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ISSUE BRIEF

TRANSITIONING AWAY FROM UNECONOMICAL NUCLEAR POWER PLANTS

PROTECTING CONSUMERS, COMMUNITIES, WORKERS, AND THE ENVIRONMENT

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Some states are considering financial support for struggling nuclear plants as policymakers worry that abrupt closure of these power plants will lead to increased carbon emissions and the loss of jobs and tax revenues. If state leaders decide to provide subsidies, it is imperative that they also enact policies to accelerate a truly clean energy future based on efficiency and renewables. So, states providing aid must also:

- Cap carbon pollution and scale investment in energy efficiency and renewable energy
- Assure best practices for waste management and plant closures
- Retrain or compensate workers and support new economic development plans for affected communities
- Limit the length and the amount of the aid
- Mandate that companies show their books to prove the plants are in severe financial distress

Most nuclear power plants in the U.S. were built before 1990 and are scheduled to reach the end of their operating licenses by 2050. But across the country nuclear plants are facing abrupt closure on economic grounds, especially in competitive wholesale electricity markets that do not put a price on carbon pollution. Many states are concerned about the climate impacts if nuclear power is replaced by fossil fuel generation and about the loss of jobs and the local tax base that nuclear plants provide. Some states have already developed plans for an orderly transition away from nuclear power. Others are weighing options, including direct financial support to nuclear facilities to delay closure. This issue brief outlines key considerations for states seeking to transition away from nuclear power in a manner that is consistent with the urgent need to decarbonize the U.S. economy.

Experience in five states grappling with the potential closure of nuclear plants—California, New York, Illinois, Connecticut, and New Jersey—makes clear that any financial support should be predicated on a showing of financial distress, narrowly tailored, and phase out at a firm date in the future. When providing aid, policymakers must also enact a cap on carbon, drive investment in energy efficiency and renewable energy, assure best practices for management of the radioactive waste and support the workers and local communities.

THE ROLE OF NUCLEAR POWER IN ADDRESSING CLIMATE CHANGE

Although nuclear power has beneficial low-carbon attributes, it also has significant safety, global security, environmental, and economic risks. Until these risks are properly mitigated and the complete nuclear fuel cycle is sufficiently regulated—from the mining and milling of uranium, through mitigating the risk of severe nuclear accident during reactor operations, to the final disposal of radioactive wastes—nuclear power should not be a leading strategy to diversify America's energy portfolio and reduce

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carbon pollution. NRDC's 2017 report, *America's Clean Energy Frontier: The Pathway to a Safer Climate Future*, sets forth an economically and environmentally sustainable strategy for cutting carbon emissions 80 percent by 2050. The strategy includes dramatic improvements in energy-efficiency across all sectors, a 13-fold increase in wind and solar energy, and the electrification of our vehicles, industrial processes, homes, and offices. If the U.S. follows this path, which we can do economically and with existing technologies, we can achieve an 80 percent reduction in greenhouse gas emissions by 2050, with a decline of nuclear power from 20 percent of our generation mix today to less than 3 percent.

BEST PRACTICES FOR NUCLEAR TRANSITIONS

As America's nuclear plants age, reach the end of licenses or license extensions, or become increasingly uneconomical in today's wholesale electricity markets, an increasing number of reactors are likely to be retired. A well-planned, systematic transition is critical to: ensure that clean, renewable and more cost-effective alternatives replace the plants; that carbon emissions do not increase; and avoid detrimental impacts to workers and to host communities that rely on nuclear facilities for their tax base. Short-term, narrowly tailored financial support for existing nuclear facilities that demonstrate severe financial distress may make sense in some cases, provided it is tied to robust efforts to ensure an orderly transition.

California, New York, Illinois, New Jersey and Connecticut have taken steps to avoid the abrupt closure of nuclear plants with varying degrees of success. The states developed these policies for a variety of reasons, including avoiding backsliding on efforts to meet state greenhouse gas reduction goals, protecting jobs, and preserving an important source of tax revenue for local communities. Their experience reveals the following best practices for transitioning away from nuclear power:

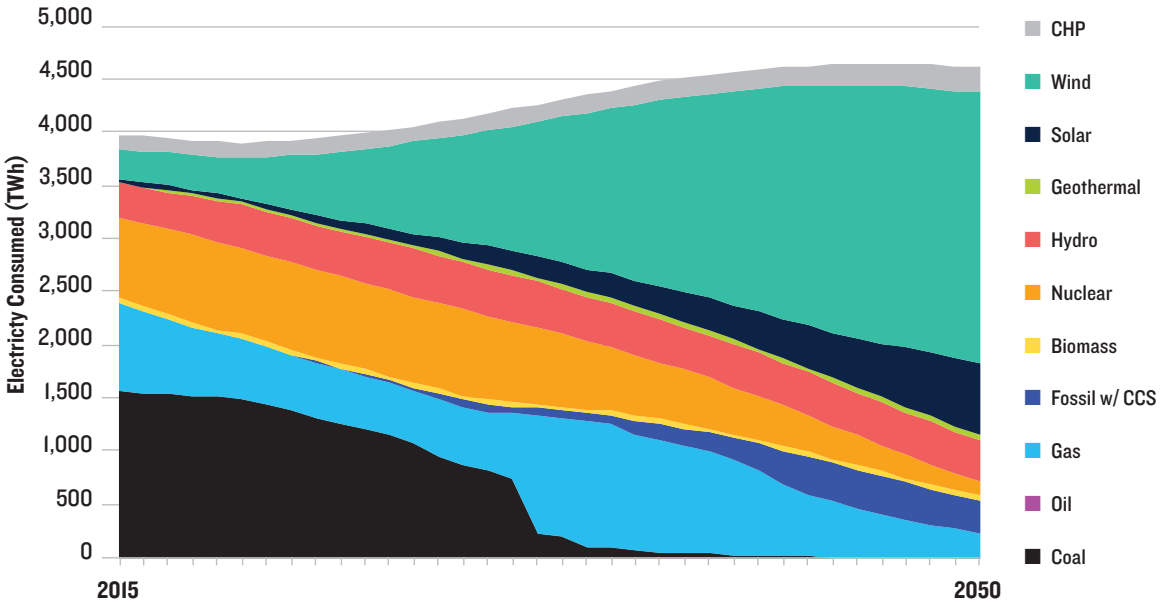
Showing of severe financial distress. Financial support for a nuclear facility can be considered if the owner can demonstrate that it will close the plant absent such support: reduced profitability is not sufficient. In New York and Illinois, plant owners filed notice of closure and opened their books to state regulators.

Narrowly tailored support. The financial support needed to extend operation of a plant should depend on wholesale electricity market prices, as well as any carbon price, and should be adjusted accordingly to avoid a windfall to shareholders at the expense of consumers. New York has a mechanism to adjust the value of nuclear subsidies biannually to reflect wholesale market and carbon price fluctuations; Illinois adjusts its nuclear subsidy to reflect wholesale market changes, ties the value of the subsidy to the Environmental Protection Agency's Social Cost of Carbon, and caps the overall cost of the subsidies.[1]

Time limits. The purpose of subsidizing existing nuclear plants is to create the time needed to plan for an orderly transition to clean energy, while taking into account the workers and surrounding community: there is no public policy justification for indefinite support. In New York the transition period extends to 2030; in Illinois the payments are structured as 10-year contracts.

Figure I: The Trend and Changing Source Mix of Electricity from 2015 to 2050, in the NRDC Pathways Core Scenario

Electricity is shown in terawatt-hours (TWh). 1 TWh is enough to meet the annual electricity needs of 96,000 households (2014 data). 1 exajoule (EJ) = 277.8 TWh



Cap on carbon emissions. The legal basis for financial support for nuclear power is the state's interest in the emission benefit, which is not otherwise recognized in wholesale or retail electricity markets. States should demonstrate the seriousness of this interest by coupling any financial assistance program for nuclear power with a cap on carbon emissions, similar to the one that Northeast and Mid-Atlantic states have adopted with the Regional Greenhouse Gas Initiative (RGGI).

Scaling energy efficiency and renewable energy. From an environmental perspective, any justification for subsidizing existing nuclear plants is to provide the time needed to scale up clean energy, e.g. energy efficiency and renewable energy. If zero-emission nuclear facilities abruptly retire, the near- to medium-term outcome can be increased generation and emissions from nearby coal, oil, and natural gas plants.

Maintaining the integrity of efficiency and renewable policies. States should not allow funds intended to drive investment in energy efficiency or renewables to be siphoned for nuclear subsidies, and nuclear generation should not "count" toward a state's renewable energy targets. This would undermine the goal of scaling up those very resources. In California, the retirement and replacement legislation calls for additional investment in efficiency, wind, solar and other zero-carbon replacement resources. New York's utility commission adopted a "zero-emission credit" mechanism to support existing nuclear plants in conjunction with a legally binding program to scale up renewable resources to meet 50 percent of the state's electricity demand by 2030 (nearly doubling its current renewable energy supply); nuclear generation will not count toward that target. Illinois's legislation provided more than twice the value of its nuclear support to kickstarting efficiency and renewables.[2]

Waste management, decommissioning, and plant autopsies. While the federal government has jurisdiction over the safety of nuclear plants, states have a strong interest in reducing the cost and land use impacts of nuclear plant operation and waste management. States should condition any financial support for nuclear power upon an enforceable agreement by the plant owners to transfer the current inventory of spent nuclear fuel in pools to dry cask storage; to continue transfer of any newly generated spent nuclear fuel in the pools to dry cask storage within a specified period of time from its removal from the reactor core; to initiate immediate, near-term decommissioning of any eligible nuclear plant; and to conduct an autopsy of the reactor core and environmental radiation surveys within a specified period of time following plant closure.

Worker transition. Nuclear plants typically employ several hundred to more than 1,000 people. Some employees can transition to the work of decommissioning when a plant closes, a process best begun immediately after nuclear plant closure employing workers with knowledge and experience of the plant being decommissioned. Plant owners can also transfer workers to other facilities within their companies, as Entergy is considering doing for up to 180 employees at its Palisades nuclear plant.[4] The California proposal includes provisions for worker retention, retraining and compensation; the New York and Illinois policies do not, although the Illinois legislation does provide $30 million for broader job-training programs, and New York has an existing clean energy, job-training program.[5]

Community transition. Many communities with nuclear power plants rely on them for a substantial portion of their tax base. A scheduled transition provides time to develop plans to attract new businesses to the area to replace lost tax revenue. States can also provide direct support for a glide path to new economic development, as Entergy is doing in southwest Michigan,[6] and as Massachusetts did for the towns of Somerset and Holyoke in connection with

ZERO EMISSION CREDITS AND WHOLESALE POWER MARKETS

Nuclear plants do not provide any unique resilience, reliability or fuel diversity benefits.[3] On the contrary, inflexible nuclear power plants are increasingly out of step with a dynamic modern power grid that requires flexibility to efficiently balance fast-changing supply and demand. The sole beneficial attribute of nuclear power is the generation of low-carbon electricity. The purpose of ZECs is to assign a monetary value to this attribute that wholesale power markets fail to provide, just as the purpose of Renewable Energy Credits (RECs) is to monetize the value of carbon-free electricity from renewables. In recent years, low natural gas prices and a stunning growth in wind and solar generation have driven down the cost of wholesale electricity generation. In response, coal and gas plant operators are trying to raise prices by securing changes to electricity markets, especially those run by PJM in the Mid-Atlantic region. This campaign has targeted state RECs and ZECs as price-distorting subsidies, while conveniently ignoring the market failures—externalized environmental costs—that have prompted states to adopt these measures, as well as many subsidies that benefit fossil fuels (such as those embedded in the tax code). Luckily, a series of court decisions have upheld the right of states to provide this support. PJM has proposed changes to its "capacity market" that would undermine the ability of states to use RECs and ZECs to promote lower-carbon electricity. All states, and especially those that within PJM, must actively engage with wholesale market operators to protect their rights and prevent such operators from infringing on their ability to set public policy.

the closure of local coal plants.[7] The California proposal includes provisions for community compensation; the New York and Illinois policies do not, although New York has a statute to provide temporary transitional tax base relief to communities that face the retirement of power plants. When nuclear facilities retire, those communities may apply for such relief.[8]

STATE APPROACHES TO NUCLEAR TRANSITIONS

California

In June 2016, Pacific Gas & Electric, along with labor and environmental organizations, announced the Diablo Canyon Joint Proposal,[9] a historic commitment to the orderly phase-out of California's last nuclear power plant by 2025 and replacement of its electric generating capacity with lower-cost, emissions-free options including energy efficiency, and wind and solar power. In September 2018, California Gov. Jerry Brown signed into law SB 1090, which mandated full implementation of all remaining provisions in the Joint Proposal. The plant is now scheduled to close by August 2025. Had the two reactors been relicensed, they could have operated an additional 29 to 49 years.

Due to its enormous size and lack of flexibility in operation, Diablo Canyon increasingly is an obstacle to adding clean generation and displacing natural gas, which also adds to greenhouse gas emissions. Removing Diablo Canyon will open space for new, less costly renewable resources, and increased generation from renewables already on the system. In addition, Diablo Canyon is located near earthquake fault lines: by shortening the life of the plant, the proposal substantially reduces the risk of catastrophic earthquake damage to an operating nuclear facility.

The retirement plan for Diablo Canyon does not include any financial subsidy for the facility. Rather, it directs an orderly and just transition, including support for workers and host communities, leading to closure of the plant in order to avoid more costly upgrades that would be required with relicensing. PG&E has estimated that costs to refurbish and operate the plant would more than double to more than 10 cents per kilowatt-hour (kWh) after 2025, and that a portfolio of energy efficiency, renewable energy, and other zero-carbon measures would cost substantially less. NRDC has estimated the savings at more than $1 billion, which exceeds the cost of the community and worker compensation that were also integral to the Joint Proposal.

New York

In August 2016, the New York Public Service Commission adopted the Clean Energy Standard (CES), which includes a zero-emission credit (ZEC)—the first carbon emissions credit created exclusively for nuclear power.[10] This was done to avoid the premature closure of three upstate facilities: James A. FitzPatrick Nuclear Power Plant, Ginna Nuclear Power Plant, and Nine Mile Point Nuclear Generating Station.

These plants had already been relicensed; the current licenses expire in 2034, 2029 and 2029, respectively, providing sufficient time to develop a cost-effective plan to replace them with energy efficiency and renewable energy.

However, the New York Public Service Commission determined that the plants were at risk of abruptly retiring because they were uneconomical under current market conditions. Agency staff reviewed financial data and tax filings for the plants, which made clear that they had been in financial distress over a number of years.[11] For the near- and medium-term, closures would have led to increased generation from polluting sources like oil and natural gas because it takes time to scale up and integrate sufficient renewable resources and energy efficiency into the electric grid.

New York is in the process of implementing its CES, which requires utilities and other electricity providers to deliver 50 percent of their electricity from renewable energy sources by 2030. The ZEC program, which requires electricity providers to purchase credits from the upstate nuclear power plants until 2030, is structured as a component of the CES, but is entirely separate and distinct from the renewables program. The Public Service Commission will undertake a public biennial review of the ZEC program to make any necessary adjustments. Not a single megawatt hour of electricity generated from nuclear facilities will count toward the renewables target.

A NOTE ON INDIAN POINT

The troubled and aging Indian Point Energy Center, a 2,000 MW two-unit facility on the Hudson River, is not included in New York's ZEC program. The state has negotiated an agreement to shut down the facility, based in part on its proximity to New York City—making emergency evacuation all but impossible—and the decades-long series of safety and operational problems that have plagued the plant.

Under the agreement, Indian Point's remaining Unit 2 reactor will close in 2020 and Unit 3 in 2021. The agreement does not specify a plan for replacement power, but Gov. Andrew Cuomo has made a commitment that the closure will not cause an appreciable increase in carbon emissions.[12] If New York implements a sufficiently strong energy efficiency portfolio on par with its ambitious requirement to scale up renewable energy to 50 percent by 2030, and follows through on the state's efforts to bolster the transmission grid, the governor can deliver on this commitment.[13]

In addition, New York is part of the nine-state Regional Greenhouse Gas Initiative, which caps carbon emissions in the power sector. The recently strengthened program requires regional emissions to decline by 3 percent annually from 2021 to 2030, on the basis of modeling that assumes the retirement of Indian Point in accordance with the agreement.

Illinois

In December 2016, the Illinois General Assembly passed the Future Energy Jobs Act.[14] The legislation includes direct financial support for the Clinton Nuclear Generating Station and Quad Cities Nuclear Generating Station in the form of zero-emission credits, but that support is narrowly tailored. It was issued in the form of a 10-year contract, and was contingent on a showing by Exelon, the plants' owner, that the facilities were no longer economically viable. Exelon had previously filed notice with the Illinois Public Utility Commission of its intent to shutter the facilities. Analysis also showed that absent this legislative package, increased generation from coal and natural gas facilities would have been required to meet the electricity demand served by the nuclear plants.

Illinois's decision to provide financial support for these nuclear plants was made in the context of a state clean energy policy badly in need of reform. The state had been a clean energy leader, having built the second-largest number of wind turbines in the nation by 2012. But in the intervening years prior to passage of the Future Energy Jobs Act, wind development in the state had ground to a halt due to structural issues with its the Renewable Portfolio Standard that prevented the procurement of renewables through long-term contracts. Similarly, the state's Energy Efficiency Portfolio Standard had been failing to achieve its original policy goals by a wide margin, in large part due to a cost cap that limited utilities' spending even if additional investments would have been cost-effective.

The 2016 legislation remedied these flaws in the state's clean energy policies, and with implementation now underway Illinois is set to be a leader in energy efficiency programming, in utility-scale renewable energy development, and—thanks to the Illinois Solar For All and Community Solar programs—in providing local communities and low-income populations equal access to the benefits of clean energy.[15]

Connecticut

In October, 2017, Connecticut enacted SB1501, "An Act Concerning Zero Carbon Solicitation and Procurement,"[16] directing agencies to solicit power agreements from Dominion Energy Inc.'s Millstone plant, the state's sole nuclear facility, as well as Class I renewable resources and hydropower. The law permits, but does not require, such agreements.

Pursuant to SB1501, the Public Utilities Regulatory Authority is currently considering whether Millstone is at risk of closure before its operating license expires. If it is found "at risk," the Connecticut Department of Energy and Environmental Protection (DEEP) would allow Millstone to be compensated for its environmental and reliability attributes in the solicitation for zero-carbon generating resources, which would allow it to command higher prices than the wholesale market. The solicitation is limited to up to 12 million megawatt-hours of energy annually, in the aggregate; any proposal selected would result in purchase agreements with the state's utilities. Dominion contends that without the higher zero-carbon market prices it would prematurely retire the two reactors at the plant.

As of the time of this writing, DEEP has determined that Millstone may be "at risk" of closing after June 2023 without additional financial support, while the Public Utilities Regulatory Authority is still evaluating the economic viability of the plant.

New Jersey

In June 2018, New Jersey adopted a Zero Emission Credit program to prop up the struggling Salem and Hope Creek nuclear generating facilities.[17] The plant owners must open their books to the state Board of Public Utilities, which will issue ZECs upon a finding of financial distress. The legislation balances concerns about consumer impacts by setting a fixed ZEC value of approximately $10/Mwh, substantially below the values set in New York and Illinois.

NUCLEAR POWER BASICS

Nuclear power represents 19.7 percent of all U.S. electricity production (and 11% of production worldwide), and the U.S. nuclear plant fleet comprises 99 reactors at 61 facilities across 30 states.[18] Most of the plants were designed and constructed in the 1960s and 1970s and almost all reach the end of their 60-year operating licenses in the 2030s and 2040s. A portion of these reactors are at risk of closing well before their license end dates because they are no longer economical and cannot compete in the marketplace, often because of the low price of natural gas and renewable energy and in some cases due to the need to replace expensive major components.

Nuclear power's beneficial low-carbon attributes are important to consider in a warming world but we must take seriously the significant safety, global security, environmental, and economic risks that this technology imposes on society. This reality demands stringent regulation of the complete nuclear fuel cycle, beginning with the mining and milling of uranium and ending with the final disposal of radioactive wastes. The 2011 Fukushima nuclear disaster in Japan, the worst since Chernobyl, illustrates some of these risks. Until these risks are properly mitigated, expanding nuclear power should not be a leading strategy for diversifying America's energy portfolio and reducing carbon pollution. More practical, economical, and environmentally sustainable approaches to reducing U.S. and global carbon emissions are available, including the widest possible implementation of energy efficiency throughout the economy, and the adoption of policies to accelerate the commercialization of clean, flexible, renewable energy technologies.

However, it does not include the sunset provisions adopted by those states. The New Jersey law also directs plant owners to develop plans "to retain, retrain, or compensate personnel whose employment would be eliminated as a direct result of the cessation of the selected nuclear power plant's operations" and to pursue "alternative economic development" for those communities.

New Jersey is the first state to consider the expedited transfer of nuclear waste to dry cask storage in the context of a ZEC program, directing plant owners to study and report on the optimal use of such storage "considering environmental impacts, worker safety, and cost impacts."

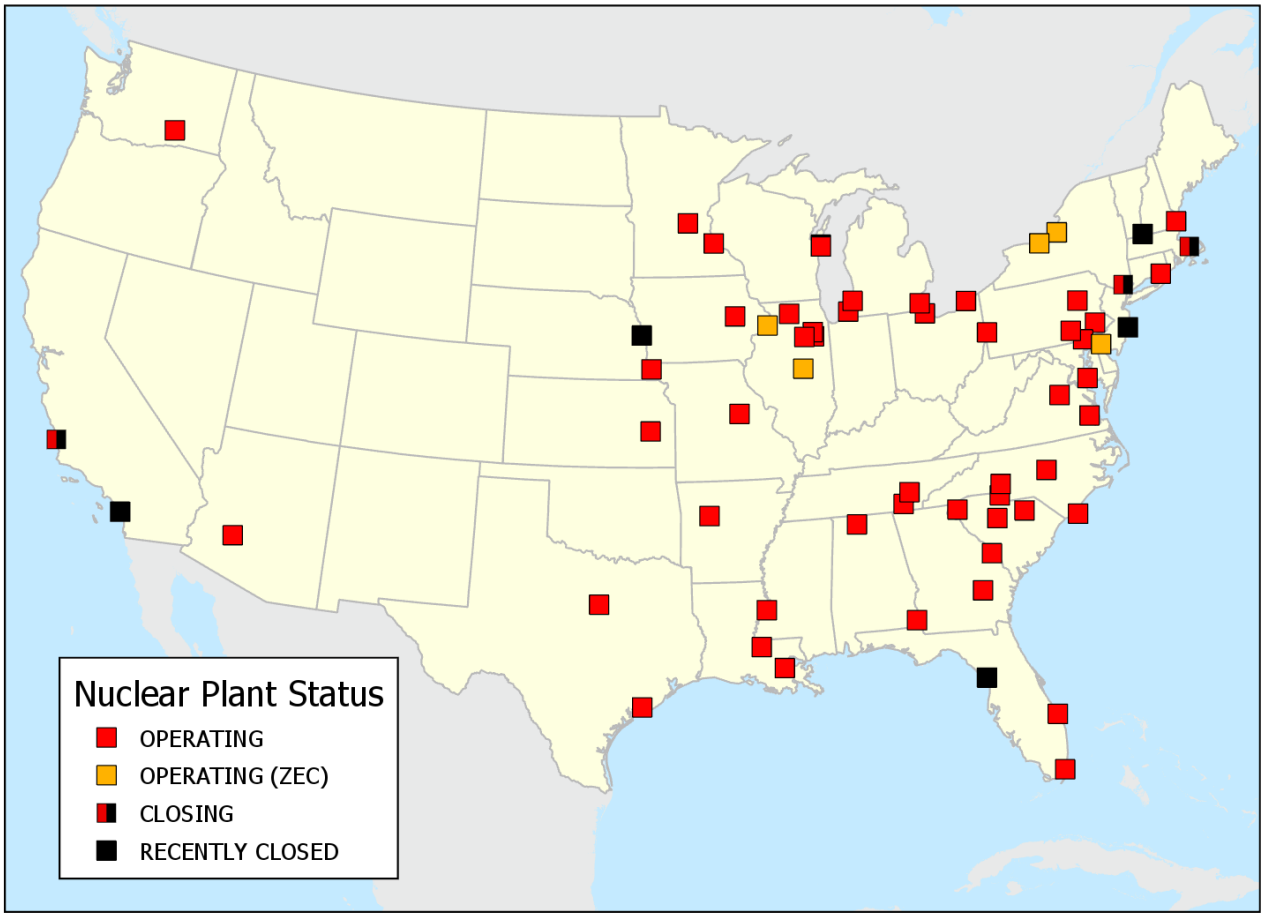
Simultaneously, New Jersey adopted a Clean Energy Law that directs utilities to deliver annual energy efficiency savings of at least 2 percent (0.75 percent for natural gas); increases the Renewable Portfolio Standard to 50 percent by 2030; overhauls the state's costly and volatile solar incentive program and expands it to include community and utility-scale solar; requires investment in 2000 MW of energy storage; and codifies Gov. Phil Murphy's commitment to invest in 3500 MW of offshore wind.[19]

NEW NUCLEAR PLANTS

Despite perennial talk of a "nuclear renaissance" by industry advocates, the nuclear sector has been plagued by poor economics and renewed concern about nuclear safety following the Fukishima disaster. There are currently only two nuclear reactors under construction in the U.S., both at the troubled Vogtle project in Georgia. The costs of that project keep increasing, and are now estimated to top $25 billion, in part because of delays in construction tied to the bankruptcy of nuclear supplier Westinghouse. Southern Co., the plant's primary owner, scrambled to avoid having its partners withdraw from the project in late October and had to accept greater responsibility for any future cost overruns. A similar project under construction in South Carolina, V.C. Summer, was scrapped by that state last year as costs skyrocketed. No other applications are pending to build a new reactor.

The future of nuclear energy in the United States is uncertain. Entrepreneurial projects promoting alternate reactor designs such as small modular, molten salt, liquid metal, high-temperature gas-cooled and pebble bed

Figure: Recent and announced nuclear plant closures, and nuclear plants receiving ZEC subsidies



reactors currently lack data from a design prototype by which to rigorously evaluate their safety, reliability, and economics. The recent fate of the nuclear start-up company Transatomic Power is a cautionary tale: this alternate reactor design, once heralded as an important tool to mitigate climate change, was instead exposed as based on engineering miscalculations, and the company folded.[20] To the extent that new nuclear reactor design projects go forward with public money, NRDC has five prescriptions for such federal programs: give priority to solving the nuclear waste problem; learn from mistakes in recent nuclear construction; consistently apply a nuclear weapons proliferation test to advanced nuclear designs; consider the full impacts of the nuclear fuel cycle associated with advanced nuclear reactors, including severe accidents; and get clarity on the economic competitiveness for advanced nuclear designs early on.[21]

ENDNOTES

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