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Issue Brief

Back from the Dead: Prospects for Restoring Closed Nuclear Plants to Operation

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Introduction

On April 30, 2021, the Indian Point Energy Center shut down Unit 3, its last operating reactor. Unit 2, the plant's other functional reactor, had gone silent a year earlier. In all, the premature closure of the Buchanan, New York, nuclear plant removed a massive 2,069 megawatts (MW) from the power grid, roughly 25% of the New York City region's power supply. Former governor Andrew Cuomo—along with the environmental group Riverkeeper and other activists who backed the closure—promised that Indian Point's electricity would be easily replaced by the state's growing wind and solar capacity, along with imported hydropower and improved efficiency.[1] Those assurances proved hollow. As many analysts predicted, Indian Point's electricity was replaced mostly by power coming from natural gas-fired power plants.[2]

New York State has what *Vox* has called "the country's most ambitious climate targets, including 100% carbon-free electricity by 2040."[3] Nonetheless, construction of renewable energy infrastructure in the state is far behind schedule. So, not surprisingly, Indian Point's precipitous closure put enormous pressure on the region's energy supply. By early 2022, 89% of downstate electricity was being produced by fossil fuels, and electricity rates were skyrocketing.[4] New York's Independent System Operator has warned that the power grid's "reliability margins will shrink in upcoming years."[5] In other words, the region is becoming more susceptible to blackouts. The Indian Point closure also produced a huge increase in electricity-related greenhouse gas emissions, of 15%–30%, depending on how they are measured.[6]

Indian Point is just one in a series of nuclear plants that have been retired long before the end of their potential life spans. Over roughly the past four years, the U.S. has shuttered five other reactors: New Jersey's Oyster Creek plant in 2018; the Pilgrim power plant in Massachusetts in 2019; Pennsylvania's Three Mile Island Unit 1 (which was not damaged in the famous 1979 accident involving another reactor at the site), also in 2019; Iowa's Duane Arnold Energy Center

in 2020; and, most recently, Michigan's Palisades plant, which closed in May 2022, despite last-ditch efforts by Governor Gretchen Whitmer to keep it open. Additional plant retirements are possible. In 2018, the Union of Concerned Scientists estimated that as many as one-third of U.S. nuclear plants were facing premature closure.[7] State subsidies and friendlier market conditions have kept most of those facilities in operation, but the number of plants still at risk remains unknown. Just over the Canadian border, Ontario officials are debating plans to shutter that province's enormous Pickering Nuclear Generating Station. Doing so would remove 3,100 MW from the shared North American power grid.[8] In Europe, policymakers have been prematurely shutting down nuclear power plants for more than a decade, based on an unrealistic gamble that wind and solar power would soon replace those sources. For decades, many progressives and environmentalists have fought against nuclear power and cheered plant closures. But in recent months, nuclear power has had a surprising reversal of fortune. Energy supplies were tight even before Russia's invasion of Ukraine, and now much of the world faces crippling energy shortages. In the U.S., surging natural gas prices have, in turn, driven up electricity rates and home heating costs. Meanwhile, the rollout of wind and solar power is lagging behind the pace demanded by renewable advocates.[9]

Facing these challenges—as well as growing climate concerns—many longtime nuclear opponents are now willing to tolerate, or even embrace, the still-controversial power source. Some government officials are searching for ways to extend the operating lives of plants scheduled for closure. In a stunning about-face, California Governor Gavin Newsom recently signed a bill authorizing the use of state funds to prevent the retirement of Diablo Canyon, the state's only nuclear plant still in operation.[10] Ontario recently announced a move to delay closure of the Pickering plant for one year while the province studies the possibility of refurbishing the facility to keep it running.[11] At the same time, today's high energy prices make nuclear power more financially competitive, increasing the incentives for plant owners to keep facilities running.

The renewed case for nuclear power has grown so compelling that some experts and policymakers are advocating patching up recently shuttered plants and returning them to service. In early 2022, three nuclear and environmental experts proposed restoring Indian Point to operational status.[12] In Michigan, Governor Whitmer is supporting the Palisades' new owner in seeking a federal grant that might allow the plant to go back into operation.[13] Japan has fast-tracked a plan to reopen many of the nuclear plants that it mothballed after the 2011 Fukushima Daiichi meltdowns.[14]

Reopening a closed nuclear power plant, however, comes with a host of technical, economic, and political challenges. This brief will explore those challenges and propose better policies to help nuclear power producers reopen closed plants when warranted.

While recent political and economic changes have slowed the rush to retire nuclear plants, we can't assume that all potential shutdowns will be avoided. Indian Point and Palisades are unlikely to be the last nuclear plants to be dearly missed soon after being unwisely retired. The U.S. needs a policy to address the loss of these vital energy assets.

Barriers to Reopening Nuclear Plants

There are four main hurdles to reopening a closed nuclear power facility: technical obstacles; regulatory processes; business climate; and political climate.

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No plan to bring a power plant back into service can succeed unless all four of these obstacles are overcome. This is a daunting prospect, to say the least. Although this issue brief will focus on nuclear power in the U.S., similar constraints to reopening shuttered plants exist in every democratic country with nuclear power.

Technical Obstacles

A nuclear power plant is a bit like a ship or an aircraft: it needs to keep operating to stay functional. "Any interruption of maintenance quickly degrades materials, structures, and components around the plant," explains Jacopo Buongiorno, professor of nuclear science and engineering at MIT.[15] Simply shutting down the plant starts the clock ticking. And, just as mariners and pilots require regular practice to stay proficient, Buongiorno notes, a nuclear plant shutdown "interrupts training for operators, technicians, and engineers, which reduces the number of qualified staff available."

Indian Point today provides a vivid look at the decommissioning process in a relatively early stage. Site manager Rich Burroni arranged a midsummer tour for the Manhattan Institute. Burroni came to work at Indian Point in 1980, "right out of college," he says, and he has spent almost his whole career there. When Holtec International—a company pioneering innovative approaches to nuclear decommissioning—prepared to take ownership of the plant in 2021, Burroni began working for Holtec, as did about a quarter of the plant's roughly 1,000 workers. The rest were let go. Prior to the handover, the plant's former owner, Entergy, removed the fuel from both reactors and surrendered its operating license. The biggest risks in producing nuclear power involve loss of coolant to the reactor, which could lead to a meltdown of the fuel rods. Removing the fuel from the reactor eliminates those risks and allows the decommissioning team to work under the less stringent rules of the Nuclear Regulatory Commission (NRC) governing nonoperating plants.

At first glance, Indian Point looks much as it has for years. The two main concrete containment domes still loom over the Hudson River. The parking lot is full of pickup trucks. But there have been dramatic changes. Each containment dome now features a 35-by-35-foot hatch—large enough to fit a semitruck. For anyone hoping that Indian Point might return to operation, the sight of these enormous voids in the containment domes drives home the finality of the plant's closure.

Holtec is decommissioning Units 2 and 3 under an NRC protocol known as DECON, which permits rapid progress. As Burroni explains, there are advantages to getting the initial work done promptly. "The critical path is to capture all the radionuclides and contain them," he says. That means moving spent fuel rods from the cooling pools to dry-cask storage and dismantling the reactors themselves. The equipment hatches in the containment buildings allow much easier access to the reactors and other components, which speeds up this work. All highly contaminated materials will be packed in dry casks and stored on site. "Once we've done that, the site becomes more of a construction project," Burroni says. At that point, work can proceed with fewer restrictions and, hence, lower costs.

The containment structures are more than just concrete buildings. In the 1970s, engineer Herschel Specter managed the licensing process for Indian Point's Unit 3 as an official with the Atomic Energy Commission (a forerunner of NRC). Today, he is a nuclear energy advocate. "The containment buildings are some of the strongest, most robust structures in the nation," Specter explains. The domes were built with "rebar as thick as your arm," woven together like an upside-down basket, and then lined with steel and immersed in concrete. "Once you start cutting into

the structure, you destroy that integrity," Specter says. "If you don't have containment integrity, you don't have a usable plant."[16] (In rare cases, containment buildings have been repaired after being cut open for maintenance work, but the process is fraught with difficulties.)

Inside the domes, the disassembly work is moving rapidly. "We've already cut and gapped the reactor cooling system loops, and we've cut up our steam generators," Burroni says. "It would take years to recover what we've done so far," he concludes. When all the surrounding equipment has been cleared away, workers will begin sawing through, or "segmenting," the reactor itself. After all the hazardous components are removed and safely stored, workers will be able to move around more freely.

Holtec hopes to have all the spent fuel and reactor components stored in dry casks by mid-2024. The casks, about 20 feet high and 10 feet wide, stand on a thick, reinforced concrete pad in a well-secured zone called an Independent Spent Fuel Storage Installation (ISFSI). Indian Point currently has 58 dry-cask units sitting on its original ISFSI pad, and Holtec recently finished building a second pad to hold more casks. By the end, Indian Point's ISFSI pads will hold 125 casks; no one knows how long they will remain there.

The casks, which are welded shut and wrapped in more than two feet of steel and concrete, are designed to last more than 100 years. "Still," Burroni says, "you are looking at an interim solution rather than the final option." Despite the Nuclear Waste Policy Act in 1982, the U.S. never completed a permanent national repository for high-level waste. As a result, Indian Point remains a de-facto waste storage location, as do more than 70 other U.S. nuclear facilities. Most nuclear experts say that such on-site storage is safe and will be adequate for decades to come. Nuclear plants are already protected with heavily armed security and multiple layers of fencing. And there has never been a dangerous release of radiation from a dry-cask unit. But the presence of dry casks at Indian Point means that the facility is likely to remain under Holtec's control—and tight security—for the foreseeable future.

For Indian Point, and most other prematurely closed nuclear plants, the technical obstacles to reopening appear insurmountable at this point. But reopening is technically feasible for the Palisades plant in Michigan. According to Patrick O'Brien, senior manager for government affairs and communications at Holtec, which also took control of the Michigan plant: "The Palisades timeline is different [from that of] our other facilities, and there is some time before we begin work that would make a restart impossible."[17] Still, the road to reopening Palisades is anything but smooth. As Holtec noted in a statement: "Challenges that would need to be resolved include financial commitment from the State of Michigan, maintenance and delayed capital improvements of the facility, procuring a power purchase agreement, upgrading the switchyard, … staffing an additional 400 or so qualified and trained staff, and finally a successful DOE application." Moreover, since Holtec is not in the business of operating legacy nuclear plants, the company would need to find "a yet to be identified third-party operator to see if this is a viable option." As O'Brien puts it, "a lot of parts would have to come together."

Nonetheless, of all the U.S. reactors undergoing decommissioning today, the Palisades plant is the leading candidate—indeed, probably the only candidate—that might conceivably be brought back into service.[18]

Regulatory Processes

Nuclear power is among the most tightly regulated industries in the United States. NRC closely supervises the development of new reactor designs, construction and decades of operation, and the complex decommissioning process. Unfortunately, NRC has not yet established any specific process for reopening a closed nuclear plant.

When a reactor is powered down for the final time, the reactor is "defueled" and the fuel rods are transferred to a storage pool. At that point, the owner surrenders the operating license and retains what NRC calls a "possession-only license." For a plant operator, that transition entails crossing a regulatory Rubicon. It is a step that no power company has yet tried to reverse.

"Retirement of the NRC operating license makes it illegal to operate the plant," explains Buongiorno.[19] In theory, a plant owner could ask NRC to have its operating license reinstated, but there is no established protocol for doing so. According to NRC public affairs officer Scott Burnell: "The agency does not have a specific example of taking a formerly operating reactor and bringing it back to operating status. That's a question that has not come before the commission."[20] In 2019, a private citizen (anticipating the Indian Point closure) petitioned NRC to develop rulemaking on how such a retired plant might be brought back into service. NRC denied the petition, noting that "the nuclear industry has not expressed a strong interest in returning retired plants to operational status and proceeding with rulemaking to develop a new regulatory framework that may not be used is not a prudent use of resources."[21]

NRC may have to address this topic soon, given the ongoing efforts to restore the Palisades plant to operation. In a mid-September e-mail exchange, Burnell noted that the agency had not yet received any documents related to reopening the Michigan plant: "The concept of attempting to change the license status of a permanently defueled reactor has yet to be explored. If any formal requests for licensing action on Palisades are filed, the agency will respond accordingly, based on whatever facts and rationale are provided, to ensure the highest standards of safety." In other words, if Holtec and a third-party operator do attempt to have the plant's operating license restored, they will be exploring virgin regulatory terrain.

The lack of NRC guidance on how an operator might pursue license reinstatement is itself a major hurdle to any company contemplating such a move. Complying with NRC requirements—even when they are clearly spelled out—is expensive and time-consuming. Venturing into an open-ended regulatory review without a road map could be financially perilous. "The process would get more difficult with each step in decommissioning," explains Adam Stein, director of nuclear energy innovation at the Breakthrough Institute in Berkeley, California. If possible at all, he says, "it would likely take years of work and cost billions of dollars."[22]

Decommissioning a plant, by contrast, is not only straightforward but can be a financially attractive option for owners of aging nuclear facilities. According to NRC, the costs of decommissioning a nuclear power plant range from $280 million to $612 million.[23] To ensure that those funds are available when needed, nuclear plant licensees are required to set aside money for decommissioning throughout the life of the plant. These funds typically accumulate in a trust fund that an owner can draw down during the decommissioning process. A 2021 study by the San Francisco consulting company Callan estimated that "nuclear decommissioning trust (NDT) fund balances totaled nearly $86 billion in 2020."[24]

Business Climate

Reviving a closed nuclear plant would also require a potential owner who sees a business opportunity promising enough to justify the enormous expense and uncertainty. Even with today's rising energy prices, that prospect remains hypothetical. Adam Stein believes that the nuclear industry's woes were exaggerated even before the recent uptick in electricity prices. "Nuclear plants operate with very high reliability," he says, producing power "well below the average electricity price in the U.S." Nonetheless, the industry's outlook remains unclear, partly because "some U.S. policies have led to less than ideal outcomes."[25]

For example, nuclear plants face extraordinarily high costs for regulatory compliance, compared with other power sources. According to a 2017 study by the American Action Forum, the average nuclear plant has an annual regulatory burden of $60 million.[26] In addition, government energy subsidies have long discriminated against nuclear power (although recent reforms are addressing this disparity). Solar and wind power have received tens of billions in federal Investment Tax Credits and Production Tax Credits over the years. The Congressional Research Service calculated that, in absolute terms, federal tax credits for wind and solar power totaled $9.8 billion in 2018, while nuclear power received $100 million.[27]

A bigger disparity emerges when federal subsidies are measured against the quantity of power produced by different energy sources. Energy analyst Robert Bryce calculated that—prior to the major revisions passed under President Biden—the U.S. federal tax incentives supporting solar power were 253 times greater than those going to nuclear energy on a per-megawatt-hour basis. Subsidies directed to the wind sector were 158 times larger than the incentives for nuclear.[28]

On the state level, in addition to significant tax breaks for wind and solar, more than half the states enforce "renewable portfolio standards," which require utilities to buy a certain share of their electricity from renewable sources. But in most cases, nuclear power does not count toward these requirements. Fortunately, more states are shifting to "clean energy standard" or "zero-emission credit" programs that reward nuclear plants as sources of zero-carbon power.[29]

Large subsidies for renewables have gone hand in hand with low natural gas prices to put some nuclear plants in an economic squeeze. From the start of the fracking boom in 2008 to 2019, natural gas prices fell some 70%.[30] That made natural gas one of the cheapest and most flexible ways to produce electricity. Nuclear plants face particular financial pressure in markets where payments to producers are determined by regional transmission organizations on an hourly (or shorter) basis, based on pricing offers by energy producers and expected demand. In these markets, surges of power from wind and solar producers can drive short-term prices below zero at times. Many of the nuclear plants that have closed are in these markets. The other model for compensating producers is a "cost-of-service" model where a rate is set for the value of electricity based on regulator-approved costs, operating expenses, and a reasonable investment return.[31] (Ratepayer advocates complain that such noncompetitive arrangements are unfair to consumers.)

Furthermore, the expanding use of wind and solar energy is paradoxically leading to greater reliance on natural gas to produce electricity. Wind and solar facilities are notoriously variable in their power output. The best way to integrate these intermittent sources into the grid is to pair them with a power source that can rapidly adjust its output to compensate for shifts in output from other producers, a process known as "load following." Modern natural gas power plants are tailor-made for load following and can be profitable even if they sit idle for long periods. In contrast, today's nuclear plants are optimized to provide ample "baseload" power—ideally, for months on end—with little variation in output. In fact, since most of nuclear power's expenses

are related to labor and infrastructure—rather than fuel—these plants can lose money when forced to operate at reduced capacity.[32] That combination of cheap natural gas and intermittent renewable energy has driven some nuclear plants out of business.

Meanwhile, more natural gas plants are coming online. Downstate New York power producers built two new gas plants prior to the Indian Point shutdown: the 1,100-MW Cricket Valley Energy Center in Dover, New York; and the 680-MW CPV Valley Energy Center in Wawayanda, New York. Nationwide, the use of natural gas for electricity generation has more than doubled since 2000.[33]

The recent rise in natural gas prices has dramatically improved the economics of nuclear power. But do these prices represent a temporary blip or a long-term trend? If nuclear plant owners fear that gas prices might eventually return to their previous lows, it will be harder for them to see a case for keeping marginal plants running, much less reopening closed facilities.

Political Climate

When nuclear power producers announce plant closures, they tend to emphasize economic conditions. For example, when Entergy announced plans to shutter Indian Point, it cited "low current and projected wholesale energy prices."[34] Nonetheless, political factors undoubtedly play a role in how energy companies assess whether to keep a plant operating—never mind whether a given closed plant might reopen. In many, if not most, recent cases of nuclear shutdowns, plant owners faced local opposition, environmental lawsuits, and antagonism from public officials.

The 2014 closure of the Vermont Yankee plant followed years of pressure from that state's powerful U.S. senator, Bernie Sanders. In California, a succession of Democratic leaders helped precipitate the early retirement of the San Onofre Nuclear Generating Station in 2013, and they nearly succeeded in forcing Pacific Gas & Electric (PG&E) to close its remaining plant, Diablo Canyon, which generates 8.6% of the state's electricity, by 2024. In New York, former governor Andrew Cuomo joined the state's attorney general and the environmental group Riverkeeper to block Entergy's efforts to extend Indian Point's operating license. Faced with a long, expensive court battle—and no promise of success—Entergy chose to close and sell off the plant. "With New York's high electric rates, Indian Point should have been a cash cow," engineer Specter says. He believes that it was political, and not just economic, headwinds that doomed the plant, asserting that Entergy "got beat up plenty by the New York politicians."

Today, those political headwinds have moderated and even reversed direction in some cases. A 2022 Pew Research poll (taken before the recent spike in energy prices) found mixed but modestly growing support for nuclear power.[35] A growing number of Democratic politicians are coming out in favor of the energy source. As noted, California Governor Newsom recently signed a bill that provides PG&E a forgivable $1.4 billion loan to help keep Diablo Canyon open until 2031.[36] The Biden administration has continued and expanded Trump administration policies supporting nuclear energy. The Inflation Reduction Act could provide up to $30 billion in tax credits for nuclear plants over the next 10 years,[37] and the $1 trillion Bipartisan Infrastructure Law, passed in November 2021, includes a $6 billion Civil Nuclear Credit (CNC) fund to bail out troubled nuclear plants.

The CNC program, while intended to aid currently operating plants, could conceivably help at least one recently shuttered plant return to service. When Michigan's Palisades plant closed in May, Governor Whitmer's office quickly announced that it would continue to search for "potential buyers, operators, and stakeholders to keep this vital energy source and the 600

good-paying jobs right here." The governor's office has been in talks with the Department of Energy about the program, and in September, Holtec announced that it had applied to the CNC program seeking funds to restore the plant to operation. The company says it hopes to make a final decision on the future of Palisades by January 2023. "We look forward to continuing to work with the administration as well as our federal, state, and community partners to make this hope a reality," Holtec president and CEO Kris Singh said in a statement.[38]

The Next Generation

Over the long run, increased U.S. Department of Energy (DOE) funding and private support for advanced reactor research could have the biggest impact on the future of the industry. Leapfrogging to the next generation of nuclear technology—rather than patching up retired legacy reactors—might prove to be the best way to help decommissioned nuclear facilities get back into the business of clean electricity.

Over the past decade, there has been an enormous upswing in public and private investment in developing new, smaller types of nuclear reactors. Whether prematurely or not, private investors and public policymakers have concluded that the traditional model of building large (approximately 1,000-MW) reactors is no longer financially viable. A number of startups—along with established companies, including GE-Hitachi (GEH) and Holtec—are designing small reactors that would be built in factories and delivered to power stations mostly complete.[39] These include Small Modular Reactors (SMRs) that are basically scaled-down versions of today's large light-water reactors, as well as advanced reactors that typically use exotic methods such as molten salt or high-temperature gas, instead of water, for cooling. These small reactors range in output from megawatts in the single digits to 300 MW. Multiple small reactors can be grouped together on a single site to reach the power output of a large plant.

Advocates for next-generation reactors have their eyes on existing or recently closed nuclear plant sites as ideal locations to install these new designs. (Retired coal-fired plants are also under consideration.) A recent Breakthrough Institute report on the future of nuclear power concludes: "Existing and retiring nuclear power plants make appealing locations for advanced reactor projects as they already meet regulatory criteria ranging from seismic stability to the siting of emergency planning zones."[40] Building small reactors at retired nuclear plants also makes engineering sense, explains Joe Delmar, who handles government affairs and communications for Holtec's SMR division. "You have the existing infrastructure, the power lines and substations," he notes. The approach also eases that ever-present challenge for nuclear power: community opposition. "You are likely to have a lot more local support in communities where nuclear plants have closed," Delmar says.[41]

Several SMR installations at former nuclear sites are in the planning stages. Holtec hopes to install its first SMR at New Jersey's Oyster Creek nuclear plant, which the company is currently decommissioning.[42] The company has also mentioned the closed Palisades plant as a "viable" location for its SMR, whether or not the existing reactor is ever brought back into service.[43] The Tennessee Valley Authority and GEH have announced a deal to install a 300-MW SMR on the grounds of the long-defunct Clinch River Breeder Reactor in Tennessee.[44] The GEH model has also been selected by the Ontario Power Generation company, which says that it hopes to have the SMR in operation at its Darlington nuclear site as early as 2028.[45] And DOE is helping fund X-energy's plan to install an array of four of its 80-MW gas-cooled reactors on the grounds of the operating Columbia nuclear plant in Richland, Washington.[46]

Advocates for siting small reactors at existing nuclear facilities say that the importance of existing transmission lines cannot be overestimated. NIMBY opposition to new power lines has been a persistent roadblock to developing wind and solar power. Many retired nuclear plants retain robust grid connections capable of moving ample power to population centers. Specter notes that transmission lines capable of handling more than 2,000 MW currently sit idle at Indian Point. Given looming shortfalls in downstate transmission capabilities, he says, "it would be a wonderful thing if those lines could be put back into use."[47]

Unfortunately, Indian Point is not on the list of nuclear facilities likely to host new SMRs anytime soon. The complex decommissioning agreement reached with New York State and other parties includes a requirement that Holtec will not "propose a new reactor at Indian Point unless the State and all local municipalities agree."[48] In Delmar's words, "Indian Point is off the table," because "Riverkeeper demanded that the site not be repurposed for SMRs."[49]

At a time when Democratic governors are scrambling to save nuclear plants in California and Michigan, is there any chance that New York's leaders might pivot to supporting nuclear power as a solution to downstate electricity woes? Not under the current administration, apparently. A query to New York governor Kathy Hochul's office was answered by James Denn, an information officer with the state's Public Service Commission who also serves as spokesman for the Indian Point Closure Task Force and the Decommissioning Oversight Board. "There is no energy shortage downstate," Denn responded in an e-mail. The increase in emissions from gas-fired power plants "is anticipated to be relatively short-term in nature" as more wind and solar power comes online, he added. As for repurposing the site, there's no rush. Once decommissioning and site restoration are completed "in the mid-2030s," Denn wrote, "we anticipate the host communities will welcome discussions on the future uses of the property. Until such time, our focus remains on ensuring the safe and timely completion of decommissioning."[50]

Nonetheless, some Holtec employees remain hopeful that Indian Point's nuclear ban might someday be lifted. Even if nuclear power never returns to this location, they'd like to see SMRs roll out at other sites. "I've been here since 1980, so I love nuclear technology," Indian Point site manager Burroni says. He sees the safe decommissioning of the plant as part of the industry's mission to prove that nuclear power has a future. "We've proven we can build them, and we've proven we can run them safely," he says. "So, if we can prove we can decommission them in a timely fashion, that should be the formula we can use to promote SMRs in this country."

Lessons

Installing new compact nuclear reactors on the grounds of retired legacy plants has the support of industry, many utilities, and DOE. But it might take a decade or longer for the first wave of demonstration SMRs to begin producing enough electricity to replace the power that is lost when a single full-size plant like Indian Point shuts down. The best policy would be to continue SMR development but also strive to prevent premature retirements of legacy nuclear plants.

Fortunately, current federal policy supports these two priorities. As noted above, the Biden administration's $6 billion Civil Nuclear Credit program could help one or more at-risk plants (possibly including Michigan's Palisades). A much broader benefit is tucked into the Inflation Reduction Act. The zero-emission nuclear power production credit will provide a temporary credit to nuclear power producers that will ensure that participating plants earn a realistic $42 per megawatt hour. According to an analysis by Breakthrough Institute's Stein, most plants will be eligible for the credit, which ends in 2032.[51] In a truly free market, such industry-specific

subsidies would not be ideal. But given the tens of billions of dollars in subsidies for intermittent wind and solar power, a modest credit for dependable nuclear power will likely prove to be a bargain for taxpayers as well as energy consumers.

Perhaps the biggest factor improving the economics of current nuclear plants is the stunning rise in natural gas prices. Even if gas prices drop somewhat from current peaks, the long-term outlook for nuclear power looks far brighter today than anyone would have predicted four years ago. Still, decisions to close plants usually involve a combination of economic and political factors. And, as New York State's policies show, not all regions share the White House's enthusiasm for nuclear power. Moreover, once a plant is on the path to decommissioning, it has considerable momentum. Several policy changes could make that slope to unnecessary shutdowns less slippery and perhaps even create a path to reopening in some cases.

Create NRC guidelines for reopening plants

Today, nuclear operators have distinct incentives to close viable plants, while reopening a plant remains a regulatory minefield. Nuclear power producers need a clearer road map for the costs and benefits of both retiring and reopening plants. The coming effort to reopen and relicense Michigan's Palisades plant could break new ground in this area. But the current lack of clear guidelines for that process vastly increases the risks facing Holtec and any potential operating partner. As Breakthrough Institute's Stein says, "NRC really needs to be more forward-looking, especially when processes take years to complete."

Require retired plants to be temporarily mothballed

"We should have a five- to ten-year cold-storage policy for nuclear plants," says Mark Nelson, managing director of the Radiant Energy Fund consulting group.[52] Instead of encouraging a rapid start to decommissioning, NRC's decommissioning trust-fund program could be modified to require plant owners to delay the start of irreversible dismantling. Several recently retired plants (including Duane Arnold, Indian Point, and Palisades) would likely be quite profitable if they were operating in today's market. Holtec's decision not to rush the deconstruction of the Palisades plant has helped the company keep its options open. If Duane Arnold and Indian Point also remained in workable condition, those plants might also be candidates for reopening today.

After the 2011 Fukushima disaster, Japan moved to shut down all its nuclear plants in order to assess their safety. But the country wisely insisted that the plants be kept in a restorable condition. Today, Japan maintains 33 reactors in this mothball status. Bringing them back into service has proved challenging (as much for political as for technical reasons), but the country hopes to have nine reactors running again by the coming winter.[53] NRC spokesman Burnell notes that Japan's mothballed reactors are under a very different regulatory regime from plants undergoing decommissioning in the U.S.: "The licenses were never surrendered. The plants were not permanently shut down; they were simply taken offline." The U.S. should consider a similar program.

Requiring owners to maintain nonoperating plants would be a financial burden. A ten-year limbo period, as Nelson proposes, might prove unfairly onerous. But requiring owners to maintain closed facilities in restorable condition for two to five years would make it vastly easier to bring a plant back online if necessary. Perhaps just as important, it would reduce the financial appeal of premature decommissioning. As we've seen, the structure of the trust-fund program can give plant owners financial incentives to retire plants earlier than planned. A small policy adjustment that encourages keeping reliable energy plants operating, instead of encouraging early retirement, would eliminate that perverse incentive. Finally, owners should be required to maintain their plants' electrical connections to the power grid for at least 10 years in order to expedite the possible installation of small, next-generation nuclear reactors at these sites.

Level the regulatory playing field for nuclear power

For years, wind and solar facilities have received state and federal tax incentives that are wildly disproportionate to those supporting nuclear power. And, since increasing wind and solar power production also generally requires the construction of new gas-fired power plants, these putatively pro-renewable policies have constituted a kind of stealth subsidy for natural gas. Fortunately, the Inflation Reduction Act (for all its fiscal excesses) includes technology-neutral zero-emission tax credits aimed at eliminating that disparity. Some individual states have taken a similar approach, replacing renewable portfolio standards (which exclude nuclear power) with clean-power standards or zero-emission credits. All states should follow that example. A more market-friendly long-term policy would reduce subsidies across the board while also lowering the regulatory obstacles blocking the development of new low-carbon energy sources.

As noted, nuclear power faces regulatory burdens that are unnecessarily strict, even given the legitimate risks involved in using fissile materials to produce electricity. NRC has helped make the construction of new, full-size nuclear plants prohibitively expensive, while also delaying the rollout of SMRs and other next-generation designs. Even owners of legacy nuclear plants face outsize regulatory obstacles. If next-generation nuclear power is to become a reality in the U.S., NRC will require a major overhaul to make its operations less byzantine and its approval processes faster. Moreover, Congress should initiate a broad review of U.S. energy policy with an eye toward reducing regulatory hurdles and allowing market forces to work.

It is too late to save Indian Point and most other prematurely closed nuclear plants. (Michigan's Palisades plant just might prove to be a groundbreaking exception.) But if the U.S. is serious about reducing carbon emissions—and providing ample, affordable energy—it needs to work harder to preserve these vital energy assets. The country needs to lower the barriers to reopening shuttered nuclear plants in the rare cases where reopening might be feasible. And it needs to smooth the regulatory path to installing next-generation reactors on the sites of working and retired nuclear plants around the nation. More fundamentally, it needs to reform the flawed policies that lead to plants being closed in the first place.

Update, November 28, 2022:

On November 19, 2022, Holtec International announced that DOE had denied the company's application for funds to help reopen its Palisades nuclear plant.[54] With the support of Michigan Governor Gretchen Whitmer, the company had applied to have Palisades included in DOE's CNC program, a $6 billion fund intended to support financially challenged nuclear plants.

"We appreciate the consideration that the Department of Energy put into our application," Holtec spokesman Patrick O'Brien said in a statement. "We fully understood that what we were attempting to do, re-starting a shuttered nuclear plant, would be both a challenge and a first for the nuclear industry." Reached for comment, a DOE spokesman cited the agency's policy of not commenting on unsuccessful applications to the CNC program.

The agency simultaneously announced that it would be providing a $1.1 billion grant to California's still-operating Diablo Canyon nuclear plant under the CNC program.[55]

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