

Study examines costs of closing nuclear plants in Germany

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Many countries have phased out production of nuclear energy because of concerns related to nuclear waste and the risk of nuclear accidents. A new study explored the impact of the shutdown of roughly half of the nuclear power plants in Germany after the 2011 Fukushima accident in Japan. The study found that the resulting reductions in nuclear power were replaced primarily by production from coal-fired sources and reductions in net electricity exports. The authors show that the switch to fossil fuel-fired power resulted in considerable increases in pollution at an estimated annual social cost of about \$12 billion.

The study was conducted by researchers at Carnegie Mellon University; the University of California, Berkeley; the University of California, Santa Barbara, and the National Bureau of Economic Research (NBER). It was published as an NBER working paper.

"Although numerous reports have recommended that nuclear [power](#) be part of the global solution to climate change because it produces minimal carbon emissions, many countries have slashed

their share of energy production from nuclear sources, primarily due to safety concerns," explains Akshaya Jha, assistant professor of economics and public policy at Carnegie Mellon University's Heinz College, who contributed to the study. "One might conclude from this that the expected [costs](#) of nuclear power exceed its benefits. But few studies have quantified the full range of economic and environmental impacts of phasing out nuclear production."

In their study, researchers sought to document the short- to medium-term impact of the phase-out of nuclear power in Germany on multiple market and environmental outcomes. In particular, the study focused on the shutdown of 10 of the 17 nuclear reactors in Germany between 2011 and 2017, following the Fukushima accident. Germany plans to shut down all of its remaining nuclear reactors by 2022. Researchers examined hourly data on power plant operations, including [electricity demand](#), local weather conditions, and energy and fuel prices. They also developed a machine learning framework that predicted the quantity of electricity produced by each power plant in Germany under two scenarios—one with the nuclear phase-out and one without it.

The study found that nuclear energy production due to the phase-out of the nuclear plants was replaced primarily by coal-fired production and by imports of electricity from surrounding countries. The move from nuclear power to fossil fuel-fired power resulted in substantial increases in emissions of global and local air pollution. In addition, electricity prices rose due to the phaseout of nuclear plants, so electricity producers benefitted but German consumers had to pay more, the study found.

Researchers estimated the social cost of the phase-out in the initial years at approximately \$12 billion per year, with more than 70 percent of the cost coming from the increased risk of mortality (an estimated 1,100 excess deaths annually)

associated with exposure to air pollution emitted by burning [fossil fuels](#).

Closing nuclear plants had benefits: reducing the risk of nuclear accidents and decreasing the costs associated with storing [nuclear waste](#). But even the largest estimates of the benefits of the nuclear phaseout were likely far smaller than \$12 billion a year.

"It's clear that German citizens care deeply about climate change yet are distinctly anti-nuclear," says Stephen Jarvis, a Ph.D. candidate at the University of California, Berkeley, the study's lead author. "Concerns about air pollution have tended to receive less attention in this debate, perhaps because the risks associated with [nuclear power](#) are much more prominent than the costs of air pollution associated with fossil-fuel-fired production."

Among the limitations of the study noted by the authors are that plant-level data on electricity production were unavailable prior to 2015, and economic factors that changed during the course of the study may have affected findings in ways independent of those studied.

"Policymakers around the world face a difficult tradeoff," says Olivier Deschenes, professor of economics at the University of California, Santa Barbara, who also contributed to the study. "As countries shift away from nuclear production, despite the substantial increases in operating costs and air pollution costs that could be associated with this policy, it is essential for policymakers and academics to convey the relative costs of [climate change](#) and air pollution versus nuclear accident risk and waste disposal to the voting public."

More information: Stephen Jarvis et al, The Private and External Costs of Germany's Nuclear Phase-Out, (2019). [DOI: 10.3386/w26598](https://doi.org/10.3386/w26598)

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