PROMISING MARKET AND FEDERAL SOLUTIONS FOR EXISTING NUCLEAR POWER

C2ES CENTER FOR CLIMATE AND ENERGY SOLUTIONS

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Since late 2012, six of the 104 nuclear reactors in the United States have retired. An additional 13 reactor retirements by 2025 have been announced. These early retirements impact the United States' ability to reduce greenhouse gas emissions and meet its near- and long-term climate goals. A recent Carnegie Mellon University study found that, without a significant recommitment to nuclear power and change to the policy environment, the United States will continue to shutter nuclear power plants, a critical wedge of reliable and zero-emission electricity, over the next few decades. Policy actions by a few states have averted some planned reactor closures. This brief first reviews lessons learned from these state actions. Then it explores electricity market options and federal programs that could adequately reward nuclear power's environmental benefits. Preserving the existing U.S. nuclear reactor fleet for as long as practical is a critical element in the transition to a low-carbon future.

INTRODUCTION

Nuclear power is responsible for around 20 percent of U.S. electricity generation and more than 50 percent of its zero-emission generation. However, these large sources of zero-emission power are being retired prematurely (in comparison to their operating license expiration dates) because of low wholesale electricity prices resulting from low natural gas prices, excess power generation capacity, declining renewable energy costs, and low growth in electricity demand.[1] Unfortunately, retiring nuclear generation is largely being replaced by fossil fuel-fired electricity, sending U.S. emissions in the wrong direction and offsetting the environmental gains made with renewables thus far. With a finite amount of carbon dioxide (and other greenhouse gases) the world can emit before reaching the atmospheric concentrations of 450 parts-per-million that risk serious climate impacts, we cannot afford such backsliding.

In addition to its climate benefit, other positive attributes of nuclear power include: reliability, fuel diversity within the broader electric generation portfolio, relatively small geographic footprint, and no conventional air pollution (i.e., no sulfur or nitrogen oxides, particulates, or air toxics). Additionally, preserving the existing nuclear power plant fleet supports local jobs

and provides significant tax revenue, maintains domestic nuclear expertise, benefits our national security, and could help promote safer nuclear power globally.

Nuclear power plants consistently operate at the highest capacity utilization rates (greater than 90 percent) of any electric power source. A typical 1-gigawatt (GW) plant produces enough zero-carbon electricity to power more than 700,000 average U.S. households. That quantity of electricity is challenging to replace with other zero-emission alternatives. For example, it would take close to 700,000 solar roofs to replace the power produced by a 1 GW nuclear power plant.[2] Finding a dependable, controllable, zero-emitting, cost-effective alternative to nuclear power is challenging. Closure decisions should not be taken lightly; once a nuclear plant is decommissioned, it's extremely difficult to resurrect it. Retirement is an irreversible decision. Preserving the existing nuclear fleet for as long as is practical buys critical time to deploy renewables, develop and deploy other zero-emission technology (e.g., carbon capture, advanced nuclear power, energy storage, and energy efficiency) and new key electricity infrastructure such as transmission lines, and avoids backsliding in our emissions trajectory.

Earlier this year, in *Solutions for Maintaining the Existing Fleet*, the Center for Climate and Energy Solutions (C2ES) identified policy solutions that offer the greatest promise to support the continued operation of the existing fleet of nuclear power plants.[3] C2ES explored several policy options, including state-level zero-emission credits (ZECs), state clean electricity portfolio standards, nuclear plant license renewals, carbon pricing, and nuclear power purchase agreements, among other things. The policy landscape, however, is evolving rapidly, and since that report, discussions of other federal options have advanced. This brief explores additional federal options, including potential Federal Energy Regulatory Commission (FERC) actions, and a federal version of ZECs that would be implemented through a reverse auction. It also takes a deeper dive on carbon and clean energy pricing options that could be implemented by Regional Transmission Organizations and Independent System Operators (RTOs and ISOs, including PJM, NYISO, and ISO-NE).[4] Prior to diving more deeply on FERC and RTOs, however, it is useful to consider the lessons from existing state programs.

LESSONS FROM RECENT EXPERIENCE WITH STATE POLICIES AND WHOLESALE POWER MARKETS

Solutions for Maintaining the Existing Fleet described how several states have developed tailored policies that are keeping at-risk nuclear plants open. The figure below shows eight plant closures that have been averted by these state policies.[5]

As C2ES previously noted, action to help at-risk nuclear plants in the United States could be taken at the federal or state level; a hybrid of federal and state actions is also possible. For states with at-risk nuclear power plants, the most promising path forward at the moment (and in the absence of federal action) is to replicate what New York, Illinois and New Jersey did (i.e., use a Zero Emissions Credit (ZEC) mechanism for nuclear power plants in combination with policies that advance renewables and possibly other low-carbon power sources). The key for any policy solutions whether federal, state or hybrid, is to compensate nuclear plants commensurate with their public benefits, without pitting them against other low-carbon sources, without making electricity bills unaffordable, and without running afoul of the Federal Energy Regulatory Commission (FERC)'s prohibition of interference in wholesale power markets.

In New York, Illinois, and New Jersey, the starting point for determining the ZEC price is the social cost of carbon—a measure of the health, economic and environmental damage caused by an additional ton of carbon pollution.[6, 7] The most analytically rigorous estimate of the social cost of carbon was compiled by a U.S. Interagency Working Group in 2010, which valued it at $42 per metric ton of carbon dioxide emission in 2020 in 2007 U.S. dollars.[8]

However, compensating nuclear power plants for the environmental benefits they provide must be carefully considered to ensure that electricity bills remain affordable. In New York, the ZEC price was adjusted downward based on other environmental-related revenues nuclear plants receive (e.g., from the Regional Greenhouse Gas Initiative). One feature of the Illinois

FIGURE 1: Location of Nuclear Power Retirements: Closed, Announced and Averted

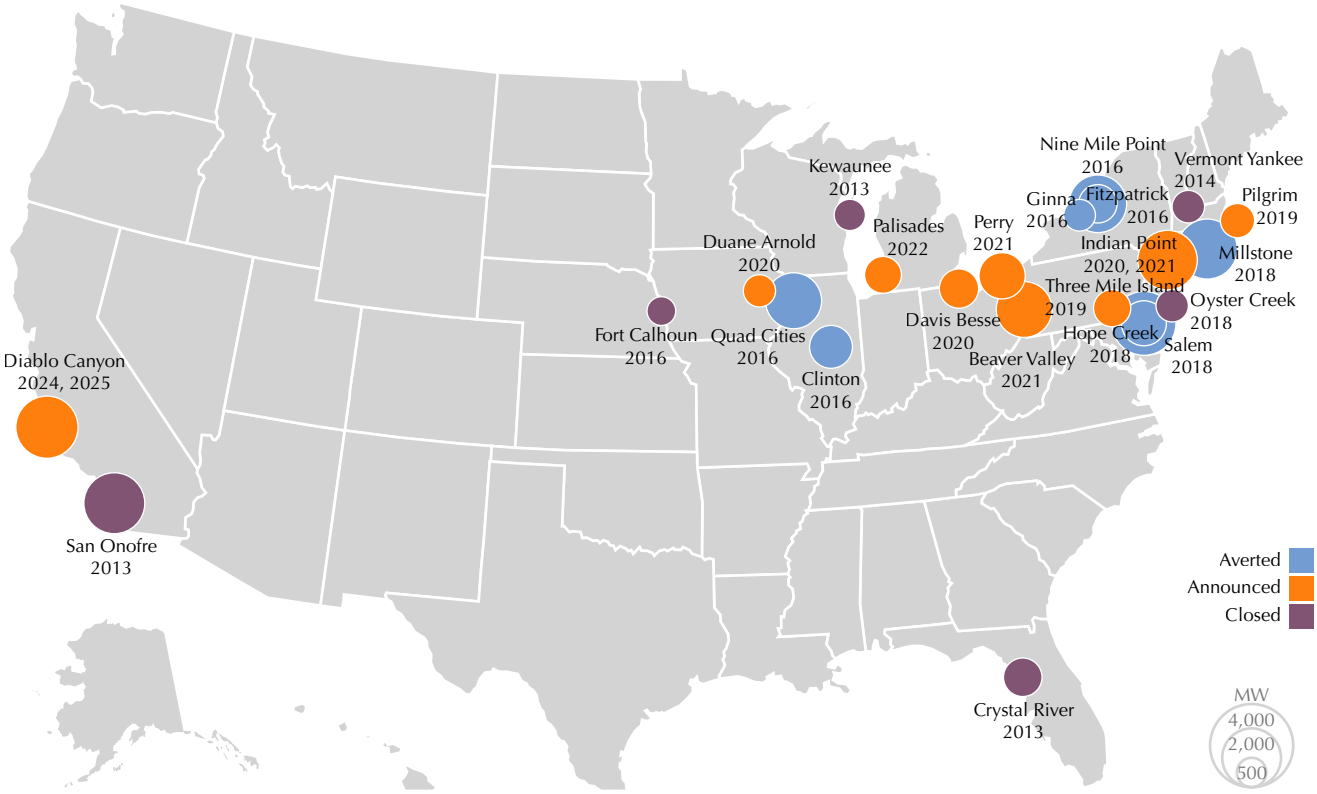

Figure shows (1) closures that have been averted by state action and the year that state action occurred, (2) announced nuclear plant retirements and expected retirement year, and (3) closures that occurred and the year the closure occurred. Plant capacity is approximated by circle size. *Figure source:* U.S. Department of Energy, Staff Report on Electricity Markets and Reliability, updated by the authors. *https://energy.gov/sites/prod/files/2017/08/f36/Staff%20Report%20on%20Electricity%20Markets%20and%20Reliability_0.pdf*

approach is a cap on ratepayer increases, which doesn't affect the ZEC price, but affects the number of ZECs purchased and hence the payments the nuclear plants receive. Additionally in Illinois, New York, New Jersey, and Connecticut, eligible nuclear plants are required to open their books to their respective state public utility commissions (PUCs). In turn, states agree not to reveal competitive information. Thus, the PUCs using the rate cap and other policy measures are able to provide the correct balance: to ensure that nuclear plants receive the compensation they need to continue to operate and provide environmental benefits to the state and at the same time allow electricity bills to remain affordable for all consumers. In the states that have acted thus far, nuclear power will receive no more, and generally significantly less, than the societal benefit provided to customers and communities.

In addition to the issue of affordability, states must also ensure that they are not interfering with the operation of wholesale power markets, which is prohibited by FERC under the Federal Power Act. Wholesale market decisions such as which plants to run (or "dispatch") are a function of many factors. Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs) ensure smooth operation of competitive wholesale markets under FERC oversight. States cannot interfere with the operation of these markets. However, states are responsible by statute to ensure compliance with federal pollution laws and also have in many cases adopted carbon reduction targets which they have concluded cannot be met without preserving existing zero-carbon nuclear plants. To this end, states can set policies (e.g., renewable portfolio standards or clean energy standards) that favor renewable or

low-carbon resources and that therefore may affect market prices.[9]

Recently, FERC, states and the courts have been paying careful attention to other state actions that could influence the wholesale power markets to ensure that states and FERC do not infringe on each other's jurisdiction. For example, a 2016 U.S. Supreme Court decision, *Hughes v Talen Energy Marketing*, invalidated a Maryland program that awarded Competitive Power Ventures (CPV) natural gas plant a capacity price that was different from the price set by the PJM capacity auction, but only if the plant "cleared" in that auction, which the court concluded impermissibly "tethered" the payment to the plant bidding as a price taker in the auction.[10] The court, however, concluded that "Nothing in this opinion should be read to foreclose Maryland and other states from encouraging production of new or clean generation through measures 'untethered to a generator's wholesale market participation'." The decision also noted that states could regulate in situations under their jurisdiction, even when that has an incidental impact on FERC markets.

FERC itself could affirm state autonomy over environmental policies including payments to procure zero-carbon-emitting power. In fact, FERC has recently opined that Illinois' ZEC program does not violate any federal rules.[11] Moreover, the two district court judges who have ruled on the ZEC programs (in Illinois and New York) held that the ZEC programs do not intrude on FERC's jurisdiction by regulating a wholesale power rate because the ZECs are separate commodities that reward generators for emission-free energy. They also held that the programs do not violate Hughes because the states' programs do not include the "fatal defect" of the program at issue in Hughes, which was that it conditioned payment on a generator clearing a FERC-regulated auction.

FERC held a technical conference in May 2017 to "explore how the competitive wholesale markets can select resources of interest to state policy makers while preserving the benefits of regional markets and economic resource selection."[12] RTOs have been individually wrestling with these questions as well. Recently, PJM proposed courses of action to reduce the impact on power markets of efforts by states to preserve and promote resources needed to meet state environmental goals. The two proposals PJM submitted to FERC were: (1) a two-part capacity repricing proposal supported by PJM staff, and (2) a proposal from PJM's independent market monitor to expand the current minimum offer price rule (MOPR).[13] The purpose of the MOPR is to prevent market participants from submitting uncompetitive, low offers to artificially depress capacity auction clearing prices. Both proposals attempt to address the consequences of state policies favoring particular power resources, where the fear is that these policies could depress wholesale power prices, pushing other types of resources out of the market.

PJM's proposals address this issue in different ways. PJM's capacity repricing proposal would have added a second capacity auction, removing offers from state-supported resources and replacing them with PJM's estimates of a competitive offer. The other proposal would have expanded the MOPR to cover subsidized resources, with some exemptions. Most states and market participants prefer the status quo over either option.[14]

FERC rejected both PJM options and instead called for expedited consideration of MOPR expansion with fewer exemptions than PJM proposed, in combination with an option for certain subsidized resources to choose to be temporarily removed from the PJM capacity market, along with a corresponding amount of load. Done correctly, FERC's proposal will allow states to protect their rights to express a preference for reliance upon clean energy resources while protecting the significant economic benefits of regional markets. While crucial implementation details still need to be worked out, proper implementation of FERC's direction in the PJM market could accommodate state clean energy public policy decisions.

OPTIONS UNDER CONSIDERATION

FERC could take a number of actions that would accommodate a state's clean energy policy goals and maintain the environmental benefits that come from preserving the existing nuclear fleet. Through its jurisdiction over competitive wholesale power markets, FERC could initiate such action on its own, or in reaction to a filing

by one or more RTOs or ISOs. At the FERC technical conference in May 2017, there was extensive discussion of the challenges that renewable-specific and, more recently, nuclear-specific state policies are posing to organized markets, with many witnesses recommending a carbon price as the ideal policy to achieve states' policy objectives within the market construct.[15] All three eastern ISOs are involved in stakeholder processes in their respective regions and have either submitted or are submitting market reform proposals to FERC: (1) NYISO recently issued a straw proposal for carbon pricing; (2) FERC recently rejected two market reform proposals submitted by PJM (discussed above), and (3) FERC approved ISO-NE's plan to split its capacity market auctions into two parts to better handle subsidized resources and the New England Power Pool (NEPOOL) is exploring additional market reforms.[16, 17]

As C2ES mentioned in *Solutions for Maintaining the Existing Fleet*, New York is looking to incorporate the cost of carbon into its wholesale power market. Activities to advance this action are continuing apace; in April 2018, the NYISO issued a straw proposal outlining how this policy might be implemented.[18] The NYISO would apply a carbon "adder" (in $/MWh) from its payments to suppliers of power in proportion to their emissions. Suppliers would include these carbon adders in their energy offers and thereby incorporate the carbon adder into NYISO's power transactions. The NYISO would apply the carbon adder to imports and exports to prevent emissions leakage and market distortions.

The carbon adder would make higher-emitting power sources more expensive than lower-emitting ones. In wholesale power markets, the highest-cost resource (typically, natural gas- or coal-fired generation) necessary to supply the market sets the market price. All else equal, the carbon adder would increase market prices overall. Because lower-emitting power sources pay a lower or no carbon adder, lower-emitting New York power sources, including efficient fossil units, renewables, hydropower, and nuclear generators, would benefit.

Because New York ZEC prices are adjusted based on other revenues the nuclear plants received, if a carbon adder were overlaid on the existing New York state ZEC policy, nuclear plants would not receive additional compensation: they would simply receive higher revenue (due to the carbon adder) in lieu of ZEC revenue. In August of 2017, PJM issued a report exploring carbon pricing frameworks, but has not issued any formal carbon pricing proposals.[19]

One proposal put forward by the Conservation Law Foundation in the NEPOOL stakeholder process and by National Grid in the NYISO process is a Dynamic Forward Clean Energy Market (DFCEM).[20, 21] The objective is to create a centralized market to procure clean energy on a least-cost basis. The market would transparently determine the value of zero-emitting generation at a particular place and time.[22] DFCEM would ensure that existing zero-emitting resources (e.g., nuclear, carbon capture and renewables) remain in the market, while also attracting new resources to meet state goals. Renewable energy credits (RECs) provide flat payments every hour, creating an incentive to offer power at negative prices just to obtain the REC, even when more power is being produced than is needed. DFCEM payments, on the other hand, scale in proportion to marginal CO_2 emissions, providing an incentive to produce clean energy where and when it would reduce the most emissions, providing no incremental incentive to offer power at negative prices.[23]

FERC could also take actions that are supportive of existing nuclear power plants, but not directly tied to nuclear power's carbon benefits. For example, FERC could allow ISOs to compensate nuclear plants for the system resilience benefits of their on-site fuel storage, or it could act to improve the functioning of capacity markets, which favor capacity such as nuclear plants with high dependability.[24] A 2017 DOE study observed that "Society places value on attributes of electricity provision beyond those compensated by the current design of the wholesale market" and recommended that FERC advance the creation of fuel-neutral markets and/or regulatory mechanisms that compensate grid participants for essential reliability and resiliency services.[25, 26] The DOE study recommended that FERC expedite market rule changes to allow essential generation sources that operate on a 24x7 basis to set the price during the hours the system needs them to run, which is not how it works today (see carbon adder discussion above).[27] Currently, there are hours of the day when the price is settling at a level that is below the costs of a unit that the system needs to run, which means those units (i.e., often operating at their minimum levels and prepared to serve load the following day) are losing money. Implicitly, markets are currently pricing flexibility (i.e., accommodating a sudden surge in variable generation) and power together.[28] The PJM CEO noted that if those two attributes could be separated, "price power balance and price flexibility as a separate grid service, that would be much more robust

and equitable."[29] Also, the PJM CEO noted that, "about 60 percent of the energy supplied in PJM in a year is supplied by resources that have to run 24/7."[30] Existing nuclear power plants could benefit from such a transparent price formation approach. The DOE study also recommended market reforms to ensure that resources are not required to operate at a loss, which could also benefit the existing nuclear fleet.

On September 28, 2017, the Secretary of Energy proposed a rule and directed FERC to take final action on it within 60 days to provide "full recovery of costs" for power plants that keep 90 days of fuel supplied on site.[31] While this approach could have helped existing coal and nuclear plants to continue to operate, by taking the cost recovery for these plants out of the market, it could have significantly reduced the effectiveness wholesale power markets. The policy would have helped both coal and nuclear plants equally, but keeping nuclear plants operating has environmental benefits while keeping uncontrolled coal plants (without carbon capture) operating has negative environmental impacts. After taking public comment, FERC rejected the DOE proposed rule, instead asking each regional grid operator to assess how best to enhance the resilience of the power system and report back to FERC. FERC Chairman Kevin McIntyre has stated publicly that if FERC finds that resources are providing resilience they must be compensated accordingly.[32] To compare the environmental impacts of alternative resilience options, FERC could order RTOs to model the emissions consequences of potential resilience solutions, consistent with how FERC considers environmental impacts under the National Environmental Policy Act (NEPA) in other matters. PJM asked FERC to direct operators to update market compensation for power plants to reflect resilience attributes. Other grid operators told FERC they can address resilience issues within their own stakeholder processes.[33]

The Trump Administration has reportedly asked the DOE to consider a number of options including invoking Section 202(c) of the Federal Power Act, under which the Energy Department can order certain power facilities to stay open in a crisis, such as a hurricane, in order to keep nuclear and coal plants operating[34] or invoking the Defense Production Act of 1950, which allows the federal government to intervene in private industry in the name of national security. If either of these options go forward, FERC might have to decide how these plants would be compensated.

PROMISING OPTIONS FOR FEDERAL LEGISLATION

Federal versions of the state-level options described earlier have the potential to be more effective and economically efficient than state action. However, four states have demonstrated that state-level action is possible, whereas federal action has thus far been elusive. A national clean energy standard (CES) proposed by then-Senator Bingaman (D-NM), then-chairman of the Senate Energy and Natural Resources Committee, in 2012 covered all clean energy sources, but gave half credit for natural gas and, in some instances, credit for energy efficiency. The most economically efficient approach would be such a CES, a Forward Clean Energy Market (DFCEM), or a meaningful carbon price, either through a cap and trade program, a carbon tax, or potentially a carbon adder applied by ISOs in organized wholesale markets (e.g., as currently being explored by NYISO). This would provide a uniform incentive to reduce carbon emissions and would result in the most carbon reductions for the lowest cost. It would not be targeted particularly at nuclear power plants, but it would make them more competitive relative to natural gas and conventional coal plants.

A promising new option is a federal ZEC mechanism. In March 2018 at Third Way's Advanced Nuclear Summit, Sen. Sheldon Whitehouse (D-RI) said, "I'm working on legislation that would pay nuclear facilities that are economically at risk for their avoided carbon emissions. I'm hopeful it's an idea that would appeal to Democrats and Republicans in Congress."[35] Sen. Whitehouse is referring to a federal ZEC mechanism incorporating a "reverse auction," in which nuclear plants bid for the ZEC price they need to continue to operate. A federal ZEC mechanism could provide financial assistance in the form of tax credits or federal payments. In either case, it would be provided to plants in the order from lowest ZEC bid to highest, until the available funding ran out. Ideally, the total amount of available financial assistance would not be made public. Thus, plants would have an

incentive to bid their true costs, lowering the requisite government outlay.

The reverse auction is desirable because in competitive wholesale power markets, plant owners are not required to publicly report their costs. Available cost information indicates that compensation based on their actual revenue gap (the difference between the nuclear plant's operating costs and the revenue it receives from power markets) would be less than the social cost of carbon for almost all of the nuclear plants that are struggling under current market conditions.[36] In order to limit eligibility to plants that genuinely need financial assistance, applicants would need to qualify by passing a financial screen administered by the U.S. Department of Energy or the U.S. Department of Treasury. The reverse auction could work at the federal level because there are enough plants to participate in a robust bidding process. At the state level, the number of plants is likely too small. Depending on the range of revenue gaps, DOE or Treasury could divide the auction into tiers to economically optimize the bidding and financial assistance process. The federal ZEC program is envisioned as an interim rather than long-term program to provide financial assistance to the existing fleet until a longer-term carbon policy is in place. A federal ZEC mechanism would reduce the need for a state-by-state approach to preserving existing nuclear plants. Depending how the federal ZEC mechanism is designed, it could reduce state-level ZEC payments in those states where such policies are already in place.

CONCLUSION

Additional bipartisan progress is possible on preserving the national security, environmental, energy system and economic benefits of nuclear power. Connecticut, Illinois, New Jersey, and New York have shown one way forward with bipartisan comprehensive policies that advance both nuclear and renewable power. Given this record of success, it appears that progress is most likely at the state level. However, discussions in RTOs, ISOs and FERC appear promising. The DFCEM is a promising new idea. The carbon adder proposal is moving forward in the NYISO. As with its ZEC program, New York could once again set the standard for sound environmental policy in power markets across the United States. Also, the concept of allowing essential generation (required for system reliability) to set market prices is compelling. Finally, a federal ZEC reverse auction has the potential to avert a greater number of premature nuclear plant closures more efficiently than independent state actions. Whether it is FERC on its own initiative or in response to initiatives by RTOs and ISOs, or Congress building on lessons from states, federal action could help move us more expeditiously toward a secure and low-carbon future.

C2ES thanks Vulcan Inc. for its support of this work. As a fully independent organization, C2ES is solely responsible for its positions, programs, and publications.

ENDNOTES

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2 More precisely, 1 GW of nuclear at 92 percent capacity factor generates: 8,059,200 MWh of electricity per year. That's equivalent to 684,524 solar rooftops (24 panels @ 280W/panel) at a 20 percent capacity factor (typical for CA, but not MA) http://www.energy.ca.gov/2013publications/CEC-400-2013-005/CEC-400-2013-005-D.pdf (Figure 3: PV Capacity Factors by Climate Zone).

As another example, five nuclear plants produce the same amount of power as 3,700,000 5-KW solar roofs. Even though the equivalent amount of power can be generated with solar roofs, additional backup generation or energy storage would be necessary to completely replace a nuclear power plant because solar panels cannot generate electricity at night or on cloudy days.

https://www.c2es.org/publications/climate-solutions-role-nuclear-power-infographic

3 Vine, Doug. "Solutions for Maintaining the Existing Nuclear Fleet." C2ES, May 2017.

https://www.c2es.org/document/solutions-for-maintaining-the-existing-nuclear-fleet/.

4 One RTO and two ISOs are referenced in this paper; PJM is an RTO serving 13 states and the District of Columbia, NYISO serves the state of New York, and ISO-NE serves the six New England states

5 Between 2013 and 2016, 4,666 MW of nuclear generating capacity, or approximately 4.7 percent of the U.S. total, retired. Another twelve reactors representing 11,119 MW of nuclear capacity (11.1 percent of U.S. nuclear capacity and approximately 0.9 percent of total U.S. generating capacity) have announced retirement plans since 2015. This does not include seven reactors that averted early retirement through state action. U.S. Department of Energy, Staff Report plus author updates. Note also that New Jersey's new state law is expected to avoid the retirement of two nuclear plants that PSEG had described as at-risk but had not formally announced as retiring. Note also that all capacities are net summer capacity.

6 "Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide." The National Academies Press. 2017. https://www.nap.edu/read/24651/chapter/2.

7 The New Jersey Clean Energy Law establishes the 2016 SCC as a benchmark and states that the ZEC payment must be "significantly less" than the SCC so it is a guideline for the NJ BPU in determining the ZEC amount.

8 "Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide." The National Academies Press. 2017. https://www.nap.edu/read/24651/chapter/2.

9 It is not the organized markets themselves that are valuing, or failing to value, environmental costs and benefits. Such costs and benefits will only be reflected in power prices to the extent that state or federal environmental policy requires it.

10 "Hughes v Talen Energy," Supreme Court of the United States, April 2016. https://www.supremecourt.gov/opinions/15pdf/14-614_k5fm.pdf.

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14 Bade, Gavin. "PJM stakeholders pan capacity market reforms in FERC comments." Utility Dive. May 8, 2018. https://www.utilitydive.com/news/pjm-stakeholders-pan-capacity-market-reforms-in-ferc-comments/523036/.

15 FERC held a technical conference on May 1-2, 2017, taking on the topic of how to reconcile wholesale markets' economic efficiency decision rules with states' interest in favoring particular resources. FERC technical conference on State Policies and Wholesale Markets Operated by ISO New England, New York ISO and PJM Interconnection, May 1-2, 2017. At the conference, over fifty state, stakeholder, industry expert and ISO witnesses discussed the interplay of organized markets with state policies that encourage or discourage particular energy resources. There was broad agreement that the integration of these policies and markets pose challenges and that it is a high priority for states, stakeholders, ISOs and FERC to work collaboratively to address them.

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19 "Advancing Zero Emissions Objectives through PJM's Energy Markets: A Review of Carbon-Pricing Frameworks." PJM, August 23, 2017. https://www.pjm.com/~/media/library/reports-notices/special-reports/20170502-advancing-zero-emission-objectives-through-pjms-energy-markets.ashx.

20 Stoddard, B. Robert. "RTO Markets Must Change to Accommodate State Policies." May 2017. https://www.ferc.gov/CalendarFiles/20170426151751-Stoddard,%20Conservation%20Law%20Foundation.pdf. An earlier incarnation of this idea was called Carbon-Linked Incentive for Policy Resources (CLIPR).

21 Spees, Kathleen, Chang, Judy, and Oates, David Luke. "A Dynamic Clean Energy Market in New England." The Brattle Group, November 2017. http://www.brattle.com/news-and-knowledge/publications/a-dynamic-clean-energy-market-in-new-england.

22 DFCEM would define an energy price premium paid to a clean resource by the ISO, with the cost collected from the responsible load-serving entity. The premium is not fixed, but instead varies in direct proportion to the marginal carbon intensity (MCI) of the dispatch, a direct analog to the locational marginal price (LMP) but in terms of lbs-CO2/MWh instead of $/MWh. The ISO would conduct annual auctions shortly before each annual capacity auction to clear resources in each state-defined clean resource category. There could be multiple categories of clean resources. All resources clearing in a category would receive the same clearing price. Bids are submitted by the states or their load serving entities as price-quantity pairs, then aggregated by the ISO. Costs of funding the DFCEM are allocated back to the load-serving entities that bid and cleared in the auction.

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24 In this case resilience means the ability to maintain continued system operations, even when some plants in the system are facing fuel delivery problems.

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26 Ibid, "Markets recognize and compensate reliability, and must evolve to continue to compensate reliability, but more work is needed to address resilience."

27 Ibid, "FERC should expedite its efforts with states, RTO/ISOs, and other stakeholders to improve energy price formation in centrally-organized wholesale electricity markets."

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31 Pursuant to section 403 of the Department of Energy Organization Act.

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