U.S. Nuclear Plant Shutdowns, State Interventions, and Policy Concerns

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The United States has the largest nuclear power plant fleet in the world, with 93 reactors that can generate approximately 95,522 megawatts (MW) of electricity. Nuclear power has accounted for about 20% of annual U.S. electricity generation since the late 1980s; in 2020 it was 19.7%.

However, the U.S. nuclear power industry in recent years has been facing economic and financial challenges, particularly plants located in competitive power markets where natural gas and renewable power generators influence wholesale electricity prices.

Twelve U.S. nuclear power reactors have permanently closed since 2012, with the most recent being Indian Point 3 on April 30, 2021. The closed reactors had electric generating capacity of 9,436 MW, nearly 10% of the total capacity of current U.S. reactors. Another three U.S. reactor retirements have been announced through 2025, with total generating capacity of 3,012 MW (equal to roughly 3% of current U.S. nuclear capacity).

However, announced retirements have not always occurred as planned. Most recently, an Illinois law signed September 15, 2021, provided subsidies that halted the planned shutdown of two nuclear plants in the state with a total of four reactors. Including those units, 20 reactors previously announced for permanent closure within the past five years have continued operating pursuant to state interventions that provide them with additional revenue sources or other assistance. State nuclear power subsidies, such as zero emissions credits and power purchases, are typically about $100 million per year for each reactor. The 20 reactors whose shutdowns were averted—in Connecticut, Illinois, New Jersey, New York, Ohio, and Pennsylvania—represent 19,831 MW of electricity generation capacity (21% of total U.S. nuclear capacity). Many other U.S. reactors have been identified by recent studies as being “at risk” of shutdown for economic reasons, although their closures have not been announced.

Economic pressure on nuclear power plants is less immediate in areas of the country where electricity prices are set by state regulators rather than markets, such as in much of the Southeast. Under such “traditional” rate regulation, all power plant expenditures must be approved by state regulators, and electricity customers are charged rates sufficient to recover those costs plus a reasonable investment return. However, many other factors can affect plant-specific costs, revenues, and operating profits.

The recent U.S. nuclear power plant retirements and announced future shutdowns have drawn congressional attention, including proposed legislation, committee hearings and markups, and enacted authorizations and appropriations. In particular, a new federal program to provide financial support to nuclear power plants at risk of closure is included in the Infrastructure Investment and Jobs Act (P.L. 117-58) signed into law November 15, 2021. The law includes an appropriation of $6 billion for the program—$1.2 billion per year from FY2022 through FY2026. A tax credit for existing nuclear power plants was included in budget reconciliation legislation passed by the House on November 19, 2021 (Build Back Better Act, H.R. 5376). Under the tax provision (Section 136109), existing nuclear power plants would receive a production tax credit of up to 1.5 cents per kilowatt-hour (kwh), or $15/MWh, through the end of 2026.

Following are the three currently operating U.S. reactors that have been announced for closure by their owners:

- Palisades, Michigan, scheduled to shut down in May 2022 because of operating losses and the expiration of a power purchase agreement; and
- Diablo Canyon 1 and 2, California, scheduled to shut down in November 2024 and August 2025, respectively, because of a settlement with labor and environmental groups to replace the plant’s output with renewable energy and energy efficiency measures.
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Introduction

The United States has the largest nuclear power plant fleet in the world, with 93 reactors that can generate approximately 95,522 megawatts (MW) of electricity. Nuclear power has accounted for about 20% of annual U.S. electricity generation since the late 1980s; in 2020 it was 19.7%. However, the U.S. nuclear power industry in recent years has been facing economic and financial challenges, particularly plants located in competitive power markets where natural gas and renewable power generators influence wholesale electricity prices.

Twelve U.S. nuclear power reactors have permanently closed since February 2013, following a 14-year period without any shutdowns. The most recent reactor retirement was Indian Point 3 on April 30, 2021. The plant’s owner, Entergy, cited low electricity prices driven by low-cost natural gas generation and increased operating costs as major reasons.

Another three U.S. reactor retirements have been announced through 2025. However, announced retirements have not always occurred as planned: 20 reactors previously scheduled for permanent closure have continued operating pursuant to state interventions that provide them with additional revenue sources or improved competitive conditions (see Figure 1). An Illinois law signed September 15, 2021, provided subsidies that halted the planned shutdown of two nuclear plants in the state with a total of four reactors. Many other U.S. reactors have been identified by recent studies as being “at risk” of shutdown for economic reasons, although their closures have not been announced.

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1 Energy Information Administration, Monthly Energy Review, January 2021. Megawatts in this report reflect “net summer” generating capacity, defined as the maximum electrical output that can be supplied to system load, as demonstrated by a multi-hour test, during summer peak demand (June 1 through September 30). EIA capacity total reduced by 1,038 MW to reflect the April 20, 2021, permanent shutdown of Indian Point 3.


4 Indian Point 3 was the last operating reactor at the Indian Point plant, whose initial nuclear reactor began generating electricity in 1962. The plant had been controversial for decades because of its location about 25 miles north of New York City along the Hudson River. The State of New York opposed Indian Point’s operating license extension by the U.S. Nuclear Regulatory Commission (NRC) and reached an agreement with the plant’s owner, Entergy, in 2017 to close the final operating units in 2020 and 2021. See New York State, “Governor Cuomo Announces 10th Proposal of the 2017 State of the State: Closure of the Indian Point Nuclear Power Plant by 2021,” news release, January 9, 2017, https://www.governor.ny.gov/news/governor-cuomo-announces-10th-proposal-2017-state-state-closure-indian-point-nuclear-power.


Figure 1. U.S. Nuclear Power Plants Currently Operating, Shut Down Since 2013, Announced Plans for Shutdown, and Operating Pursuant to State Intervention

Source: CRS, using data from S&P Global Platts, Esri Data and Maps, with information from the U.S. Energy Information Administration and plant operator announcements.

Notes: Plant shutdowns are from February 2013 through the end of April 2021. See Table 1. Two U.S. reactors are currently under construction: Units 3 and 4 at the Vogtle nuclear power plant in Georgia. There are no nuclear power plants in Alaska, Hawaii, or U.S. territories.
Reactors that have been identified in recent studies as being “at risk” of near-term retirement, but with no shutdown date announced by their owners, are not shown in the accompanying maps and tables, because of widely varying study methodologies, data, and results. Identifying “at risk” reactors with broad screening studies is difficult because each nuclear reactor can have a unique set of market, location, cost, revenue stream, maintenance, contract, and regulatory factors that operators may consider when deciding to shut down reactor operations earlier than previously anticipated.

The maps in this report graphically illustrate that actual and planned reactor shutdowns are mostly concentrated in particular regions of the country, such as the Northeast and Midwest, where supply, demand, transmission constraints, and fuel costs in regional markets largely determine wholesale electricity prices and generator revenues. If the wholesale market price of electricity (the price received by power plants) is chronically lower than a nuclear plant’s operating costs, the owner of the plant may decide to shut it down rather than endure losses indefinitely. Plant owners in such situations also may be unwilling to make large capital investments that may be necessary to keep their reactors operating.

Wholesale electricity prices were pushed to historically low levels in recent years by rising amounts of low-cost generation from natural gas, wind, and solar, and by weak electricity demand growth. Low prices were cited by plant owners in the permanent closure of at least eight reactors during the past decade (see Table 1). However, rising natural gas prices in 2021 led to substantial increases in wholesale electricity prices in the second half of the year, according to the Energy Information Administration (EIA). Average electricity prices rose in all regions during 2021, including a near-doubling in the Midcontinent region and a 37% increase in California from the previous year. A continuation of this trend could ease future economic pressure on nuclear power plants in regions with market-based rates.

Economic pressure on nuclear power plants is less immediate in areas of the country where electricity prices are set by state regulators rather than markets, such as in much of the Southeast. Under such “traditional” rate regulation, all power plant expenditures must be approved by state regulators, and electricity customers are charged rates sufficient to recover those costs plus a reasonable investment return. However, as noted above, many other factors can affect plant-specific costs, revenues, and operating profits. In particular, plants that have guaranteed revenue streams through long-term power purchase agreements may be somewhat insulated from wholesale price fluctuations. For background information about some of the variables and complexities that affect nuclear power economics, see CRS Report R44715, Financial Challenges of Operating Nuclear Power Plants in the United States, by Phillip Brown and Mark Holt.

Concerns about reactor shutdowns, particularly their potential effects on local economies and efforts to reduce power sector greenhouse gas emissions, have prompted action in the 117th Congress to provide incentives and financial support for operating nuclear power plants. In particular, a new federal program to provide financial support to nuclear power plants at risk of closure is included in the Infrastructure Assistance and Jobs Act (P.L. 117-58), signed into law November 15, 2021. Other legislative proposals such as federal clean electricity standards and tax credits could support existing nuclear power plants and reduce the likelihood of earlier-than-planned shutdowns.

Scope of Report
This report provides maps and tables that show nuclear reactor shutdowns, announced closures, and state interventions to prevent reactor shutdowns. For clarity, each of those categories is shown in a separate set of maps and tables, along with a general map that shows all currently operating U.S. nuclear reactors and their status. The map of reactors that have been kept operating by state action is accompanied by brief

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descriptions of those actions; many involve the establishment of “zero emission credits” that electric utilities must purchase from nuclear plants, increasing nuclear plant revenues.

**Nuclear Reactor Shutdowns: 2013-2021**

From 2013 through April 2021, power plant operators permanently shut down 12 nuclear reactors representing 9,436 MW of electricity generation capacity. Table 1 contains additional information about each reactor. Figure 2 includes a map showing the location of each reactor listed in the table.

**Table 1. U.S. Nuclear Reactor Shutdowns: 2013-2021**

<table>
<thead>
<tr>
<th>Reactor</th>
<th>State (Cong. District)</th>
<th>Shutdown Date</th>
<th>Generating Capacity (Megawatts)</th>
<th>Start-Up Year</th>
<th>Major Factor(s) Contributing to Shutdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crystal River 3</td>
<td>Florida (FL-11)</td>
<td>Feb. 2013</td>
<td>860</td>
<td>1977</td>
<td>Cost of major repairs to reactor containment</td>
</tr>
<tr>
<td>Kewaunee</td>
<td>Wisconsin (WI-8)</td>
<td>May 2013</td>
<td>566</td>
<td>1974</td>
<td>Operating losses</td>
</tr>
<tr>
<td>San Onofre 2</td>
<td>California (CA-49)</td>
<td>June 2013</td>
<td>1,070</td>
<td>1983</td>
<td>Cost of replacing defective steam generators</td>
</tr>
<tr>
<td>San Onofre 3</td>
<td>California (CA-49)</td>
<td>June 2013</td>
<td>1,080</td>
<td>1984</td>
<td>Cost of replacing defective steam generators</td>
</tr>
<tr>
<td>Vermont Yankee</td>
<td>Vermont (VT-at large)</td>
<td>Dec. 2014</td>
<td>620</td>
<td>1972</td>
<td>Operating losses</td>
</tr>
<tr>
<td>Fort Calhoun</td>
<td>Nebraska (NE-1)</td>
<td>Oct. 2016</td>
<td>479</td>
<td>1973</td>
<td>Operating losses</td>
</tr>
<tr>
<td>Oyster Creek</td>
<td>New Jersey (NJ-3)</td>
<td>Sept. 2018</td>
<td>614</td>
<td>1969</td>
<td>Agreement with state to avoid building cooling towers</td>
</tr>
<tr>
<td>Pilgrim</td>
<td>Massachusetts (MA-9)</td>
<td>May 2019</td>
<td>685</td>
<td>1972</td>
<td>Operating losses; rising capital expenditures</td>
</tr>
<tr>
<td>Indian Point 2</td>
<td>New York (NY-17)</td>
<td>April 2020</td>
<td>1,020</td>
<td>1974</td>
<td>Low electricity prices; settlement with state</td>
</tr>
<tr>
<td>Duane Arnold</td>
<td>Iowa (IA-1)</td>
<td>Aug. 2020</td>
<td>601</td>
<td>1975</td>
<td>Lower-cost alternative power purchases</td>
</tr>
<tr>
<td>Indian Point 3</td>
<td>New York (NY-17)</td>
<td>April 2021</td>
<td>1,038</td>
<td>1976</td>
<td>Low electricity prices; settlement with state</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>9,436</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** CRS, with information from the U.S. Energy Information Administration and plant operator announcements.

**Notes:** Generating capacity numbers reflect “Net Summer” capacity.
Figure 2. Nuclear Reactor Shutdowns, 2013-2021

Source: CRS, using data from S&P Global Platts, Esri Data and Maps, with information from the Energy Information Administration and plant operator announcements.

Notes: Plant shutdowns are from February 2013 through the end of April 2021. There are no nuclear power plants in Alaska, Hawaii, or U.S. territories.
Announced Nuclear Reactor Shutdown Plans

As of the date of this report, power plant operators have announced their intent to shut down three operating nuclear reactors, representing 3,012 MW of electricity generation capacity (about 3% of total current U.S. nuclear capacity). Table 2 contains additional information about each reactor. Figure 3 includes a map showing the location of each reactor listed in the table, along with all other operating reactors in the country.

Table 2: Announced Nuclear Reactor Shutdown Plans
Organized by Announced Shutdown Date

<table>
<thead>
<tr>
<th>Reactor</th>
<th>State (Cong. District)</th>
<th>Announced Shutdown Date</th>
<th>Generating Capacity (Megawatts)</th>
<th>Start-Up Year</th>
<th>Major Factors Contributing to Announced Shutdown</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palisades</td>
<td>Michigan (MI-6)</td>
<td>May 2022</td>
<td>772</td>
<td>1972</td>
<td>Operating losses; end of power purchase agreement</td>
</tr>
<tr>
<td>Diablo Canyon 1</td>
<td>California (CA-24)</td>
<td>Nov. 2024</td>
<td>1,122</td>
<td>1985</td>
<td>Settlement with labor and environmental groups to use renewables and efficiency</td>
</tr>
<tr>
<td>Diablo Canyon 2</td>
<td>California (CA-24)</td>
<td>Aug. 2025</td>
<td>1,118</td>
<td>1986</td>
<td>Settlement with labor and environmental groups to use renewables and efficiency</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
<td><strong>7,1093,012</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Source: CRS, with information from the U.S. Energy Information Administration and plant operator announcements.*

*Notes: Generating capacity numbers reflect “Net Summer” generating capacity.*
Figure 3. Announced Nuclear Reactor Shutdown Plans

Source: CRS, using data from S&P Global Platts, Esri Data and Maps, with information from the U.S. Energy Information Administration and plant operator announcements.
State Interventions to Support Nuclear Power Generation

Six states have intervened to provide financial support or other assistance for 20 nuclear reactors—representing 19,831 MW of electricity generation capacity (21% of total U.S. nuclear capacity)—that had been previously announced for closure or identified as likely to close. Most recently, an Illinois law signed September 15, 2021, provided subsidies that halted the planned shutdown of two nuclear plants in the state with a total of four reactors. State subsidies that benefit nuclear power, such as zero emissions credits or power purchase agreements, have typically been up to $100 million per year for each reactor. Table 3 contains additional information about each reactor, including the type of intervention. Figure 4 shows the location of each reactor listed in the table, along with all other operating reactors in the country. Background information, reference materials, and context about the six state incentive programs are also included below.

Table 3. U.S. Nuclear Reactors Supported by State Intervention
Organized Alphabetically by State

<table>
<thead>
<tr>
<th>Reactor</th>
<th>State (Cong. District)</th>
<th>Generating Capacity (Megawatts)</th>
<th>Start-Up Year</th>
<th>State Intervention Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Millstone 2</td>
<td>Connecticut (CT-2)</td>
<td>853</td>
<td>1975</td>
<td>Power Purchase Agreement</td>
</tr>
<tr>
<td>Millstone 3</td>
<td>Connecticut (CT-2)</td>
<td>1,233</td>
<td>1986</td>
<td>Power Purchase Agreement</td>
</tr>
<tr>
<td>Byron 1</td>
<td>Illinois (IL-16)</td>
<td>1,164</td>
<td>1985</td>
<td>Carbon Mitigation Credits</td>
</tr>
<tr>
<td>Byron 2</td>
<td>Illinois (IL-16)</td>
<td>1,136</td>
<td>1987</td>
<td>Carbon Mitigation Credits</td>
</tr>
<tr>
<td>Clinton</td>
<td>Illinois (IL-13)</td>
<td>1,065</td>
<td>1987</td>
<td>Zero Emission Credits</td>
</tr>
<tr>
<td>Dresden 2</td>
<td>Illinois (IL-16)</td>
<td>902</td>
<td>1970</td>
<td>Carbon Mitigation Credits</td>
</tr>
<tr>
<td>Dresden 3</td>
<td>Illinois (IL-16)</td>
<td>895</td>
<td>1971</td>
<td>Carbon Mitigation Credits</td>
</tr>
<tr>
<td>Quad Cities 1</td>
<td>Illinois (IL-17)</td>
<td>908</td>
<td>1972</td>
<td>Zero Emission Credits</td>
</tr>
<tr>
<td>Quad Cities 2</td>
<td>Illinois (IL-17)</td>
<td>911</td>
<td>1972</td>
<td>Zero Emission Credits</td>
</tr>
<tr>
<td>Hope Creek</td>
<td>New Jersey (NJ-2)</td>
<td>1,172</td>
<td>1986</td>
<td>Zero Emission Credits</td>
</tr>
<tr>
<td>Salem 1</td>
<td>New Jersey (NJ-2)</td>
<td>1,153</td>
<td>1977</td>
<td>Zero Emission Credits</td>
</tr>
<tr>
<td>Salem 2</td>
<td>New Jersey (NJ-2)</td>
<td>1,142</td>
<td>1981</td>
<td>Zero Emission Credits</td>
</tr>
<tr>
<td>Ginna</td>
<td>New York (NY-24)</td>
<td>580</td>
<td>1970</td>
<td>Zero Emission Credits</td>
</tr>
<tr>
<td>Nine Mile Point 1</td>
<td>New York (NY-24)</td>
<td>621</td>
<td>1969</td>
<td>Zero Emission Credits</td>
</tr>
<tr>
<td>Nine Mile Point 2</td>
<td>New York (NY-24)</td>
<td>1,292</td>
<td>1987</td>
<td>Zero Emission Credits</td>
</tr>
<tr>
<td>Davis-Besse</td>
<td>Ohio (OH-9)</td>
<td>908</td>
<td>1977</td>
<td>Nuclear Resource Credits</td>
</tr>
<tr>
<td>Perry</td>
<td>Ohio (OH-14)</td>
<td>1,240</td>
<td>1987</td>
<td>Nuclear Resource Credits</td>
</tr>
<tr>
<td>Beaver Valley 1</td>
<td>Pennsylvania (PA-17)</td>
<td>907</td>
<td>1976</td>
<td>PA joined Regional Greenhouse Gas Initiative (RGGI)</td>
</tr>
<tr>
<td>Beaver Valley 2</td>
<td>Pennsylvania (PA-17)</td>
<td>901</td>
<td>1987</td>
<td>PA joined RGGI</td>
</tr>
<tr>
<td>Reactor</td>
<td>State (Cong. District)</td>
<td>Generating Capacity (Megawatts)</td>
<td>Start-Up Year</td>
<td>State Intervention Type</td>
</tr>
<tr>
<td>---------</td>
<td>------------------------</td>
<td>---------------------------------</td>
<td>---------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>19,831</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Source:** CRS, with data from the U.S. Energy Information Administration and state policy documents.

**Notes:** Generating capacity numbers reflect “Net Summer” generating capacity. All nuclear power reactors in Pennsylvania could benefit from the state joining RGGI, a carbon dioxide cap-and-trade system in the Northeast and Mid-Atlantic. Beaver Valley is included in this table because the plant owner rescinded its closure order, and cited RGGI as the reason for not shutting down the reactors. Ohio subsidies were postponed and then repealed without being implemented, although the two Ohio nuclear plants have continued to operate. Exelon announced in July 2021 that its two-unit Braidwood plant could close “sometime in the next few years,” with no specific date; Braidwood has also been awarded carbon mitigation credits by Illinois as an “at risk” plant.
Figure 4. U.S. Nuclear Reactors Supported by State Intervention

Source: CRS, using data from S&P Global Platts, Esri Data and Maps, with data from the Energy Information Administration and state intervention policies.

Notes: NRC = Nuclear Resource Credits (similar to ZECs); PPA = Power Purchase Agreement; RGGI = Regional Greenhouse Gas Initiative; ZEC = Zero Emission Credits; CMC = Carbon Mitigation Credits. All nuclear power reactors in Pennsylvania could benefit from the state joining RGGI. Beaver Valley is included in this map because the plant owner rescinded its closure order, and cited RGGI as the reason for not shutting down the reactors. Ohio subsidies were postponed and then repealed without being implemented, but the two Ohio nuclear plants have continued to operate. The two-unit Braidwood plant in Illinois has also been awarded carbon mitigation credits as an “at risk” plant, but it is not shown on this map because it never had an announced shutdown date.
Connecticut

Connecticut enacted a law in 2017 to authorize the state’s Department of Energy and Environmental Protection (DEEP) to hold competitive procurements for power from nuclear plants found to be at risk of retirement.8 Two power reactors are currently operating in Connecticut, Millstone 2 and 3 (with unit 1 having been previously retired). DEEP and the Connecticut Office of Consumer Counsel determined in 2019 that Millstone 2 and 3 were at risk of permanent shutdown beginning on June 1, 2023, when the Millstone plant’s current capacity obligations with the regional transmission organization expire.9

In the power purchase solicitation that took place after Millstone was found to be at risk, DEEP approved Millstone’s bid to sell half the plant’s output for a 10-year period running through 2029, or 9 million megawatt-hours per year. Connecticut’s two regulated electric utilities were required to purchase the power from Millstone at $49.99 per megawatt-hour, for a total of about $450 million per year. The power purchase includes all of Millstone’s zero emission credits (ZECs), which can be resold.10 New England real-time wholesale electricity prices averaged $30.67 per megawatt-hour in 2019,11 $19.32 below the price in the Millstone power purchase contracts. At those rates, the resulting subsidy to Millstone would average about $174 million per year.

Illinois

Exelon announced in 2016 that it would shut down its single-unit Clinton plant and the two-unit Quad Cities plant in 2017 and 2018, respectively.12 The Illinois General Assembly enacted a law (Public Act 99-0906) on December 1, 2016, to provide ZECs to keep the plants operating for 10 years. The law set the price of a ZEC at $16.50 per megawatt-hour, based on the social cost of carbon,13 to be adjusted for market conditions and other factors. Under criteria in the law, the Illinois Power Authority procures the ZECs from the three reactors at Clinton and Quad cities at the mandated price and sells them to utilities in the state. The total cost of the ZECs over 10 years is estimated to be about $3.6 billion, or about $360 million per year for the three eligible

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reactors. The Illinois ZEC program and a similar program in New York were challenged in federal court but ultimately upheld.

Although the Illinois ZEC program averted the planned closure of the Clinton and Quad Cities plants, Exelon announced in August 2020 that it would retire two other nuclear plants in the state: the two-unit Byron plant in September 2021 and the final two operating reactors at its Dresden plant in November 2021. Exelon said the two plants “face revenue shortfalls in the hundreds of millions of dollars” despite efficient and reliable operation. As noted above, the planned shutdowns were averted by an Illinois law signed September 15, 2021, that provides “carbon mitigation credits” to nuclear plants at risk of closure for economic reasons. Exelon also had warned that its two-reactor Braidwood plant could close “sometime in the next few years,” and that plant is also receiving carbon mitigation credits.

Under the new law, each carbon mitigation credit represents 1 MWh of eligible nuclear power generation. The Illinois Power Agency is to procure five-year contracts for 54.5 million credits per year from eligible nuclear plants. The credits are to be purchased by utilities serving at least 3 million retail customers in the state, with automatic pass-through to ratepayers.

Under the act, eligible nuclear plants submitted bids to supply the credits. To bid, plants were required to submit cost, revenue, and operational data to prove they faced economic risk. Eligibility was limited to nuclear plants in the Illinois portion of the PJM interconnection, of which there are three: Byron, Dresden, and Braidwood. At 1 credit/MWh, the 54.5 million available credits almost exactly equal the electric generation of the three eligible nuclear plants in 2019, according to EIA. On December 1, 2021, the Illinois Commerce Commission awarded the three plants the 54.5 million credits annually through the end of May 2027.

The price paid for the credits is to be the bid price minus other plant revenues, so the value of the credits may vary from month to month. Bids were not allowed to exceed a customer protection cap equal to baseline costs set at $30.30/MWh in 2022 and rising to $34.50/MWh in 2026.

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New Jersey

New Jersey enacted a law in 2018 to provide ZECs to nuclear power plants in the state that could demonstrate a need for subsidies to continue operating.21 PSEG Nuclear, the operator of New Jersey’s three nuclear reactors—Salem 1 and 2 and Hope Creek—applied for the ZECs in December 2018. The application stated that “PSEG intends to retire the plants within the next three years unless there [is] a material beneficial financial change.”22

The New Jersey Board of Public Utilities (BPU) in April 2019 awarded ZECs to the three reactors worth about $100 million each for three years. The BPU staff concluded that the reactors were financially viable without the subsidies. However, the BPU Board found that “operational risks” and “market risk” as defined by the law made the three reactors eligible for ZECs. In dissenting from the BPU decision, one commissioner contended that the three reactors had not “satisfactorily demonstrated” that they would shut down without state subsidies.23

New York

The owners of four nuclear reactors in upstate New York announced in 2016 that they would permanently be closed for economic reasons.24 To keep the plants operating, the State of New York Public Service Commission approved a ZEC system in August 2016 that provided additional revenue for the four reactors and required them to continue operating through 2029.25 The order required the New York State Energy Research and Development Authority (NYSERDA) to purchase ZECs from the four reactors and resell them to state-regulated electric utilities (“load serving entities”). The initial ZEC price was set at $17.48 per megawatt-hour at a cap of 27.618 million megawatt-hours per year. This yielded a maximum annual ZEC subsidy for the four reactors of $483 million for the first two years of the program, with adjustments to be made every two years.

Ohio

The permanent shutdown of Ohio’s two nuclear power plants, Davis-Besse and Perry, was announced in an April 25, 2018, filing with the Nuclear Regulatory Commission (NRC) by the plants’ owner, FirstEnergy Solutions (now Energy Harbor after a bankruptcy reorganization). The

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NRC filing said FirstEnergy Solutions would cease operation of Davis-Besse by May 31, 2020, and Perry by May 31, 2021.\(^{26}\)

FirstEnergy Solutions rescinded the shutdown notice for the two nuclear plants on July 26, 2019,\(^{27}\) three days after the Ohio Legislature enacted a bill, H.B. 6, to provide subsidies to keep them operating.\(^{28}\) H.B. 6 authorized the collection of $150 million per year from ratepayers for a “nuclear generation fund,” which would provide financial support to Davis-Besse and Perry. The nuclear subsidy collections were to begin on January 1, 2021.\(^{29}\)

A proposed referendum to repeal H.B. 6 was abandoned in January 2020 after sufficient signatures were not gathered in time.\(^{30}\) However, on July 16, 2020, the U.S. Attorney for the Southern District of Ohio filed a criminal complaint that the enactment of H.B. 6 and failure of the repeal effort had been directly affected by “multiple acts of bribery” by the Ohio Speaker of the House and other state officials.\(^{31}\)

Citing the scandal and other concerns about the implementation of H.B. 6, an Ohio industry association appealed to the Ohio Supreme Court to stay the scheduled January 1, 2021, initiation of ratepayer charges for the act’s nuclear and other electric generation subsidies.\(^{32}\) The Ohio Supreme Court granted the temporary stay on December 28, 2020.\(^{33}\) Ohio Governor Mike DeWine signed legislation on March 31, 2021, that repealed the H.B. 6 nuclear subsidies.\(^{34}\)

Following the nuclear subsidy suspension and repeal, Energy Harbor has not announced any changes to the status of Davis-Besse and Perry, which are continuing to operate.

Future use of any Ohio subsidies could also be affected by a Federal Energy Regulatory Commission (FERC) order to expand the Minimum Offer Price Rule (MOPR) issued by the PJM regional transmission organization. The Ohio nuclear plants are in the PJM region. FERC may revisit its order under the Biden Administration. For more information, see CRS Insight IN11223, *FERC Directs PJM to Expand Minimum Offer Price Rule*, by Richard J. Campbell.

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\(^{29}\) Ohio Legislature, 133\(^{rd}\) General Assembly, House Bill 6 as enrolled, Sec. 3706.46, https://www.legislature.ohio.gov/legislation/legislation-summary?id=GA133-HB-6. Other electric generation subsidies were also included in the legislation.


Pennsylvania

FirstEnergy (now Energy Harbor), owner of the two-unit Beaver Valley nuclear plant in western Pennsylvania, announced in March 2018 that the plant would close in 2021. Energy Harbor rescinded Beaver Valley’s planned retirement in March 2020, after observing the Pennsylvania Governor’s efforts to join the Regional Greenhouse Gas Initiative (RGGI), a carbon dioxide cap-and-trade program in the Northeast and Mid-Atlantic. Energy Harbor said its decision to keep the plant operating was “largely driven” by the governor’s actions to join RGGI, “which will begin to help level the playing field for our carbon-free nuclear generators.”

Governor Wolf issued an Executive Order in October 2019 directing the Pennsylvania Department of Environmental Protection (DEP) to develop a rulemaking that would establish the framework to join RGGI. DEP’s final rule to participate in RGGI was approved by the state’s Independent Regulatory Review Commission on September 1, 2021. Policymakers in Pennsylvania’s legislative bodies have voiced strong opposition to joining RGGI and the governor’s actions to join the program without enacting new legislation.

The 11 northeastern and mid-Atlantic states that participate in RGGI have agreed to a regional cap on carbon dioxide (CO₂) emissions from fossil-fuel-fired electric power plants. The RGGI emissions cap increases costs for fossil fuel plants relative to non-emitting generating sources such as nuclear plants. To demonstrate compliance with the emissions cap, covered power plants must submit emission allowances to the implementing state agency to cover the number of short tons of CO₂ the plant emitted over the past compliance period (three years in the RGGI program). The vast majority of RGGI emission allowances are initially distributed through quarterly auctions, and power plants may buy and sell allowances among themselves throughout the compliance period. In RGGI’s most recent auction (March 2021), the auction clearing price for allowances was $7.60 per short ton of CO₂, the highest price in RGGI’s history. For more information, see CRS Report R41836, *The Regional Greenhouse Gas Initiative: Background, Impacts, and Selected Issues*, by Jonathan L. Ramseur.

Congressional Action

The 117th Congress has enacted or is considering multiple approaches to addressing potential shutdowns of existing nuclear power plants. Some bills currently under consideration would target at-risk plants by providing direct payments or tax credits. Another major approach would indirectly help existing reactors by including nuclear power in broader “clean energy” incentives and mandates. The future of nuclear power has been discussed at several recent hearings, with

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38 For more information, see the Pennsylvania Department of Environmental Protection RGGI website, https://www.dep.pa.gov/Citizens/climate/Pages/RGGI.aspx.

concerns raised about continued shutdowns as well as about ensuring that safety standards are maintained for at-risk plants.

**Infrastructure Assistance and Jobs Act**

A new federal program to provide financial support to nuclear power plants at risk of closure is included in the Infrastructure Assistance and Jobs Act (P.L. 117-58) signed into law November 15, 2021.

A nuclear reactor is eligible for the bill’s assistance program (Section 40323) if it “competes in a competitive electricity market” and the Secretary of Energy certifies that it is likely to close because of economic factors, that such closure would result in increased pollution, and that NRC has reasonable assurance that the reactor would operate safely. Priority is given to reactors that maximize their use of U.S.-origin fuel. In applying to the Secretary for certification, reactors at risk of closure would have to submit cost and revenue data and an estimate of potential increased air pollution that would result from their shutdown. The revenue data would include the impact of any state assistance programs, unless the federal credits would be used to reduce the state payments. For example, the Illinois law authorizing carbon mitigation credits (cited above) requires nuclear plants applying for the credits to include any anticipated federal support in their revenue projections.

Reactors certified by the Secretary could submit bids to receive credits for four years, specifying an amount per megawatt-hour of electricity generated that would be paid for each credit. The bids would include a commitment to generate a specific number of megawatt-hours during the four-year period. The bids could not exceed the losses that the certification process had projected that a reactor would incur without assistance. Certification for the assistance program can be renewed until September 30, 2031. The Secretary is to use the bidding results to award credits to as many certified reactors as possible within available funding.

Appropriations for the nuclear plant assistance program were provided in the same bill by Division J, Title III, Energy and Water Development and Related Agencies. The program received a total of $6 billion, with $1.2 billion appropriated per year from FY2022 through FY2026.

**Production Tax Credit for Existing Reactors**

A tax credit for existing nuclear power plants was included in budget reconciliation legislation passed by the House on November 19, 2021 (Build Back Better Act, H.R. 5376).

Under the tax provision (Section 136109), existing nuclear power plants would receive a production tax credit of up to 1.5 cents per kilowatt-hour (kwh), or $15/MWh, through the end of 2026. To qualify for the credit, a nuclear plant would have to satisfy requirements on prevailing wages and apprenticeships or have a generating capacity below 1 MW. An existing nuclear plant not meeting those requirements would qualify for a credit of up to 0.3 cents/kwh.

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The credit would be reduced if the price of electricity generated by an eligible plant rose above specific levels. The credit would also be offset in specified circumstances by amounts received from state or federal zero-emission credit (ZEC) programs.

Clean Electricity Performance Program

The House-passed Build Back Better Act (H.R. 5376) also includes a program of grants and fees to encourage utilities to increase their supply of low-carbon electricity, including nuclear energy.

The Clean Energy Performance Program in H.R. 5376 would require the Department of Energy (DOE) to provide annual grants to utilities that increase their clean electricity percentage by at least four percentage points over the previous year. If a utility did not increase its clean electricity share by that amount, it would owe a payment to DOE. After the first year, a utility would have to meet the four percentage point goal to receive a grant the following year. Grants would be $150 for every MWh of clean electricity that exceeded a level of 1.5% more than the amount a utility had generated the previous year. The payment for failure to meet the 4 percentage point increase would be $40/MWh of the generation shortfall.

While those grants and payments would not directly benefit nuclear power plants, they could influence an electric utility’s decisions on nuclear plant closures, expanding a nuclear plant’s generating capacity, or even building new reactors.

Other Bills and Hearings

The Senate Energy and Natural Resources Committee held a hearing on nuclear energy March 25, 2021, which included a focus on existing U.S. nuclear plants. Chair Joe Manchin said in his opening statement, “Lifetime extensions are cheaper than new builds and are generally cost competitive with other generation technologies. We cannot afford to let this carbon-free energy resource fade out.” Manchin subsequently sent a letter to President Biden urging him “to take action to preserve our existing nuclear fleet and prevent further closures.” An amendment to provide a production tax credit for existing nuclear power plants was proposed by Senator Ben Cardin in the Senate Finance Committee but not offered for a vote during a markup of draft energy tax legislation on May 26, 2021.

Nuclear plant closures were discussed at a May 6, 2021, hearing by the House Appropriations Subcommittee on Energy and Water Development on the DOE FY2022 budget request. Under questioning, Energy Secretary Jennifer M. Granholm pledged to work with Congress to find ways


to keep existing reactors operating, a goal that was supported by Subcommittee Chair Marcy Kaptur.

The 10th anniversary of the March 2011 Fukushima nuclear accident in Japan also prompted congressional comment on the future of U.S. nuclear power, especially the safety of existing plants. Senator Edward Markey, Chair of the Subcommittee on Clean Energy, Climate, and Nuclear Safety of the Environment and Public Works Committee, issued a statement on the Fukushima anniversary calling on the Nuclear Regulatory Commission (NRC) to ensure that the lessons of Fukushima are applied to existing U.S. reactors and not relaxed to ensure nuclear industry profitability.45

Legislation has been introduced in the 117th Congress to establish a national clean energy standard (CES), which would require electric utilities to provide specific amounts of power to their customers from eligible low- or zero-carbon generators. A CES that includes nuclear energy could increase the demand for electricity from existing reactors and possibly provide an economic incentive for building new ones. The CLEAN Future Act (H.R. 1512), introduced March 2, 2021, by House Energy and Commerce Committee Chair Frank Pallone Jr., includes a CES that would gradually rise to 100% zero-emission electricity generation by 2035 and afterward. Nuclear power is eligible in the CLEAN Future Act. The House Energy and Commerce Committee held a hearing on the bill March 24, 2021.46

The 116th Congress enacted the Energy Act of 2020 (Division Z of P.L. 116-260), which authorized appropriations for DOE’s ongoing “sustainability” research and development program to improve the economics, safety, and continued operation of existing nuclear power plants. Division D of P.L. 116-260 provided appropriations of $47 million for the sustainability program for FY2021, the same as in FY2020.

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