be an important asset.
4. **Identifying local technical/community colleges and universities.** Determine which schools of higher education that serve the region either already offer courses in nuclear engineering or have structures in place that could support the development of courses or certification programs required for higher-skill nuclear plant training. These should be institutions that are able to absorb significant amounts of funding and direct the bulk of it specifically to program development, rather than to overhead or indirect expenses. Depending on the state or region, "local" in this case may mean several hundred miles away.
5. **Identifying whether a community workforce organization exists in the area.** These organizations have direct experience working with and coordinating between community stakeholders, including both businesses and academic institutions.
6. **Identifying state or local business councils and economic development groups.** These groups may be able to help mobilize funding for a community to prepare prior to a large construction project entering a locality. This can be especially important for smaller communities that may lack the city infrastructure, such as wastewater or transit systems, that are necessary to accommodate an influx of workers and families.
7. **Engaging with local building trade unions.** Some SMR developers are already in communication with trade unions about their projects and the jobs and training needs that will accompany them.
8. **Working with the state.** State support for a developer's project and the communities that will surround them can be crucial to the success of

the endeavor. A state-level restriction on new nuclear construction may be an insurmountable hurdle for a new project.

9. **Developing usable simulator systems to train future employees**. New nuclear designs will require new simulators to train future SMR employees, as well as to train those who will be administering the trainings. Developers may want to consider whether it is possible to locate regional simulators in a location that would support multiple nuclear builds.

Local academic institutions have an important role to play in the development of local workforces that advanced nuclear operators can employ, but policymakers must be careful and intentional in their implementation of funding support. McLeod at the SRSCRO cautions not to make academic institutions compete for the same students. Instead, each institution should optimally have a training program unique to itself. A brand-new training program at an academic institution takes significant funding to stand up. McLeod suggests at least $500,000 per year per program/school committed for at least five years' running: Programs receiving less funding over a shorter period run a heightened risk of ending before graduating anyone. In addition, for regions without academic institutions with nuclear experience, the path to establishing new certification programs grows more complicated. Local colleges and trade schools may need to identify instructors from elsewhere to teach local workforces, McLeod cautions.

Role for Coal Plant Owners

Participation by coal plant owners will support a successful transition of coal plant workers onto an SMR plant. The role of the coal plant owner/operator should include:

1. **Starting early**. Much as the advanced nuclear developer should reach out to the coal plant owner and surrounding universities and businesses

long before the start of construction, a coal plant operator that is invested in providing for its employees should work to identify potential alternative employment for the workers on par with their current skill set, function, and compensation.

2. **Identifying potential utility partners with existing commercial nuclear power assets.** In order to facilitate a worker transition to an SMR, the coal plant operator would benefit from working with a utility that already has infrastructure in place to train and qualify nuclear power plant workers.
3. **Exploring whether and where possibilities may already exist to facilitate transitional training.** For communities in which no nuclear reactor currently operates, coal plant trainees would likely need to relocate for a period to the community of another reactor or simulator to complete their training and education.

Jobs at SMRs

A core component of an equitable clean energy transition is for the employment opportunities that replace lost coal jobs to be good positions with good salaries and benefits that support a diverse workforce. Repowering former coal plant sites with well-paid jobs in nuclear energy is an opportunity for diverse members of the local community to find alternative employment in the energy sector. The employment needs of nuclear plants could be significant compared to other energy technologies (e.g., solar and wind farms or natural gas generators) that a local utility or community could choose to build to replace retiring coal plants. Nuclear plant positions also usually offer higher salaries similar to or higher than those offered at coal plants. The median hourly wage in the nuclear industry at large has been estimated at $39.19—nearly 105% higher than the national median and about a quarter

higher than the median hourly wage of the coal industry ($28.69).[39] For nuclear work in utilities specifically, the median hourly wage is $47.00, compared with $41.30 for coal work in utilities.[40] Today's nuclear electric power generation segment is also heavily unionized at 21 percent in 2020.[41]

In addition, the nuclear fuels and electric power generation sectors perform better on several diversity metrics than other parts of the economy, employing more Asians and individuals of two or more races than the national workforce average. Nuclear workplaces, however, remain particularly male-dominated: In the fourth quarter of 2020, women constituted just 29 percent of the nuclear fuels sector and 34 percent of the nuclear electric power generation sector.[42] Like much of the energy sector, the nuclear industry has a long way to go toward reaching gender parity and fostering safe and positive work environments for women.

Significant variability is likely to exist between the different SMR developers working to deploy reactors in the United States with regard to their workforce requirements. The number of jobs at any given site may increase, for example, if multiple plants or modules are built. Conversely, the passive safety features of many are likely to result in a reduction in the overall number of operators needed to run the reactors. Ultimately, for many of these developers, the actual employee count remains unknown but is likely to trend downward in quantity compared to the traditional light-water reactors that operate today.

For example, Oregon-based NuScale Power, which is developing an SMR, has estimated that its largest, 12-module NuScale plant that could generate 924

[39] *Wages, Benefits, and Change: A Supplemental Report to the Annual U.S. Energy and Employment Report*, National Association of State Energy Officials et al., https://static1.squarespace.com/static/5a98cf80ec4eb7c5cd928c61/t/606d1178a0ee8f1a53e66206/1617760641036/Wage+Report.pdf, 10.
[40] Ibid., 49, 59.
[41] U.S. Department of Energy, *United States Energy & Employment Report 2021*, https://www.energy.gov/sites/default/files/2021-07/USEER%202021%20Main%20Body.pdf, 72.
[42] Ibid., 25, 72.

megawatts-electric (MWe) would require 270 employees—nearly double the 143 employees a comparably sized coal power plant would need.[43] In contrast, a similarly sized combined cycle natural gas plant requires 29 employees—far fewer staff than a 12-module NuScale SMR.[44] In 2019, university researchers estimated that the NuScale build planned for construction at the Idaho National Laboratory could result in nearly 13,500 job years in eastern Idaho over four years of construction and boost labor income by more than $644 million, with additional jobs created over the lifetime of the plant.[45] Another SMR developer, however, has estimated that a plant on one of its future targeted sites could operate smoothly with only about 100 total employees (excluding an external engineering team).[46]

Many of the jobs held at coal plants overlap with those that an SMR would require. As NuScale elaborates in a report that the company released on this topic, "[m]any coal plant jobs are directly transferable to the NuScale plant," including positions such as managers, supervisors, engineers, mechanics, and security officers. This transferability is attributable in part to the overlaps in coal and nuclear plant systems and components including, as the company notes, "the steam turbine; main steam system; generator; main condenser; condensate pumps; feedwater pumps; feedwater heaters; cooling towers; circulating cooling water; electrical and control systems; and water treatment."[47]

[43] The data reflect information that NuScale received from utility members on its advisory board. See: "NuScale SMR Technology."
[44] Ibid.
[45] Geoffrey Black and Steven Peterson, *Economic Impact Report Construction and Operation of a Small Modular Reactor Electric Power Generation Facility at the Idaho National Laboratory Site, Butte County, Idaho* (Boise State University and University of Idaho: January 29, 2019): 4-5, https://www.rediconnects.org/wp-content/uploads/2019/02/SMR-Economic-Impact-Report-FINAL.pdf.
[46] Private conversation with an SMR developer, October 15, 2021.
[47] "NuScale SMR Technology."

NuScale has also estimated the number of jobs it would need to fill at one of its power plants and the education level these positions would require (see Table 2).

Table 2. Education levels for NuScale job positions.

Number of NuScale Job Positions	Required Education Level	Job Position Examples
45	Bachelor of Science	Department Managers Technical Supervisors System Engineers
162	Associates Degree, Vocational Education, and/or Nuclear Experience	Plant Operators Maintenance Craftsmen Radiation Protection Chemistry Technicians Training Staff
61	High School or GED	Site Support Craftsmen Security Officers Storekeeper
2	Entry Level	Administration Support

Note. Reprinted with permission from NuScale Power, LLC, from "NuScale SMR Technology: An Ideal Solution for Repurposing U.S. Coal Plant Infrastructure and Revitalizing Communities," NuScale Power, 2021, https://mc-67443a0a-0a3b-4888-8568-874354-cdn-endpoint.azureedge.net/-/media/Nuscale/Files/Technology/Technical-Publications/nuscale-smr-technology-an-ideal-solution.ashx.

Additionally, a majority of the front-running North American SMR developers will require control room operators, according to the 2021 survey of advanced nuclear companies conducted by the U.S. Nuclear Industry Council.[48] Thirteen respondents told USNIC they will need control room operators. Among the companies that elaborated further, several said they will require anywhere from one to three operators per shift who will be located on-site. Three companies said their plants will not require control room operators, whether due to their autonomous operation or another reason.

TerraPower, LLC, based in Bellevue, Washington, is an advanced nuclear developer working to demonstrate its Natrium sodium fast reactor with a

[48] "Advanced Reactor Stakeholder Public Meeting," U.S. Nuclear Regulatory Commission, August 26, 2021, https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML21235A110.

molten salt energy storage system at the site of a retiring coal plant owned by Rocky Mountain Power, a subsidiary of PacifiCorp. The company currently estimates that the plant would operate with about 250 permanent staff. Rocky Mountain Power-employed plant operators may be able to transition onto operating the Natrium reactor, according to Jeff Navin, TerraPower's director of external affairs. Navin expects that the electric workers at the former coal facilities could also easily transfer onto work at the nuclear plant.

While the company has workforce development funding set aside, Navin says TerraPower intends to work with the local union representing workers at the facility, and with the U.S. Department of Labor (DOL) or community colleges to facilitate the additional training that may be required. The international unions and schools already have apprenticeship programs to support members, many of which are funded by the DOL. Conversations, Navin adds, are also underway with the University of Wyoming, which partners with the University of Idaho on certain engineering programs.

Optimally, training for coal plant workers for non-operator positions at the nuclear plant would take place either prior to the shutdown of the coal plant while the workers are still employed, or as a separate paid position for the time it takes to train into the new position.

Utilities vary in their requirements for what level of educational attainment employees must meet in order to hold different jobs. Some utilities, for example, require that nuclear operators obtain a bachelor's degree. However, in some cases experience trumps the degree: Many "Nuclear Navy" officials who move to work for the civilian workforce joined the U.S. Navy out of high school and completed their education with their high school degree.

There is also a natural degree of variation between coal and nuclear plant work. Some of the parameters of work at nuclear facilities may not appeal to all coal plant workers. These differences include:

- **Fitness-for-duty requirements.** This includes the ability to pass a drug test regularly, which is still required even as additional states allow recreational or medical use of certain controlled substances
- **Constant oversight by supervisors on the job**, including by NRC inspectors
- **More stringent quality controls or enforcement**, including from the DOL's Occupational Safety and Health Administration
- **Requirements to withhold proprietary information** about brand-new plant designs
- **Requirements, for licensed operator positions, to travel** to an existing nuclear facility for on-the-job training and experience prior to receiving a license
- **In the case of operators, training as frequently as every six weeks** to maintain qualification

Section 3: Survey of Retiring Coal Plants

As developers get closer to their first advanced reactor demonstrations, it is vital that they find and pick safe locations with supportive communities for their SMR deployments.

The sites of retired or retiring coal plants throughout the country offer many attractive features for advanced nuclear developers. The switchyard, transmission, transportation access, and water supply of retired coal plants

provide a unique opportunity for the adaptive reuse of the site. However, certain plant sites may be better suited to repowering with SMR technology than others. There are a range of legal, environmental, and technical constraints to consider when developers choose potential host communities. To understand the size of the opportunity for coal repowering, we surveyed the list of roughly 300 coal plants that have retired since 2010 or will retire through 2045.[49] We then filtered out the coal plant sites that were in states with prohibitions on new nuclear, were subject to potential safety hazards, or were too small or too large for SMR replacement. Table 3 summarizes this methodology for reducing the list of retired and retiring coal plant sites to those most suitable for coal-to-SMR repowering.

This analysis is not meant as a site-selection process, but to illustrate the number and diversity of potential sites for coal repowering with SMRs. By looking at state-level constraints or opportunities, developers and policymakers can focus their efforts.

Table 3. Methodology for Identifying Coal Plants Suited for SMR Repowering.

Filter 1	Removed plants located in states with active policy restrictions against construction of new nuclear plants
Filter 2	Removed plants located within safety hazards identified by FPTZ
Filter 3	Removed plants with a total nameplate capacity of less than 300 MWe and a nameplate capacity per unit of greater than 1000 MWe
Note. FPTZ = University of Michigan's Fastest Path to Zero initiative. Specifics regarding the safety hazards are available in Appendix A. "Nameplate capacity" signifies the maximum rated output of the generator of the coal plant in megawatts-electric (MWe).	

For example, some retired or retiring coal plants are located in areas that pose significant environmental risk, such as 100-year flood zones and places with greater likelihoods of landslides or earthquakes. Other sites are located in states with restrictions on new nuclear construction that would complicate repowering with advanced nuclear: Some states require a demonstrated

[49] This analysis was performed using the University of Michigan Fastest Path to Zero ANSL tool, developed with support from Advanced Research Projects-Energy in collaboration with Oak Ridge National Laboratory.

solution for waste disposal, while others require approval by the legislature. Table 4 summarizes the current set of state restrictions on new nuclear facilities.

Table 4. State Restrictions on New Nuclear Facilities.

State	Restriction(s)
California	Availability of fuel rod reprocessing technology
Connecticut	Demonstrable disposal technology for high-level waste
Hawaii	Approval by a two-thirds vote in each house of the state legislature
Illinois	Demonstrable disposal technology for high-level waste or general assembly approval
Maine	Approval by vote during statewide election; certification by the PUC; demonstrable disposal and storage technology for high-level waste
Massachusetts	Approval by a majority of voters during statewide election; approval by both houses of the state legislature certifying the following: federally-licensed high-level waste disposal facility; adequate emergency preparedness plan developed; effective emission standards; demonstrable disposal technology for high-level waste; optimality of nuclear for meeting energy needs
Minnesota	Ban on new construction
New Jersey	Finding by the Commissioner of Environmental Protection for safe radioactive waste disposal
New York	Geographically limited moratorium
Oregon	Finding by the Energy Facility Siting Council of a federal repository for and terminal disposition of high-level waste; approval by vote during statewide general election
Rhode Island	Approval by the general assembly
Vermont	Approval by the general assembly
West Virginia	Demonstrable disposal technology for high-level waste; economic feasibility for ratepayers; compliance with environmental requirements; approval by the public service commission with documentation confirming the foregoing requirements

Note. Adapted from "State Restrictions on New Nuclear Power Facility Construction," National Conference of State Legislatures (August 17, 2021), https://www.ncsl.org/research/environment-and-natural-resources/states-restrictions-on-new-nuclear-power-facility.aspx; Suzanne Hobbs Baker, "Innovating New Nuclear Site Selection & Engagement Approaches" (University of Michigan Fastest Path to Zero), accessed Oct. 17, 2021, https://uploads-ssl.webflow.com/5f05cd440196dc2be1636955/615e1a1ddaee716c57553ec0_Fastest%20Path%20Overview.pdf. In September 2021, the State of Texas enacted a bill that places restrictions on new general construction permits for facilities licensed to store high-level waste, except for facilities on the site of a currently or formerly running nuclear reactor. While the intention of the bill was ostensibly to prevent the storage of nuclear waste in Texas, experts are still determining whether the state will also interpret the law as indirectly banning most new nuclear construction. See: Texas, House, *HB 7: An Act relating to the storage or disposal of high-level radioactive waste*, September 9, 2021, https://capitol.texas.gov/tlodocs/872/billtext/pdf/HB00007F.pdf.

In still other cases, some coal plants' capacity is too small or too large for a one-to-one replacement with nuclear power, even with the wider range of

power available due to the modularity of many advanced reactor designs. That disparity, however, might not be an issue if local energy demand has recently grown or shrunk due to an influx or exodus of people or businesses.

The filtered list of coal plant sites suitable for repowering with SMRs is listed in Appendix A. There, we also provide several additional layers of analysis on the filtered list of sites, including information on local support for nuclear energy, as well as data from the Centers for Disease Control and Prevention's Social Vulnerability Index and the U.S. Environmental Protection Agency's EJSCREEN tool that help to identify overburdened, underserved, or struggling communities. Communities with high percentile values of local unemployment, poverty, cancer rates, and particulate matter counts could most benefit from coal-to-SMR replacement; at a minimum, understanding the local strains on the community due to or made worse through the operation of coal-fired generators is an important component of site characterization for advanced nuclear developers.

Even through extensive downselection of coal facilities, the analysis yields 79 sites that have good conditions to at least consider advanced nuclear power as a replacement technology (Figure 1).

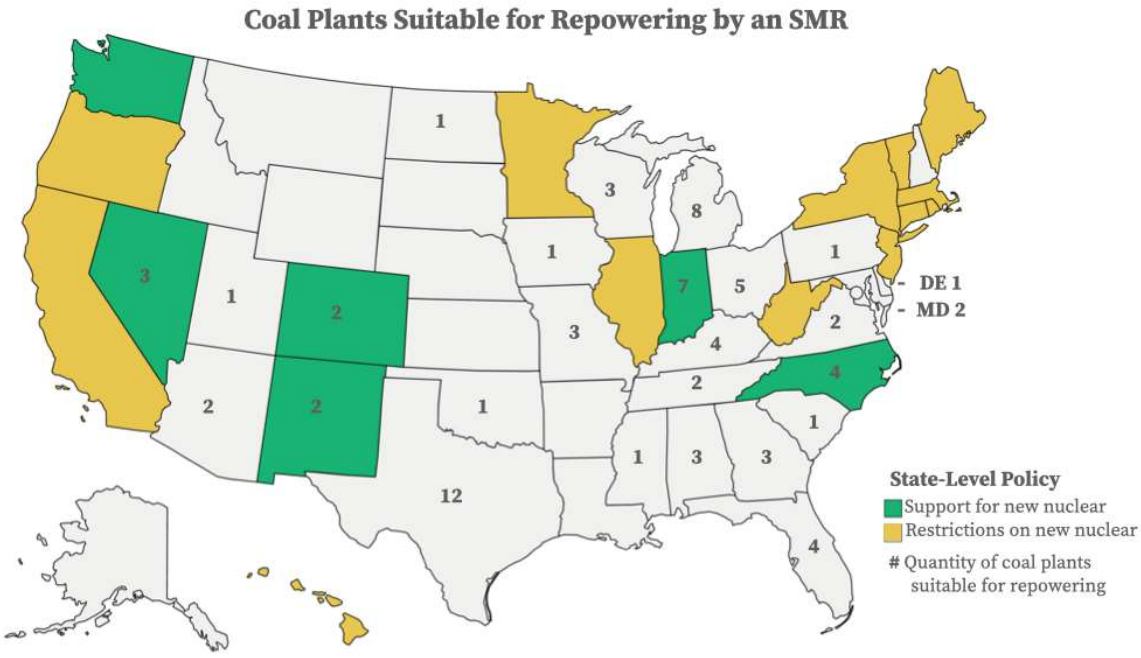

Figure 1. U.S. map of the quantity of coal plant sites in each state suitable for SMR repowering.

Looking at Figure 1, opportunities for coal repowering with SMRs exist in almost every part of the United States, except along the West Coast. Notably, some states with many retiring coal plants—such as West Virginia and Illinois—have restrictions on new nuclear plants and may not be the ideal location for a first demonstration until such a time that the state relaxes or lifts its restrictions.

Viable SMR Options

Researchers have identified as many as 74 different advanced reactor projects in North America.[50] Only a handful of these developers have started their pre-

[50] "2020 Advanced Nuclear Map: Progress Amidst a Tumultuous Year," Energy for Growth Hub and Third Way, December 21, 2020, https://www.thirdway.org/graphic/2020-advanced-nuclear-map-progress-amidst-a-tumultuous-year.

application or application work with the NRC.[51] These companies are the frontrunners for the eventual deployment of SMR technology in the United States, some of whom are targeting deployment as early as 2027. Several of the companies have also received federal support from the DOE toward the demonstration of their reactor designs; are in the running for U.S. Department of Defense pilots of microreactor technologies; and/or have existing plans in place with electric utility companies that want to buy advanced reactors or the power they generate. Table 5 provides details about the SMR developers who have formally begun engagement with the NRC, what stage of engagement they have reached, and their current generating capacities, based on publicly available information.

Table 5. SMR developers formally engaging with the U.S. Nuclear Regulatory Commission.

Company	Reactor Name	Stage of NRC Engagement	Maximum Est. Capacity/Module
NuScale Power LLC	NuScale Power Module™	Safety Evaluation Report Issued 8/28/2020	77 MWe[a]
Kairos Power LLC	Kairos	Application Stage (for 35-MW non-power test reactor demonstration)	140 MWe[e]
General Atomics	Energy Multiplier Module (EM2)	Pre-Application Stage	265 MWe[b]
X-Energy LLC	Xe-100	Pre-Application Stage	80 MWe[c]
TerraPower LLC and GE Hitachi	Natrium Reactor	Pre-Application Stage	345 MWe[d]
TerraPower LLC and GE Hitachi	Molten Chloride Fast Reactor	Pre-Application Stage	—
Terrestrial Energy USA	Integral Molten Salt Reactor	Pre-Application Stage	195 MWe[f]

[51] "Design Certification Application - NuScale," U.S. Nuclear Regulatory Commission, last modified December 2, 2020, https://www.nrc.gov/reactors/new-reactors/smr/nuscale.html; "Advanced Reactors (non-LWR designs)," U.S. Nuclear Regulatory Commission, last modified September 7, 2021, https://www.nrc.gov/reactors/new-reactors/advanced/ongoing-licensing-activities/pre-application-activities.html.

Note. Adapted from "Advanced Reactors (Non-LWR Designs)," U.S. Nuclear Regulatory Commission, last modified September 7, 2021, https://www.nrc.gov/reactors/new-reactors/advanced/ongoing-licensing-activities/pre-application-activities.html.
[a] Smallest Light-Water Reactor," NuScale Power LLC, last accessed October 28, 2021, https://www.nuscalepower.com/benefits/smallest-reactor.
[b] "Advanced Reactors," General Atomics, last accessed October 28, 2021, https://www.ga.com/nuclear-fission/advanced-reactors.
[c] "Reactor: Xe-100," X-Energy LLC, last accessed October 28, 2021, https://x-energy.com/reactors/xe-100.
[d] "Natrium," TerraPower LLC, last accessed October 28, 2021, https://natriumpower.com/.
[e] "Technology," Kairos Power LLC, last accessed October 28, 2021, https://kairospower.com/technology/.
[f] "Cost Advantage," Terrestrial Energy USA, last accessed October 28, 2021, https://www.terrestrialenergy.com/technology/advantage/.

Additionally, two developers of microreactor designs have also initiated application activities with the NRC. While the power output of these smaller reactors would be too small to near, meet, or exceed a coal plant's output, microreactors will be well-suited for providing power for smaller industrial or transportation applications, or for powering individual communities. Agency staff are working on an application for a custom combined license for Oklo Power LLC's Aurora reactor, which is graded at 1.5 MWe. Separately, Westinghouse Electric Co. is in the pre-application stage for its 1 MWe–5 MWe eVinci reactor. Due to their tiny size, microreactors could be licensed and demonstrated on shorter timescales, and potentially reduce regulatory hurdles for subsequent advanced reactor license applicants.

Section 4: Conclusions and Policy Implications

With hundreds of communities across the United States facing the closure of coal power plants between 2010–2045, there is a significant need to support these communities in

a way that revitalizes their economies and improves public health. Stated goals by the Biden-Harris administration to decarbonize the U.S. economy fully by 2050 could accelerate the closure of fossil-fueled plants. While programs are in place and under development to support these environmental justice communities, they do not meet the scale of the problem.

Policymakers should think holistically about how they can foster economic revitalization of struggling energy communities in ways that provide comparable, well-paid employment opportunities in line with the desires and the values of a given area, all while reducing emissions from the local energy sector.

We identified 79 retired and retiring coal plants that would be a good fit for coal-to-SMR repowering. SMRs could provide a unique opportunity to repower closing coal plants in a way that keeps jobs local and takes advantage of existing brownfield infrastructure. Their similarities to the power generation and employment needs of coal plants, and their overlapping transmission, water, and transportation requirements, could make them a well-suited option to repurpose retired coal plant sites. Currently, dozens of advanced reactor companies are moving toward commercialization, with the first demonstrations likely in the next five years.

Policymakers are beginning to evaluate the specific technical potential to repower coal sites with nuclear energy, but more policy support will be needed to ensure communities are informed and empowered to make decisions about potential nuclear projects. Conversations are starting between coal, nuclear, elected official, and academic stakeholders to make coal-to-nuclear repowering projects a reality, as well as what opportunities may exist for

workforce switching between coal and nuclear plants. However, if each community or each nuclear developer starts from scratch when exploring potential projects, a coal-to-nuclear transition will be very slow to scale. A process based on best-practices should be developed and used as a template for future projects.

No such blueprint yet exists for how to enable a community-centered transition from coal to a nuclear energy facility. But policymakers can pull from other models and learn from the environmental justice movement to shape a meaningful engagement strategy. Traditional nuclear energy utilities have typically used a top-down approach for planning and site selection. The energy transition brings into question how smaller groups without past nuclear experience, such as municipal utilities and public power authorities, might take the lead in pursuing clean energy projects, including the possibility of replacing coal plants with nuclear facilities. An approach that begins in and with communities could make it possible for them to self-vet and self-identify their interest in hosting an SMR project. Lessons can be learned from past nuclear projects but also from other energy infrastructure projects.[52] Policymakers should now begin to move away from attempting to push communities to become early adopters of technologies and move instead toward offering resources that help communities gain access to the technology on their own terms.

In Section 3, the report identifies a set of criteria for thinking about what conditions are necessary precursors to successful technology adoption. Some of the most important metrics include federal regulatory obstacles, state-level policy obstacles and incentives, and local social sentiment. The Fastest Path to Zero initiative at the University of Michigan has developed a set of tools expressly to enable communities to quickly determine if they have significant

[52] Jessica R. Lovering, Suzanne Baker, and Todd Allen, "Social License in the Deployment of Advanced Nuclear Technology," *Energies* 14 (2021): 4304. https://doi.org/10.3390/en14144304.

or intractable obstacles to help avoid sinking significant resources into pursuing projects that ultimately do not have the conditions for success.

These tools can be used as part of a flexible, user-driven process of weighing and prioritizing nuclear siting criteria in a tailored fashion, but they cannot replace essential stakeholder input when it comes to nuclear plant siting. This input is a requisite for determining whether a community consents to hosting a facility. In future research, the Good Energy Collective plans to explore the potential for community-based grant making as a tool to fund locally led feasibility studies that allow local leaders, such as municipal economic development groups, to design and facilitate these conversations within their own communities.

Increasingly, the nuclear industry is promoting nuclear energy as a tool to address environmental justice concerns because the technology has no operating emissions. But whether a technology is "just" depends not only on the cleanliness of the resource but also, in equal measure, the stakeholder engagement process, models of ownership, and distribution of benefits. For this reason, nuclear developers must co-develop, alongside communities, fair and equitable decision-making processes that involve all stakeholders from a given community and provide an equal chance of access to beneficial, clean energy technologies like nuclear that provide well-paying jobs and local tax revenue. It should be an explicit goal of policymakers and the energy sector at large to provide marginalized groups with systematic access on an opt-in basis to the benefits of energy technologies, not just to their risks.

Appendix A

As detailed in Section 3, the list of sites we identify as best suited for potential repowering with SMR technology first excludes coal plants in those states that have a restriction or ban on new nuclear construction. We then remove coal plants with retirement dates after 2045, as well as plants located within safety hazards identified by the University of Michigan Fastest Path to Zero initiative and plants with a nameplate capacity per unit of greater than 924 MWe. The safety hazards represented are:

- Cell slopes of greater than 18%
- Cells too close to an identified fault line, which in turn determines a standoff distance
- Cells within an area of landslide hazard
- Cells with a safe-shutdown earthquake peak ground acceleration (2% chance in a 50-year return period) greater than 0.5 g

This downselection results in 79 coal plant sites, depicted in Table A, which may offer the fewest outright barriers to entry for an SMR developer. An online spreadsheet of the 79 sites is available to view online.[53]

The table provides the coal plant's name, state, county, nameplate capacity (in MW), number of units, and nameplate capacity per unit. It also provides several additional levels of analysis developed by the Fastest Path to Zero initiative that may be useful to policymakers and to coal and nuclear communities. These include:

- **Support**: The national percentile of public support for nuclear energy on a county basis (i.e., how much does the county containing this coal plant support new nuclear power plants compared to the rest of the counties in the United States), as determined by the Fastest Path to Zero initiative

[53] "Opportunities for Coal Communities Through Nuclear Energy: An Early Look," Good Energy Collective, Google Sheet, https://docs.google.com/spreadsheets/d/1ZeN6DHfmpQlRxBkid-0qy_j5MPKYzIMzEkBxKwoWrHU/edit#gid=1855018552.

in collaboration with the University of Oklahoma (data forthcoming). Support is an aggregation of the combined national percentile of nuclear sentiment parameters, including support for new nuclear power plants; support for new reactors at existing nuclear power plants; perceived risk of nuclear power; and perceived benefit of nuclear power.

- **EJ and Social Vulnerability**: An aggregation of environmental justice indicators, as identified by the Centers for Disease Control and Prevention's Social Vulnerability Index and obtained from the Fastest Path to Zero initiative. The number is a percentile ranking combining the Social Vulnerability Index ranking variables: socioeconomic, household composition, minority status/language, and housing type/transportation. This metric can only be compared to itself (i.e., the data taken in the counties containing retiring coal plants), not to the rest of the country.
- **Pollution**: An equal-weight combination of the 11 U.S. Environmental Protection Agency EJSCREEN indicators presented as a percentile across the country (i.e., how much pollution does the county containing this coal plant experience compared to the rest of the communities in the United States).
- **Favorable Standard**: An indication of whether the state has a Clean Energy Standard or other mechanism that specifically includes nuclear energy, where 1 means the state has such a mechanism.

Table A. Coal Plant Sites Suitable for Repowering with Small Modular Reactors.

Plant Name	State	County	Nameplate Capacity (MW)	# of Units	Nameplate/Unit	Support	EJ and Social Vulnerability	Pollution	Favorable Standard
Widows Creek	AL	Jackson	1968.6	8	246.1	0.79	0.57	0.6	0
Colbert	AL	Colbert	1350	5	270.0	0.74	0.43	0.69	0
Charles R Lowman	AL	Washington	538	3	179.3	0.52	0.73	0.57	0
Navajo	AZ	Coconino	2409.3	3	803.1	0.17	0.71	0.46	0

Cholla	AZ	Navajo	702.9	2	351.5	0.26	1	0.31	0
Comanche (CO)	CO	Pueblo	778.5	2	389.3	0.16	0.87	0.64	0
Cherokee	CO	Adams	420.5	3	140.2	0.2	0.59	0.8	0
Indian River Generating Station	DE	Sussex	340	3	113.3	0.75	0.4	0.58	0
St Johns River Power Park	FL	Duval	1358	2	679.0	0.67	0.69	0.77	0
Crystal River	FL	Citrus	964.3	2	482.2	0.85	0.6	0.38	0
Indiantown Cogeneration LP	FL	Martin	395.4	1	395.4	0.98	0.4	0.59	0
Lansing Smith	FL	Bay	340	2	170.0	0.62	0.61	0.55	0
Harllee Branch	GA	Putnam	1746.2	4	436.6	0.76	0.43	0.5	0
Hammond	GA	Floyd	953	4	238.3	0.6	0.89	0.8	0
Yates	GA	Coweta	679.9	5	136.0	0.73	0.24	0.65	0
George Neal North	IA	Woodbury	496.2	2	248.1	0.25	0.7	0.59	0
R M Schahfer	IN	Jasper	1943.4	4	485.9	0.51	0.27	0.52	1
Merom	IN	Sullivan	1080	2	540.0	0.19	0.64	0.6	1
Wabash River	IN	Vigo	860.2	5	172.0	0.18	0.73	0.8	1
AES Petersburg	IN	Pike	804.9	2	402.5	0.3	0.17	0.68	1
A B Brown	IN	Posey	530.4	2	265.2	0.31	0.01	0.73	1
Dean H Mitchell	IN	Lake	383.5	3	127.8	0.51	0.73	0.84	1
Eagle Valley (IN)	IN	Morgan	301.6	4	75.4	0.33	0.22	0.68	1
Paradise	KY	Muhlenberg	2558.2	3	852.7	0.09	0.61	0.58	0
Cane Run	KY	Jefferson	644.6	3	214.9	0.32	0.57	0.88	0
Elmer Smith	KY	Daviess	445.3	2	222.7	0.26	0.62	0.8	0
HMP&L Station Two Henderson	KY	Henderson	405	2	202.5	0.2	0.79	0.57	0
Chalk Point LLC	MD	Prince Georges	728	2	364.0	0.06	0.63	0.8	0
Dickerson	MD	Montgomery	588	3	196.0	0.58	0.33	0.77	0
St Clair	MI	St Clair	1547	6	257.8	0.51	0.28	0.65	0
Belle River	MI	St Clair	1395	2	697.5	0.51	0.28	0.65	0

Trenton Channel	MI	Wayne	775.5	3	258.5	0.69	0.87	0.85	0
Dan E Karn	MI	Bay	544	4	136.0	0.39	0.44	0.67	0
Presque Isle	MI	Marquette	450	5	90.0	0.34	0.31	0.28	0
Eckert Station	MI	Ingham	375	6	62.5	0.31	0.57	0.68	0
J R Whiting	MI	Monroe	345.4	3	115.1	0.8	0.15	0.67	0
B C Cobb	MI	Muskegon	312.6	2	156.3	0.32	0.7	0.7	0
Meramec	MO	St Louis	648	2	324.0	0.44	0.26	0.87	0
Montrose	MO	Henry	564	3	188.0	0.28	0.6	0.53	0
Sibley	MO	Jackson	524	3	174.7	0.31	0.54	0.78	0
R D Morrow	MS	Lamar	400	2	200.0	0.72	0.53	0.51	0
G G Allen	NC	Gaston	1148.4	5	229.7	0.74	0.67	0.85	1
Marshall (NC)	NC	Catawba	697	2	348.5	0.76	0.29	0.78	1
L V Sutton Steam	NC	New Hanover	671.6	3	223.9	0.8	0.38	0.63	1
Buck	NC	Rowan	370	4	92.5	0.74	0.81	0.76	1
Coal Creek	ND	McLean	1209.6	2	604.8	0.38	0.08	0.22	0
Four Corners	NM	San Juan	2269.6	5	453.9	0.49	0.92	0.51	0
San Juan	NM	San Juan	1848	4	462.0	0.49	0.92	0.51	0
Mohave	NV	Clark	1636.2	2	818.1	0.22	0.74	0.68	0
Reid Gardner	NV	Clark	636.8	4	159.2	0.22	0.74	0.68	0
North Valmy	NV	Humboldt	567	2	283.5	0.42	0.59	0.36	0
Conesville	OH	Coshocton	1890.8	4	472.7	0.41	0.62	0.65	1
FirstEnergy Eastlake	OH	Lake	1257	5	251.4	0.94	0.13	0.78	1
Killen Station	OH	Adams	660.6	1	660.6	0.1	0.77	0.49	1
FirstEnergy Bay Shore	OH	Lucas	498.8	3	166.3	0.55	0.69	0.76	1
O H Hutchings	OH	Montgomery	414	6	69.0	0.57	0.67	0.83	1
Northeastern	OK	Rogers	473	1	473.0	0.48	0.28	0.69	0
Eddystone Generating Station	PA	Delaware	707.2	2	353.6	0.54	0.41	0.91	0
Canadys Steam	SC	Colleton	489.6	3	163.2	0.59	0.8	0.48	0
Johnsonville	TN	Humphreys	1485.2	10	148.5	0.61	0.37	0.48	0
Bull Run	TN	Anderson	950	1	950.0	0.83	0.61	0.76	0
W A Parish	TX	Fort Bend	2736.8	4	684.0	0.78	0.9	0.68	0

Monticello	TX	Titus	1980	3	660.0	0.51	0.89	0.6	0
Limestone	TX	Limestone	1849.8	2	924.9	0.58	0.95	0.44	0
Big Brown	TX	Freestone	1186.8	2	593.4	0.7	0.84	0.43	0
Tolk	TX	Lamb	1135.8	2	568.0	0.55	0.92	0.39	0
Harrington	TX	Potter	1080	3	360.0	0.34	0.99	0.63	0
J T Deely	TX	Bexar	932	2	466.0	0.43	0.83	0.71	0
Oklaunion	TX	Wilbarger	720	1	720.0	0.55	0.91	0.48	0
Sandow No 5	TX	Milam	661.5	1	661.5	0.65	0.76	0.43	0
Sandow No 4	TX	Milam	590.6	1	590.6	0.65	0.76	0.43	0
Welsh	TX	Titus	558	1	558.0	0.51	0.89	0.6	0
Gibbons Creek	TX	Grimes	453.5	1	453.5	0.65	0.86	0.54	0
Bonanza	UT	Uintah	499.5	1	499.5	0.24	0.48	0.34	0
Yorktown	VA	York	375	2	187.5	0.96	0.2	0.65	0
Glen Lyn	VA	Giles	337.5	2	168.8	0.65	0.27	0.48	0
Pleasant Prairie	WI	Kenosha	1233.2	2	616.6	0.52	0.51	0.74	0
Pulliam	WI	Brown	350.2	4	87.6	0.82	0.33	0.64	0
Genoa	WI	Vernon	345.6	1	345.6	0.45	0.38	0.38	0

Note. Adapted from University of Michigan Fastest Path to Zero Initiative. In September 2021, the State of Texas enacted a bill that places restrictions on new general construction permits for facilities licensed to store high-level waste, except for facilities on the site of a currently or formerly running nuclear reactor. While the intention of the bill was ostensibly to prevent the storage of nuclear waste in Texas, experts are still determining whether the state will also interpret the law as indirectly banning most new nuclear construction. See: Texas, House, HB 7: An Act relating to the storage or disposal of high-level radioactive waste, September 9, 2021, https://capitol.texas.gov/tlodocs/872/billtext/pdf/HB00007F.pdf.