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Nuclear Energy's Bottom Line

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Ideas

The United States used to build nuclear-power plants affordably. To meet our climate goals, we'll need to learn how to do it again.

By Rogé Karma

Illustration by The Atlantic

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Nuclear energy occupies a strange place in the American psyche—representing at once a dream of endless emissions-free power and a nightmare of catastrophic meltdowns and radioactive waste. The more prosaic downside is that new plants are extremely expensive: America's most recent attempt to build a nuclear facility, in Georgia, was supposed to be completed in four years for $14 billion. Instead it took more than 10 years and had a final price tag of $35 billion—about 10 times the cost of a natural-gas plant with the same energy output.

But the United States might not have the luxury of treating nuclear energy as a lost cause: The Department of Energy estimates that the country must triple its nuclear-power output by 2050 to be on track for its climate targets. For all the recent progress in wind and solar energy, renewables on their own almost certainly won't be enough. Arguably, then, we have no choice but to figure out how to build nuclear plants affordably again.

Half a century ago, nuclear energy seemed destined to become the power source of the future. The first commercial-reactor designs were approved in the 1950s, and by the late '60s, America was pumping them out at a fraction of what they cost today. In 1970, the Atomic Energy Commission predicted that more than 1,000 reactors would be operating in the United States by the year 2000.

In the popular history of atomic energy in America, the turning point was the infamous meltdown at the Three Mile Island plant in 1979. In the aftermath of the accident, environmentalists pressured regulators to impose additional safety requirements on new and existing plants. Nuclear-energy advocates argue that these regulations were mostly unnecessary. All they did, in this telling, was make plants so expensive and slow to build that utility companies turned back to coal and gas. Activists and regulators had overreacted and killed America's best shot at carbon-free energy.

This story contains some kernels of truth. The safety risk of nuclear energy is often wildly overblown. No one died at Three Mile Island, and later studies found that it didn't have any adverse health effects on the local community. Even including the deadly meltdowns at Chernobyl and Fukushima, nuclear power has most likely caused only a few hundred deaths, putting its safety record on par with wind turbines and solar panels, which occasionally catch fire or cause workers to fall. (The immediate areas around the sites of the Chernobyl and Fukushima disasters have, however, been rendered uninhabitable for decades because of the potential dangers of radiation.) Nuclear waste can be harmful if mishandled, but isn't difficult to store safely. Air pollution from fossil fuels, meanwhile, is estimated to kill anywhere from 5 million to 9 million people every year.

The claim that excessive regulation single-handedly ruined the American nuclear industry, however, doesn't hold up. The cost of building new nuclear plants was already rising before Three Mile Island. Several nuclear-energy experts told me that a major driver of those cost increases was actually a *lack* of industry standards. According to Jessica Lovering, the executive director of Good Energy Collective and a co-author of a widely cited study on the cost of nuclear energy, throughout the '60s and '70s, utilities kept trying to build bigger, more ambitious reactors for every new project instead of just sticking with a single model. (Lovering used to be the head of nuclear policy at the Breakthrough Institute—a think tank that tends to warn against excessive regulation.) "It's like if Boeing went through all the trouble to build one 737, then immediately threw out the design and started again from scratch," she told me. "That's a recipe for high costs." The 94 nuclear reactors operating in

the United States today are based on more than 50 different designs. In countries such as France and South Korea, by contrast, public utilities coalesced around a handful of reactor types and subsequently saw costs remain steady or fall.

Lovering also noted that the overregulation story leaves out a crucial fact: Because of a slowing economy, electricity demand flatlined in the early 1980s, causing American utilities to stop building basically *every* electricity-generating resource, not just nuclear plants. By the time the U.S. finally did try to build them again, in 2013, the American nuclear industry had all but withered away. "In the 1970s, we had a whole ecosystem of unionized workers and contractors and developers and utilities who knew how to build this stuff," Josh Freed, who leads the climate and energy program at Third Way, a center-left think tank, told me. "But when we stopped building, that ecosystem died off." This became obvious during the disastrous Vogtle project, in Georgia—the one that ended up costing $35 billion. Expensive changes had to be made to the reactor design midway through construction. Parts arrived late. Workers made all kinds of rookie mistakes. In one case, an incorrect rebar installation triggered a seven-and-a-half-month regulatory delay. Experts estimate that by the time it was finished, the project was four to six times more expensive per unit of energy produced than plants built in the early '70s.

Given the impracticality of nuclear energy, some environmentalists argue that we should focus on wind and solar. These technologies can't power the entire grid today, because the sun doesn't always shine and the wind doesn't always blow. With enough advances in battery-storage technology, however, they could in theory provide 24/7 power at a far lower price than building nuclear plants. "The nuclear industry has been promising cheap, clean energy for decades at this point," David Schlissel, a director at the Institute for Energy Economics and Financial Analysis, told me. "Why waste our money on false hopes when we could be putting it towards technologies that have a real chance of working?"

He may be right about the technology. But just because it might one day be *technically* feasible to power the entire grid with renewables doesn't mean it will ever be *politically* feasible. That's because wind and solar require land—a lot of land. According to Princeton University's "Net-Zero America" study, reaching net-zero emissions with renewables alone would involve placing solar panels on land equivalent to the area of Virginia and setting up wind farms spanning an area equivalent to Arkansas, Iowa, Kansas, Missouri, Nebraska, and Oklahoma combined. The more land you need, the more you run into the meat grinder of American NIMBYism. Efforts to build renewables are already getting bogged down by local opposition, costly lawsuits, and permitting delays. These challenges will only intensify as the easiest sites come off the board.

Transmission lines, which are needed to transport renewable energy from where it's generated to where it's used, may present an even bigger challenge. Some lines have taken nearly two decades just to receive their full suite of approvals. "There's a chance we will

suddenly get our act together and overcome the many, many constraints to deploying renewables," Jesse Jenkins, who leads the Princeton Zero-Carbon Energy Systems Research and Optimization Lab, told me. "But I'm certainly not willing to bet the fate of the planet on that happening."

The case for nuclear, then, is less about technological possibilities than it is about political realities. Nuclear can generate the same amount of power while using 1/30th as much land as solar and about 1/200th as much as wind. Reactors can be built anywhere, not just in areas with lots of natural wind and sunshine, eliminating the need for huge transmission lines and making it easier to select sites without as much local opposition. And nuclear plants happen to generate the greatest number of high-paying jobs of any energy source, by far. (On average, they employ six times as many workers as an equivalent wind or solar project does and pay those workers 50 percent more.) That helps explain why four different towns in Wyoming recently fought over the right to host a nuclear project. Nuclear power is also the only energy source with overwhelming bipartisan support in Washington, which makes Congress more likely to address future bottlenecks and hurdles as they arise.

As for how to make the economics work, there are two schools of thought. One holds that if America forgot how to build nuclear because we stopped doing it, we just need to start back up. Pick a design, build lots of plants, and we'll eventually get better. Other countries have done this with great success; South Korea, for instance, slashed the cost of constructing nuclear plants in half from 1971 to 2008. Here, the Vogtle project carries a silver lining: The second of the plant's two reactors was about 30 percent cheaper to build than the first, because workers and project managers learned from their mistakes the first time around. "I consider Vogtle a success," Mike Goff, acting assistant secretary for the Department of Energy's Office of Nuclear Energy, told me. "We learned all kinds of hard lessons. Now we just need to apply them to future projects."

The second school of thought is that we've been building nuclear reactors the wrong way all along. This camp points out that over the past half century, basically every kind of major infrastructure project—highways, skyscrapers, subways—has gotten more expensive, whereas manufactured goods—TVs, solar panels, electric-vehicle batteries—have gotten cheaper. Lowering costs turns out to be much easier when a product is mass-produced on an assembly line than when it has to be built from scratch in the real world every single time. That's why dozens of companies are now racing to build nuclear reactors that are, in a phrase I heard from multiple sources, "more like airplanes and less like airports." Some are simply smaller versions of the reactors the U.S. used to build; others involve brand-new designs that are less likely to melt down and therefore don't require nearly as much big, expensive equipment to operate safely. What unites them is a belief that the secret to making nuclear cheap is making it smaller, less complicated, and easier to mass-produce.

Both paths remain unproven—so the Biden administration is placing bets on each of them. The president's signature climate bill, the Inflation Reduction Act, included generous tax credits that could reduce the cost of a nuclear project by 30 to 50 percent, and the Bipartisan Infrastructure Law included $2.5 billion to fund the construction of two new reactors using original designs. The Department of Energy, meanwhile, is exploring different options for permanent nuclear-waste storage, investing in building a domestic supply chain for uranium, and helping companies navigate the process of getting reactor designs approved.

There's no guarantee that the U.S. will ever relearn the art of building nuclear energy efficiently. Betting on the future of atomic power requires a leap of faith. But America may have to take that leap, because the alternative is so much worse. "We just have to be successful," Mike Goff told me. "Failure is not an option."