

The Time to Phase Out Coal is Now

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Coal is the dirtiest source of electricity that we have. It has the highest emissions of both carbon dioxide and traditional air pollutants per unit of energy produced. Considering only those emissions to the atmosphere, coal is harmful to Americans now and disastrous for our future.

Over the past decade, my research group at Duke and NASA has studied the impacts of the activities, such as coal burning, that drive climate change. We have examined multiple factors that affect our well-being including public health, labor productivity, and agriculture. The air pollution and climate change caused by burning coal can each influence these factors. Consider health as an example. The sulfur and nitrogen oxides emitted by coal-fired power stations produce fine particulate matter and surface ozone, both of which increase risk of respiratory and cardiovascular diseases when inhaled. The carbon dioxide emitted by the coal-fired power stations drives warmer temperatures that lead to increased risk of death and disability from heat exposure. Labor productivity and crops are similarly affected by both air pollution and heat exposure. Using the latest epidemiological data and our best estimates of current population exposures to air pollution and heat, we evaluate these impacts and their economic values using methods subject to rigorous testing and peer-review. We find that the total environmental damages attributable to emissions to the atmosphere add $\sim 32 \pm 13\text{¢}$ per kWh to the cost of electricity produced by coal-fired power plants.

These damages would make coal a money-loser for American citizens and businesses even if coal-fired power was free. Coal may make profits for a few companies, but the rest of our businesses are saddled with higher medical and property insurance premiums due to the air pollution and climate change caused by coal, and their workers are less productive due to inhaling air pollution and facing extreme heat. Citizens and cities across the nation face losses from climate-enhanced wildfires, hurricanes, floods, droughts, and heatwaves. Farmers take a hit from both the surface ozone and climate change caused by coal. Everyone, but especially the elderly, children, the poor, and people of color, suffers from illnesses and deaths due to the pollution and climate change caused by coal.

Moreover, this is not the 19th century when we didn't have other good alternatives. In today's electricity market, the true cost of coal-fired power is about 40¢ per kWh including environmental impacts, whereas renewables are typically just 3-4¢ per kWh (without counting current tax credits) and battery storage currently costs $\sim 12\text{¢}$ per kWh and is declining fast. Those are costs from the US Department of Energy, with environmental damages from my research

group (which are miniscule for renewables). This makes any use of coal indeed a bad deal for taxpayers.

Furthermore, the environmental damages that we've been able to evaluate are only a fraction of the total damages. Air pollution also causes pre-term births, loss of cognitive function in the elderly, decreases in IQ in children, and a host of other impacts that are difficult to quantify. Coal usage also leads to many additional environmental impacts beyond those attributable to air pollution. Mining can devastate local landscapes, and operation of each large coal plant creates more than 2 million tons of coal ash waste every year. That waste often ends up in our waters. In my state of North Carolina, Duke Energy recently had to pay \$545 million to clean up the Dan River (though as an 'accident' the Utility Commission allowed them to pass on the costs to customers). When Hurricane Florence came ashore in North Carolina in 2018, another 'accidental' coal ash spill occurred into the Cape Fear river, again causing enormous damages. Similarly, next door in Tennessee, the TVA spilled over a billion gallons of ash into Eastern Tennessee rivers, resulting in ~\$1 billion in cleanup costs. But it doesn't end there, as the cleanup workers were exposed to pollutants including sulfur, mercury, arsenic and radioactive compounds in the ash, leading to more than 30 deaths and roughly 200 sick or dying. A 2018 court verdict found the TVA negligent, which allows workers to sue for damages that are expected to add greatly to the total costs. With climate change fueled in part by the burning of coal, the flooding and severe hurricanes that cause such spills will increase in the future. All these additional damages from coal usage mean that the true cost to consumers and taxpayers is substantially higher than our evaluation of 40¢ per kWh. It is important to stress that most of the economic valuation of environmental damages due to coal burning comes from impacts that occur over the next 20 years and take place within the US. These are primarily the health impacts on Americans.

Given the true costs of coal usage, the government has a fiduciary duty to its citizens to do all it can to enhance the pace of our national shift from coal to renewables. Not only is rapidly phasing out coal usage economically sensible, it is also vital to reduce climate change globally.

Under the 2015 Paris Climate Agreement, the world agreed on a goal of keeping global warming below 1.5°C. In 2018 the UN's Intergovernmental Panel on Climate Change wrote a Special Report on Global Warming of 1.5°C in response to a request from governments for the science community to describe how nations could achieve that goal. I co-led the chapter that examined the possible pathways to reaching the 1.5°C goal, and we found that the median reduction required in energy produced from coal globally was nearly 70% by 2030 and 83% by 2050 relative to 2020. Those are the global values, but wealthy countries with older power plants, such as the US, would need to phase out their use of coal considerably faster to make up for the expected pace in poorer countries with recently constructed coal-fired power stations such as Pakistan and Indonesia. To have a high likelihood of meeting the goals of the Paris Agreement, coal usage should be almost completely eliminated in wealthier countries by 2030-2035. In the International Energy Agency's 2021 World Energy Outlook they report that to reach net zero emissions by mid-century, as required to achieve the 1.5°C target, global unabated coal use needs to decrease 55% by 2030 and stop completely by 2040. That's worth repeating: 100% gone just over 18 years from now. There may be a small number of plants that can be retrofitted with carbon capture and sequestration, but that is expensive and site-specific as to the availability of

sequestration. It is not practical for older plants such as those in the US, where the average age of coal-fired power plants is over 40 years, whereas in Asia it is just 13 years. Hence if we are to keep a small fraction of coal-fired power plants running past 2040 with carbon capture and sequestration those are most likely to be in Asia whereas ours should be largely shut off this decade.

The rapid phaseout of coal using required to meet the Paris Agreement's goal has clear implications for coal mining. To have even a 50% chance of meeting the 1.5°C target, 90% of the world's remaining coal needs to be left in the ground. Yet current plans of governments around the world have roughly 2 and a half times as much coal being extracted in 2030 as is consistent with the 1.5°C target. The US government can contribute to improving our trajectory by stopping coal leasing on federal lands. Failing to meet the 1.5°C target will lead to a world with ever more frequent and damaging climate-related disasters of the sort already afflicting our country. While the Administration is working hard to get the US on a pathway that will avoid the worst damages from climate change, coal leasing on Federal lands would undermine that progress. Working to mitigate climate change while leasing Federal lands for coal mining is like setting up a health center that gives out free cigarettes.

We can do so much better.

Analyses show that building new renewable electricity generation within 35 miles of existing coal plants, so new transmission lines are not needed, would provide cheaper power than continuing to operate 80% of the current US coal fleet, without even accounting for environmental damages. We need to get this cheaper power flowing to businesses and consumers. While some utilities are dragging their feet and hanging onto returns on past spending on coal-fired power plants that their monopoly status guarantees, others are doing what's best for their customers and already switching to renewables. The Northern Indiana Public Service Company is a good example, announcing in 2018 that building renewable energy is cheaper than keeping coal plants open. They proposed a portfolio of solar, storage and demand management to move from 65% coal generation to 15% by 2023 and none by 2028, with projected savings for their customers of \$4 billion over 30 years. That's the kind of example the rest of the country's utilities should follow.

While most of the benefits of ceasing to use coal are glaringly obvious, there are those whose livelihood depends on coal. It is crucial to plan for the impacts on affected workers and communities from phasing out coal, and to repurpose and reclaim lands affected by coal extraction and usage. We have successful examples of such economic shifts, including programs to help tobacco farmers shift to healthier crops. But it's also important to realize that the transition from coal to clean energy creates far more jobs than are lost. This is clear from past data, which show that clean energy employment has grown far more rapidly than coal jobs have been lost, and that by 2020 clean energy accounted for more than 40 percent of America's entire energy workforce. Looking forward, the International Energy Agency indicates that under current pledges for climate change mitigation, North America is expected to lose around 50,000 jobs in the coal sector while gaining around 300,000 jobs in clean energy. While it's important to keep the welfare of coal workers in mind, it's equally important to consider future clean energy jobs and the future of farmers who will lose their crops, the people who will lose their homes to

wildfires or hurricanes, those who will die from heatwaves or air pollution, and those whose coastal towns will be swallowed by the sea completely if we keep burning coal. Rather than trying to protect coal jobs that harm America as a whole, the sensible way forward would be to phase out coal as rapidly as possible while providing help to affected workers and communities.

Phasing out coal is only part of a vital decarbonization of the US economy. In our latest research, to appear shortly in the Proceedings of the National Academy of Sciences, we document how such a transition leads to enormous health, labor, agriculture, and economic benefits for the US via reduced air pollution and climate change. As I previously reported to Congress, a transition away from fossil fuels would save the lives of millions of Americans over the coming decades, dramatically reduce the number of hospital admissions for respiratory illnesses, cases of child asthma and the early onset of dementia, increase crop yields greatly and avoid hundreds of millions of hours of lost labor. Roughly one-quarter to one-third of those benefits stem from phasing out coal. Furthermore, most of the benefits come from our own actions as air pollution in the US is much more under our own control than is climate change.

It's time to respond to the climate crisis and place the welfare of all Americans over the welfare of fossil fuel corporations. The first of the fossil 'dinosaurs' to go should be coal, and the US should be doing everything possible to hasten that demise while helping affected workers and communities. Given our current understanding of the damages caused by coal usage, it would be immoral and irresponsible to do anything else.

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