Union of Concerned Scientists

FACT SHEET

A Dwindling Role for Coal

Tracking the Electricity Sector Transition and What It Means for the Nation

Over the last decade, the US electricity sector has undergone a historic transition away from coal to cheaper, cleaner energy sources. In 2008, coal represented about 51 percent of our nation's electricity supply. By 2016, that share had fallen to 31 percent, as 59 gigawatts (GW), or about 17 percent, of the nation's coal-fired generating capacity had been retired and another 13 GW (4 percent) had been switched to other fuels. As a result, the nation has realized steep reductions in pollution produced by coal-fired electricity, leading to public health benefits worth an estimated $250 billion[1] from 2008 to 2016: millions of Americans are now breathing cleaner air, and hundreds of thousands fewer are dying or becoming sick from coal-related ailments. Market forces are the primary cause of this shift toward cleaner sources of energy; the availability of low-cost natural gas, flattening electricity demand, and the rapidly declining cost of renewable energy such as wind and solar have together made coal power less economically competitive.

The closure of many more coal-fired power plants seems inevitable. Utilities have already announced that another 51 GW, or 18 percent of currently operating coal-fired generating capacity, will be converted to natural gas or retired altogether from 2017 through 2030. The Union of Concerned Scientists (UCS) has conducted a three-part analysis on the transition away from coal-fired electricity: (1) a look at what happened to the nation's coal-fired generating units between 2008 and 2016; (2) an evaluation of the economic viability of the current coal fleet using an updated "economic stress test" (Fleishman et al. 2013; Cleetus et al. 2012); and (3) an assessment of the demographics of communities living near coal plants. Our analysis finds that an additional 57 GW (20 percent of current coal capacity) are uneconomic today compared to existing natural gas power plants and therefore could face retirement. With advance planning and investment, the nation can take advantage of many cost-effective clean energy options—such as renewable energy and energy efficiency—to replace retiring coal-fired power plants while maintaining an affordable and reliable electricity supply.

The transition away from coal is a huge public health boon for millions of Americans, sharply lowering emissions of harmful pollutants, including sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulate matter, mercury, and other toxics. However, it also raises complex challenges for communities that depend on coal-fired power plants for jobs and local taxes. Through community snapshots, we also explore the challenges and opportunities facing coal-dependent communities in Illinois, Michigan, North Carolina, and West Virginia that have faced or may face the closure of a coal-fired power plant.

Our analysis and the experiences of communities underscore the need for policies that enable planning for and investment in a cost-effective, reliable, and just transition to a clean energy economy. Policymakers should incentivize investments in renewable energy and energy efficiency to create jobs and diversify local economies, ensure that public health benefits and clean energy opportunities flow to all communities in an equitable way, and help struggling coal-dependent communities with job transition assistance and economic development.

The former coal-fired Ottawa Street Power Station, now a highly efficient office building in downtown Lansing, Michigan. Photo credit: J.C. Kibbey.

Looking Back: A Decade of Clean Energy Progress

This analysis identifies 357 GW of coal-fired generating capacity (or 1,256 coal units[2]) in operation in 2008 across the United States. By the end of 2016, 17 percent (59 GW) had been retired and an additional 4 percent (13 GW) had been converted[3] to other fuels, mostly natural gas. Figure 1 maps the change in the operational coal fleet from 2008 to 2016. Considering only the contributions from the 1,256 coal units in 2008 and 2016, the shift away from coal has led to an 80 percent reduction in SO_2 emissions and a 64 percent reduction in NO_x emissions as well as a 34 percent reduction in global-warming carbon dioxide (CO_2) emissions. However, increased reliance on natural gas threatens to undermine the gains in CO_2 reductions (Deyette 2015); in 2016, energy-related CO_2 emissions from burning natural gas exceeded the emissions from burning coal for the first time (EIA 2016).

The widespread availability of cheap natural gas has led to fundamental changes in our electricity system, with natural gas surpassing coal for the first time in 2016 as the leading source of electricity in the United States (EIA 2017). The Department of Energy recently concluded that the economics of natural gas-fired generation has been the biggest contributor to coal and nuclear retirements (DOE 2017).

In addition, renewable energy made up nearly 9 percent[4] of our nation's power supply in 2016—more than double the 2010 level. State and federal incentives have certainly helped drive this incredible growth in recent years. However, recent cost comparisons show that new wind and solar facilities are now cheaper than new fossil fuel generation, even without subsidies (Lazard 2016).

At the national level, our analysis shows that the retirement of record numbers of coal units over the last decade has led to a dramatic reduction in the total number of people living near a coal plant. Between 2008 and 2016, the number of people living within three miles of an operating coal plant fell from about 8.5 million to approximately 3.3 million[5]. Our analysis also assesses the demographics of communities living close to coal-fired power plants using data from the US Census (Krieger et al. 2016; EPA 2015). Such a demographic screening can help guide community engagement and identify analysis needs that can help during transition planning. We find that coal units are disproportionately located in low-income communities, and our analysis suggests that additional policies will be needed to address this disparity. See the technical appendix for additional details.

Community Snapshots

The details of how the national transition away from coal plays out in individual communities raise complex issues that demand national, state, and local attention. Snapshots of four communities grappling with these changes, seen through the eyes of each community's residents, highlight a range of these issues, including effects on public health, equity and justice, the local tax base, and jobs. [Read more at: *www.ucsusa.org/communitysnapshots*]

The Ottawa Street Power Station in Lansing, Michigan, burned coal until 1992. It then sat deserted for almost 20 years until the Accident Fund, an insurance company, refurbished the building with the help of local economic development officials and tax incentives to create its LEED-certified headquarters, creating or retaining about 1,000 jobs. This example shows how old coal power plants can be repurposed to fit into new economic development models that emphasize vibrant urban cores and well-paying professional jobs and also how forward-thinking policy is critical to these models.

The Fisk Street and Crawford Generating Stations in Chicago, Illinois, closed in 2012 after a long, successful fight led by local groups such as the Little Village Environmental Justice Organization (LVEJO). However, this story illustrates that the work is not finished with the closure of a coal plant, as the community continues to face new environmental problems caused by other sources of pollution. It also highlights LVEJO's work to foster economic development in communities that have faced chronic underinvestment and to chart a path forward in state energy policy that includes minority and low-income communities.

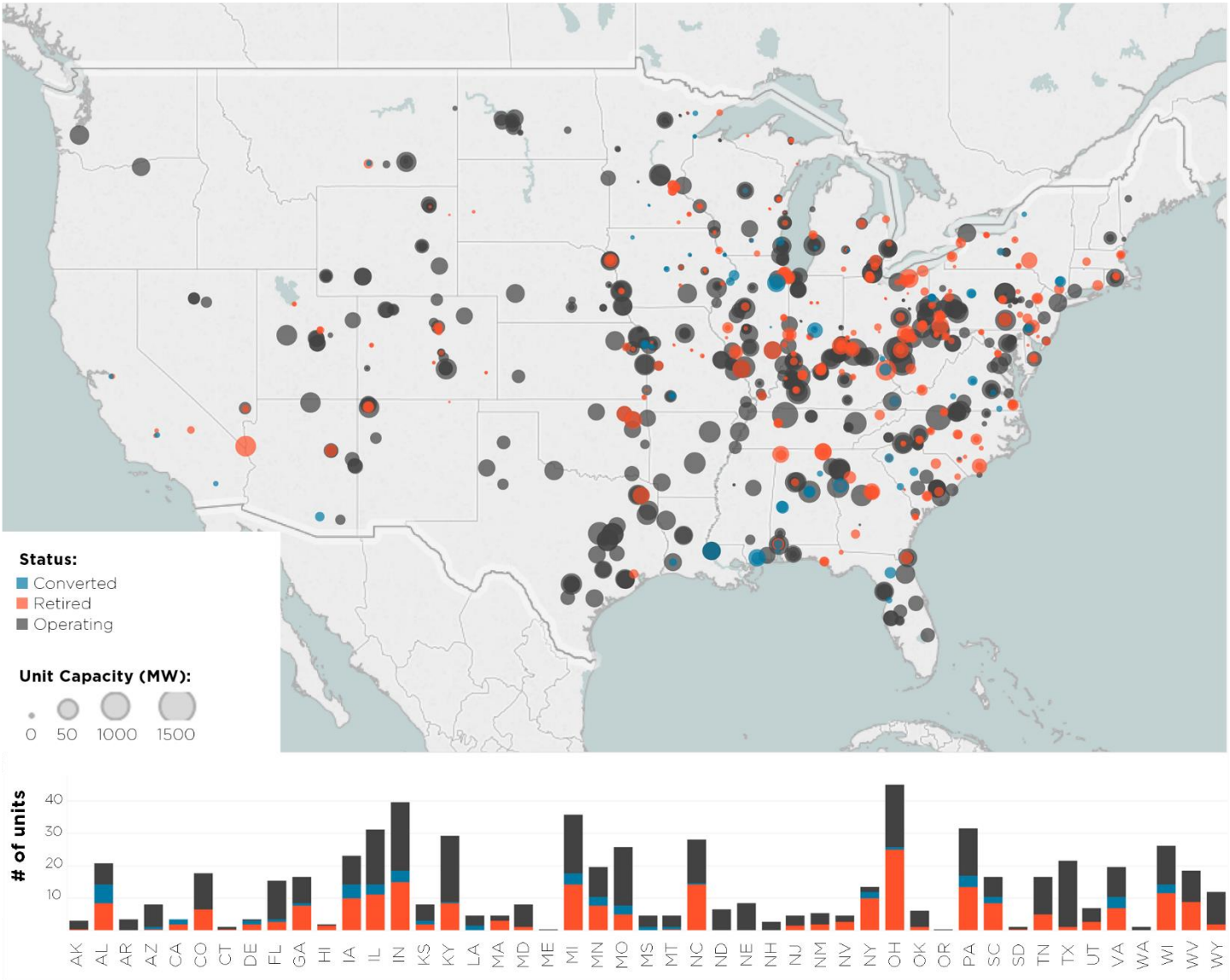
The Roxboro Plant in Semora, North Carolina, is an operating rural coal plant that is identified as uneconomic in the UCS analysis. Regardless of whether the plant closes, the experience of residents in Semora illustrates one of the negative impacts of burning coal for electricity: water pollution resulting from the disposal of coal ash. This story highlights the challenges faced by rural environmental justice communities as they try to ensure that ongoing waste disposal and pollution do not pose public health and environmental threats to local residents.

The West Edge Factory in Huntington, West Virginia, tells the story of how coal-mining communities are beginning to adapt to the transition away from coal and the loss of coal jobs. The Coalfield Development Corporation is a family of social enterprises that focuses on training young people to work in other industries such as local agriculture, sustainable construction, and solar installations right in the heart of coal country.

The closure of a coal plant—while hugely beneficial to public health—can raise concerns about jobs and the local tax base for surrounding communities, and it therefore requires thoughtful advance planning in consultation with local stakeholders (see Text Box). Our community snapshot from Lansing, Michigan, shows how the closure of a coal plant can lead to economic revitalization. However, the retirement of a major coal plant is not the end of the story, as the snapshot from Chicago, Illinois, indicates.

See the technical appendix for details on the analysis methodology and results as well as state-level breakdowns of the transition. Plant-level results and data are available in a downloadable spreadsheet. [Read more on our website at: *www.ucsusa.org/coaltransitiondata*]

FIGURE 1. The Dramatic Shift Away from Coal-Fired Electricity in the United States from 2008 to 2016



States in the eastern half of the United States have been most dramatically affected by the transition away from coal because coal units are more numerous there. The bar graph shows the total number of coal units operating in 2008 and their color-coded operating status in 2016 (operating, retired, or converted). Actual numbers by state (along with total capacity and generation) can be found in the technical appendix.

BASED ON DATA FROM S&P GLOBAL (2017).

Looking Ahead: A Continuing Clean Energy Transition

As we look ahead to the future of our nation's coal fleet, the transition away from coal will likely continue. Plant owners have announced that more than 38 GW (13 percent of the nation's coal generating capacity in 2016) will be retired between 2017 and 2030—and 5 GW of that amount had already been retired by July 2017. An additional 13 GW (5 percent of 2016 coal generating capacity) are slated for possible conversion to natural gas or outright retirement by 2030.

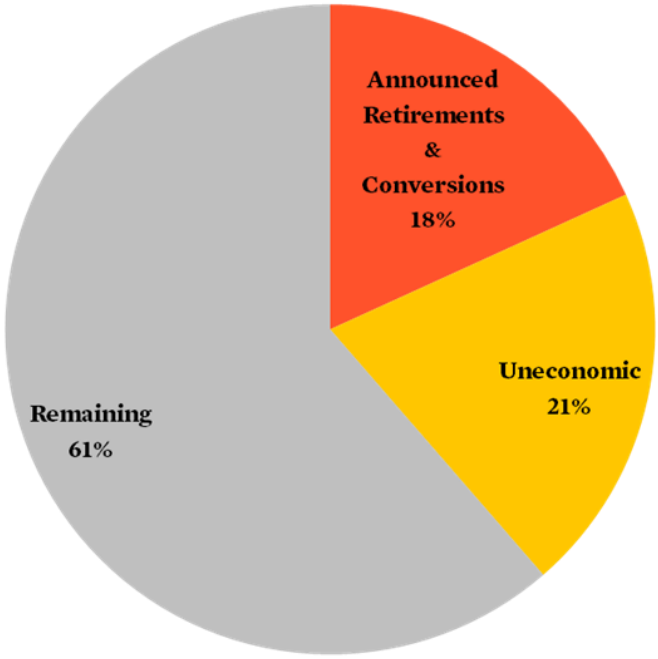
The retirement and conversion of these units mean that the size of the population living within three miles of an operating coal plant can be expected to fall further, from about 3.3 million to just under 1.9 million. However, where coal plants are converted to natural gas, the potential resulting pollution reduction benefits may be undermined. Although natural gas burns cleaner than coal, it is still a fossil fuel, and its use, production, storage, and transport produce pollution experienced both locally and globally.

A look at current operating costs, on a unit-by-unit basis, shows that much of the remaining coal fleet faces significant economic uncertainty over the coming years due to economic competition from natural gas and renewable energy resources. We conducted an "economic stress test" of the remaining coal units by comparing their cost of generating electricity to that of several alternatives, including existing natural gas plants that have the potential to increase their electricity output, new natural gas plants, and new wind and solar resources. Our base case compares the cost of electricity generated by coal units to the cost of electricity generated by an existing natural gas combined cycle (NGCC) unit. It shows that units making up 57 GW of the installed coal capacity are uneconomic—that is, a further 20 percent of the nation's 2016 coal generating capacity is uncompetitive and therefore could face retirement or conversion (see Figure 2). Our snapshot of Semora, North Carolina, highlights one community's perspective on a coal plant that shows up in our analysis as uneconomic compared to existing natural gas generation.

Our analysis also finds a significant number of currently operating coal units that are just marginally economic, meaning that even a slight increase in costs would make them uncompetitive compared to the alternatives. One possibility is a decrease in the price of natural gas or further decreases in the cost of building wind and solar power plants. Conversely, several factors could increase the cost of coal-fired electricity, including additional environmental regulations, increases in the cost of delivered coal, or increases in operating costs as these units continue to age.

As a proxy for the myriad of factors that could affect coal-fired generation, we used a "cost adder" of $10 per metric ton of emitted CO_2 to compare the 2016 coal fleet to the same list of alternative resources. In this scenario, 92 GW of generating capacity, or 32 percent of the nation's coal fleet, are deemed uneconomic compared to existing NGCC plants. Coal also faces strong competition from new wind generation in this scenario, with more than 40 GW of capacity (14 percent of the 2016 coal fleet) becoming uneconomic. See the technical appendix for additional details on the different sensitivities considered by the economic stress tests and an assessment of pollution controls on coal units.

FIGURE 2. More than 20 Percent of the Nation's 2016 Coal-Fired Capacity Struggles to Compete with Existing Natural Gas Plants

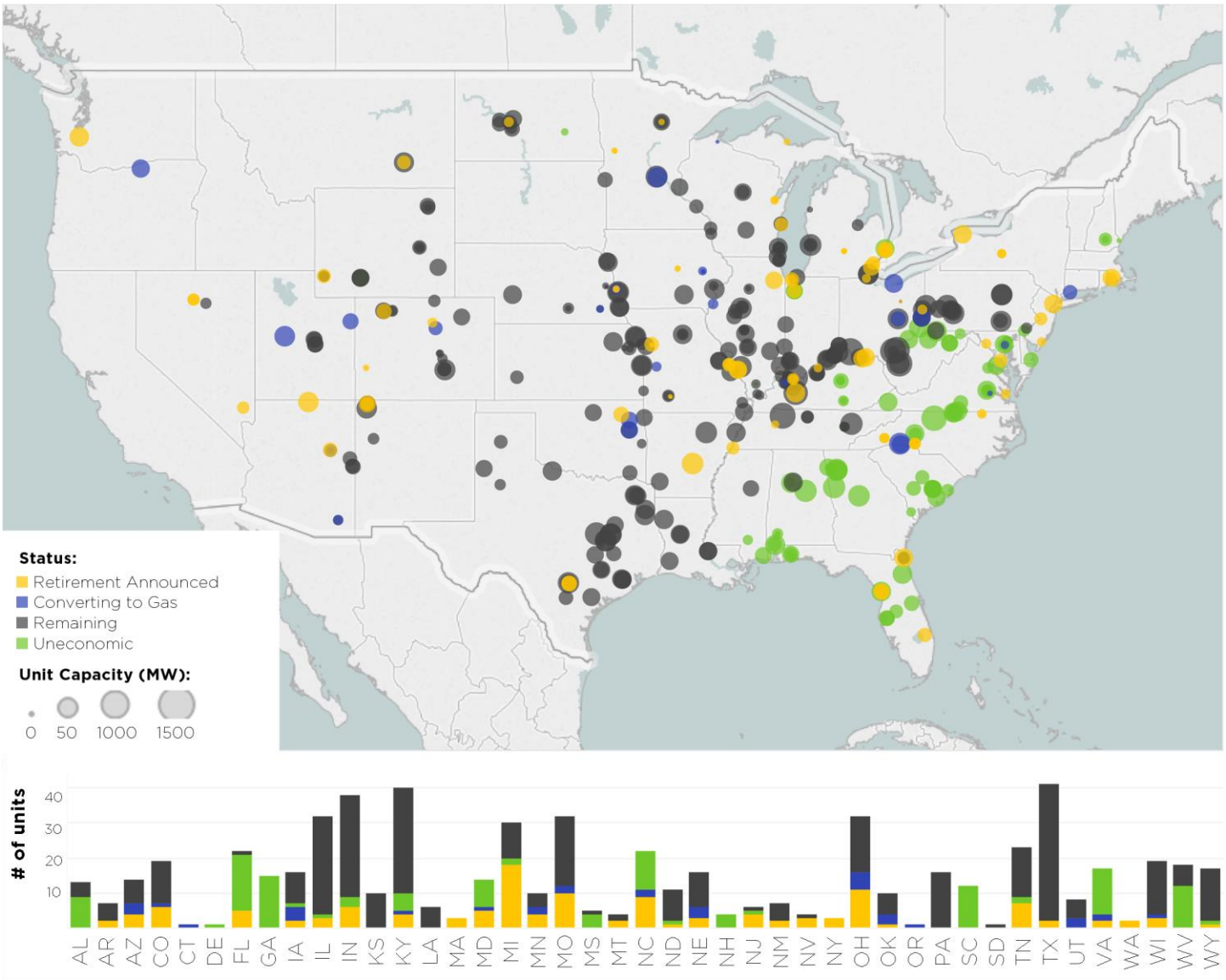


Our reference case shows 57 GW of coal-fired capacity to be uneconomic compared to existing NGCC units. These 57 GW represent more than 20 percent of the nation's 2016 coal-fired generating capacity.

Percentages in this pie chart are relative to the total coal capacity that was evaluated using the economic stress test; 4.2 GW of coal capacity was excluded due to insufficient data.

In addition to these overall market factors, decisions about whether and when to retire individual coal units depend on a number of local factors. These include what cost-effective alternatives are currently available in the regional electricity grid and what can be brought on line within a few years, whether the unit is owned by a regulated utility that can recover above-market costs directly from ratepayers, and how seriously individual states and/or the nation will address the threats of pollution and climate change in coming years. Nevertheless, the trend is clear—many of the units we have identified as uneconomic are likely to face early retirement. How that transition plays out—in communities living near these plants, in coal-mining communities, and nationwide—will have a profound effect on our clean energy future

FIGURE 3. Coal Units Around the Country Face an Uncertain Future



This map of the 2016 fleet of operating coal units is color coded to show announced retirements and conversions and units that are uneconomic compared to existing NGCC units. The bar graph shows the total number of units by state; actual numbers can be found in the technical appendix.

Eighty-four units excluded from the economic stress test due to insufficient data are not shown on this map.

BASED ON DATA FROM S&P GLOBAL (2017).

In addition to these overall market factors, decisions about whether and when to retire individual coal units depend on a number of local factors. These include what cost-effective alternatives are currently available in the regional electricity grid and what can be brought on line within a few years, whether the unit is owned by a regulated utility that can recover above-market costs directly from ratepayers, and how seriously individual states and/or the nation will address the threats of pollution and climate change in coming years. Nevertheless, the trend is clear—many of the units we have identified as uneconomic are likely to face early retirement. How that transition plays out—in communities living near these plants, in coal-mining communities, and nationwide—will have a profound effect on our clean energy future.

Regional Implications

Given market realities, as much as 108 GW of coal-fired generating capacity (representing 38 percent of 2016 coal capacity) could face retirement over the next decade. Available cost-effective clean energy options can go a long way toward replacing coal-fired power. We will also need a significant ramp-up of clean energy resources, transmission, and energy storage over the next decade to close the gap completely nationwide. With advanced planning and investments, a continued transition away from coal can happen while we maintain affordability and reliability for consumers and avoid a wholesale shift to natural gas (Deyette 2015). Building a large amount of new natural gas infrastructure could lock the power sector into producing harmful emissions for decades and expose utilities to substantial risk of being stuck with stranded assets when cleaner energy options become even more economical. Increasing the portion of renewables on the grid, instead of overreliance on any one fuel, can provide fuel diversity and serve as a hedge against natural gas price volatility.

With adequate foresight and strong policies, we can switch to cleaner sources of electricity as the transition away from coal continues. Twenty-nine states have adopted Renewable Electricity Standards that will drive ongoing investments in wind and solar resources. Twenty-four states have adopted Energy Efficiency Resource Standards that will continue to reduce energy demand while saving consumers money. Just by meeting these standards, the additional renewable energy and the expected electricity savings through 2025 can fill the gap left by retiring and uneconomic coal units in some regions of the country, particularly the West, the Northeast, and parts of the Midwest. Furthermore, market trends are leading to the development of more renewable resources than prescribed by state policies, thanks to favorable economics and strong resources in places such as Texas and the Midwest, recent cost reductions in wind and solar and the federal tax credits, and corporate commitments to renewable energy. The Southeast, however, risks turning to natural gas to meet future electricity needs, potentially missing out on the full benefits of increased renewable energy and energy efficiency. See the technical appendix for further detail.

Policy Recommendations

To accelerate our nation's transition to clean energy and ensure that the benefits flow to everyone, UCS recommends the following:

1. State and federal policymakers, utility regulators, power grid operators, utility companies, and power producers should work with communities to ensure a smooth transition to cleaner forms of energy to replace retiring coal-fired power plants and make appropriate resource planning, grid investment, and policy choices. Prioritizing renewable energy and energy efficiency can help maintain reliability and affordability while cutting harmful pollutants. A wholesale switch to natural gas, on the other hand, would create consumer, environmental, and climate risks (Deyette 2015). With cleaner and cheaper options available, regulators should think twice before approving permits or retrofit costs for coal-fired plants or investments that could further an overreliance on natural gas.
2. State and federal public health and environmental standards should be strengthened and enforced to continue driving reductions in pollution produced by coal-fired power plants. These policies should especially ensure that benefits flow to disadvantaged communities—including low-income, minority, and tribal communities—who bear a disproportionate burden of negative health effects caused by pollution.
3. Utilities, coal companies, and national, state, and local policymakers must meaningfully engage with affected stakeholders—including coal-dependent communities, miners, coal plant workers, and minority and low-income residents living near coal plants—to ensure transition plans are in place well ahead of the anticipated closure of a coal-fired power plant. With adequate time and resources, plans can be developed that include provisions for remediation and redevelopment at the plant and at sites associated with it (such as coal ash impoundments); contingencies for lost local tax revenues; and opportunities for local economic diversification, worker training, and the creation of new, well-paying jobs.
4. Congress and the Trump administration must ensure that programs and funding are targeted toward communities facing the challenges of a closing coal plant or shuttered coal-mining operation. *Coal miners and coal-dependent*

communities need real action; attempts to roll back vital public health and environmental safeguards are not likely to change market factors driving out coal.

5. State and federal policymakers should enact new and strengthened policies to advance renewable energy, energy efficiency, energy storage, and grid modernization to help deliver affordable, reliable power and cut carbon emissions in line with climate goals. With the Clean Power Plan on hold, additional robust policies are needed to continue and accelerate clean energy momentum nationwide.

Jeremy Richardson *is a senior energy analyst in the UCS Climate & Energy Program.* ***Sam Gomberg*** *is a senior energy analyst in the program.* ***Julie McNamara*** *is an energy analyst in the program.* *We are grateful to* ***J.C. Kibbey****, Midwest outreach and policy advocate, for conducting interviews for the community snapshots.*

ENDNOTES

1 This calculation includes only the coal units identified for this analysis. See the technical appendix for details.

2 Power plants can consist of multiple generators, or units. This is a unit-level analysis because a power plant can remain open even as one or multiple units are taken offline.

3 The capacity of a given unit may change following its conversion to a different fuel, but we did not consider this possibility.

4 This figure includes wind, utility-scale solar, geothermal, and biomass but excludes conventional hydroelectric power. See the Energy Information Administration's Electricity Data Browser (EIA 2017).

5 This calculation does not account for people moving; the analysis assumes the demographics and population are static and considers only the change in operating status of coal-fired power plants.

REFERENCES

Cleetus, R., S. Clemmer, E. Davis, J. Deyette, J. Downing, and S. Frenkel. 2012. *Ripe for retirement: The case for closing America's costliest coal plants.* Cambridge, MA: Union of Concerned Scientists. Online at *www.ucsusa.org/clean_energy/smart-energy-solutions/decrease-coal/ripe-for-retirement-closing-americas-costliest-coal-plants.html*, accessed June 22, 2017.

Deyette, J. 2015. *The natural gas gamble: A risky bet on America's clean energy future.* Cambridge, MA: Union of Concerned Scientists. Online at *http://www.ucsusa.org/sites/default/files/attach/2015/03/natural-gas-gamble-full-report.pdf*, accessed June 22, 2017.

Energy Information Administration (EIA). 2017. Electricity data browser. Washington, DC. Data downloaded in July 2017 from *https://www.eia.gov/electricity/data/browser/*.

Energy Information Administration (EIA). 2016. Energy-related CO_2 emissions from natural gas surpass coal as fuel use patterns change. *Today in Energy*. Washington, DC. Blog, August 17. Online at *https://www.eia.gov/todayinenergy/detail.php?id=27552*, accessed June 22, 2017.

Fleischman, L., R. Cleetus, S. Clemmer, J. Deyette, and S. Frenkel. 2013. *Ripe for retirement: An economic analysis of the US coal fleet.* Cambridge, MA: Union of Concerned Scientists. Online at *www.ucsusa.org/clean_energy/smart-energy-solutions/decrease-coal/economic-analysis-us-coal-plants.html*, accessed June 22, 2017.

Krieger, E., A. McPhail, E. Czolowski, J. Hays, and S.B.C. Shonkoff. 2016. *The Clean Power Plan in Pennsylvania and Ohio: Analyzing power generation for health and equity.* Oakland, CA: PSE Healthy Energy. Online at *www.psehealthyenergy.org/our-work/publications/archive/our-air-health-and-equity-impacts-of-ohios-power-plants/*, accessed June 22, 2017.

Lazard. 2016. *Lazard's levelized cost of energy analysis: Version 10.0.* New York. Online at *https://www.lazard.com/media/438038/levelized-cost-of-energy-v100.pdf*, accessed June 22, 2017.

S&P Global Market Intelligence (S&P Global). 2017. SNL interactive. New York. Online at *www.snl.com* (paywall restricted), accessed June 22, 2017.

US Department of Energy (DOE). 2017. *Staff report to the secretary on electricity markets and reliability.* Washington, DC: Department of Energy. Online at *https://energy.gov/downloads/download-staff-report-secretary-electricity-markets-and-reliability*, accessed August 30, 2017.

US Environmental Protection Agency (EPA). 2015. *EJ screening report for the Clean Power Plan.* Research Triangle Park, NC: Office of Air and Radiation. Online at *archive.epa.gov/epa/cleanpowerplan/ej-screening-report-clean-power-plan.html*, accessed June 22, 2017.

Union of Concerned Scientists

FIND THIS DOCUMENT ONLINE: www.ucsusa.org/coaltransition

The Union of Concerned Scientists puts rigorous, independent science to work to solve our planet's most pressing problems. Joining with people across the country, we combine technical analysis and effective advocacy to create innovative, practical solutions for a healthy, safe, and sustainable future.

NATIONAL HEADQUARTERS
Two Brattle Square
Cambridge, MA 02138-3780
Phone: (617) 547-5552
Fax: (617) 864-9405

WASHINGTON, DC, OFFICE
1825 K St. NW, Suite 800
Washington, DC 20006-1232
Phone: (202) 223-6133
Fax: (202) 223-6162

WEST COAST OFFICE
500 12th St., Suite 340
Oakland, CA 94607-4087
Phone: (510) 843-1872
Fax: (510) 451-3785

MIDWEST OFFICE
One N. LaSalle St., Suite 1904
Chicago, IL 60602-4064
Phone: (312) 578-1750
Fax: (312) 578-1751

WEB: www.ucsusa.org

PRINTED ON RECYCLED PAPER USING VEGETABLE-BASED INKS