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Nuclear Energy: Overview of Congressional Issues

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Summary

The policy debate over the role of nuclear power in the nation's energy mix is rooted in the technology's fundamental characteristics. Nuclear reactors can produce potentially vast amounts of useful energy with relatively low consumption of natural resources and emissions of greenhouse gases and other pollutants. However, facilities that produce nuclear fuel for civilian power reactors can also produce materials for nuclear weapons. In addition, the process of nuclear fission (splitting of atomic nuclei) to generate power produces radioactive material that can remain hazardous for thousands of years and must be contained. How to manage the weapons proliferation and safety risks of nuclear power, or whether the benefits of nuclear power are worth those risks, are issues that have long been debated in Congress.

The 99 licensed nuclear power reactors at 60 sites in the United States generate about 20% of the nation's electricity. Two new reactors are currently under construction. About a dozen more are planned, but whether they will eventually move forward will depend largely on their economic competitiveness with natural gas and coal plants. Throughout the world, 447 reactors are currently in service or operable, and 56 more are under construction.

The March 2011 disaster at the Fukushima Dai-ichi nuclear power plant in Japan increased attention to nuclear safety throughout the world. The U.S. Nuclear Regulatory Commission (NRC), which issues and enforces nuclear safety requirements, established a task force to identify lessons from Fukushima applicable to U.S. reactors. The task force's report led to NRC's first Fukushima-related regulatory requirements on March 12, 2012. Several other countries, such as Germany and Japan, eliminated or reduced their planned future reliance on nuclear power after the accident.

Highly radioactive spent nuclear fuel that is regularly removed from nuclear power plants is currently stored at plant sites in the United States. Development of a permanent underground repository at Yucca Mountain, NV, was suspended by the Obama Administration, but the Trump Administration has requested funding for FY2018 to revive the program. The House has approved the Yucca Mountain funds, but the Senate Appropriations Committee did not, following a pattern of recent years.

The Obama Administration had appointed the Blue Ribbon Commission on America's Nuclear Future to recommend an alternative approach to the Nuclear Waste Policy Act's focus on Yucca Mountain. In response to the commission's recommendations, the Department of Energy issued a new waste strategy in January 2013 that called for the selection of new candidate sites for nuclear waste storage and disposal facilities through a "consent-based" process and for a surface storage pilot facility to open by 2021. However, a new nuclear waste policy has not been enacted by Congress, so Yucca Mountain remains the sole authorized candidate site.

The level of security that must be provided at nuclear power plants has been a high-profile issue since the 9/11 terrorist attacks on the United States in 2001. Since those attacks, NRC issued a series of orders and regulations that substantially increased nuclear plant security requirements, although industry critics contend that those measures are still insufficient.

Encouraging exports of U.S. civilian nuclear products, services, and technology while making sure they are not used for foreign nuclear weapons programs has long been a fundamental goal of U.S. nuclear energy policy. Recent proposals to build nuclear power plants in several countries in the less developed world, including the Middle East, have prompted concerns that international controls may prove inadequate.

Contents

Contacts

Synthesis of Key Issues

The long-running policy debate over the future of nuclear energy is rooted in the technology's inherent characteristics. Initially developed for its unprecedented destructive power during World War II, nuclear energy seemed to hold equal promise after the war as a way of providing limitless energy to all humanity. International diplomacy has focused ever since on finding institutional mechanisms for spreading the perceived benefits of nuclear energy throughout the world while preventing the technology from being used for the proliferation of nuclear weapons. Much of this international effort is focused on key nuclear fuel cycle facilities—plants for enriching uranium in the fissile isotope U-235 and for separating plutonium from irradiated nuclear fuel. Such plants can be used to produce civilian nuclear reactor fuel as well as fissile material for nuclear warheads.

Yet even the use of nuclear power solely for peaceful energy production has proven intrinsically controversial. The harnessing of nuclear fission in a reactor creates highly radioactive materials that must be kept from overheating and escaping from the reactor building, as occurred during the accidents at Fukushima, Chernobyl, and, to a lesser extent, Three Mile Island. Spent nuclear fuel that is regularly removed from reactors during refueling must be isolated from the environment for up to 1 million years. Potential technologies to reduce nuclear waste through recycling usually involve separating plutonium that could be used for nuclear weapons and would still leave substantial amounts of radioactive waste to be stored and disposed of. Central storage and disposal sites for nuclear waste have proven difficult to develop throughout the world, as illustrated by long-running controversy over the proposed U.S. waste repository at Yucca Mountain, NV.

The March 2011 disaster at Japan's Fukushima Dai-ichi nuclear power plant, which forced the evacuation of areas as far as 30 miles away, has slowed nuclear power expansion plans around the world, particularly in Japan and Western Europe. However, dozens of new reactors are still being planned and built in China, India, Russia, and elsewhere.[1] In these areas, nuclear power's initial promise of generating large amounts of electricity without the need for often-imported fossil fuels, along with the more recent desire to reduce greenhouse gas emissions, remains a compelling motivation.

With 99 licensed reactors, the United States has the largest nuclear power industry in the world. But U.S. nuclear power growth has been largely stagnant for the past two decades, as natural gas and renewable energy have captured most of the market for new electric generating capacity.[2] Congress enacted incentives for new nuclear plants in the Energy Policy Act of 2005 (P.L. 109-58), including production tax credits, loan guarantees, and insurance against regulatory delays. Those incentives, combined with rising natural gas prices and concerns about federal restrictions on carbon dioxide emissions, prompted announcements by late 2009 of up to 30 new nuclear power reactors in the United States.[3] However, subsequent drops in natural gas prices and uncertainty about carbon dioxide controls have put most of those projects on hold. Currently, two new reactors in Georgia are under construction. The construction of two identical reactors in

[1] World Nuclear Association, "World Nuclear Power Reactors and Uranium Requirements," September 2017, http://www.world-nuclear.org/information-library/facts-and-figures/world-nuclear-power-reactors-and-uranium-requireme.aspx.

[2] Energy Information Administration, "U.S. Electric Generating Capacity Increase in 2016 Was Largest Net Change Since 2011," February 27, 2017, https://www.eia.gov/todayinenergy/detail.php?id=30112.

[3] Nuclear Regulatory Commission, "Expected New Nuclear Power Plant Applications," updated September 28, 2009. Available from the author.

South Carolina was halted July 31, 2017. An older reactor, Watts Bar 2 in Tennessee, received an NRC operating license on October 22, 2015, after construction had been suspended for two decades. Its twin unit, Watts Bar 1, the most recently completed U.S. reactor, received its operating license in 1996. A variety of incentives to renew the growth of nuclear power have been proposed, including a plan by the Trump Administration to provide additional revenue to nuclear and coal power plants in wholesale electricity markets.

Existing U.S. nuclear power plants are facing difficult competition from natural gas and renewable energy. Six U.S. reactors were permanently closed from 2013 through 2016. Three of those units closed because of the need for expensive repairs, while the others were operating well but could not compete in their local wholesale electricity markets. All six units had substantial time remaining on their initial 40-year operating licenses or had received or planned to apply for 20-year license extensions from the Nuclear Regulatory Commission (NRC). The owners of seven additional reactors have announced their permanent closure by the mid-2020s. The actual and planned shutdowns have prompted widespread discussion about the future of other aging U.S. reactors.

The extent to which the growth of nuclear power should be encouraged in the United States and around the world will continue to be a major component of the U.S. energy policy debate. Questions for Congress will include the implementation of policies to encourage or discourage nuclear power, post-Fukushima safety standards, development of new nuclear power and fuel cycle technologies, and nuclear waste management strategies.

Basic Facts and Statistics

The 99 licensed nuclear power reactors at 60 sites in the United States generate about 20% of the nation's electricity. The oldest of today's operating reactors were licensed in 1969, and the most recent had been in 1996, before the 2015 issuance of an operating license to Watts Bar 2. The reactors were initially licensed to operate for 40 years, but 80% have received or applied for 20-year license renewals by NRC. Under the current mixture of 40- and 60-year licenses, 28 of today's operating reactors would have to shut down by 2030 and the rest by 2049, except for the newly licensed Watts Bar 2.[4]

Whether new reactors will be constructed to replace the existing fleet or even to expand nuclear power's market share will depend largely on costs. The cost of building and operating a new nuclear power plant in the United States is generally estimated to be significantly higher than natural gas combined-cycle plants (which use both combustion and steam turbines to generate electricity) and above wind and solar as well. For example, the Energy Information Administration (EIA) estimates that, for plants coming on line in 2022, the average cost of electricity generation from a nuclear power plant would be 9.9 cents per kilowatt-hour (kwh), while advanced combined-cycle gas would cost 5.7 cents/kwh and coal plants with carbon sequestration would be 12.3-14.0 cents/kwh. EIA estimates that, including tax credits, electricity from onshore wind would cost 5.2 cents/kwh, solar photovoltaics 6.7 cents/kwh, and geothermal 4.3 cents/kwh.[5] Such estimates depend on a wide range of variables, such as future fuel costs, regional solar and wind availability, and environmental regulations.

[4] Nuclear Regulatory Commission, *Information Digest,*2017-2018, NUREG-1350, Volume 29, August 2017, Appendix A, https://www.nrc.gov/docs/ML1722/ML17228A746.pdf.

[5] Energy Information Administration, "Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2017," Table 1b, April 2017, https://www.eia.gov/outlooks/aeo/pdf/
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As noted above, the United States currently has two reactors under construction, at the Vogtle nuclear plant site in Georgia. The new reactors, after considerable construction delays and cost overruns, are now scheduled to begin operating in 2021 and 2022.[6] Licenses to build and operate eight additional reactors have been issued by NRC and two more are under review. However, applications for 12 other new reactors have been withdrawn or suspended.[7] Aside from the two new Vogtle units, the 10 planned reactors with licenses issued or under review do not have specific schedules for moving toward construction.

Throughout the world, 447 reactors are currently in service or operable, and 56 more are under construction. France is the most heavily nuclear-reliant country in the world, with 58 reactors generating 72% of the country's electricity in 2016. Thirty-one countries in 2016 (plus Taiwan) generated at least some of their electricity from nuclear power. [8]

After the Fukushima accident, Germany, which had previously generated about 30% of its electricity with nuclear power, closed 8 of the country's 17 power reactors and decided to shut the remainder by 2022. Japan, which had also generated about 30% of its electricity with nuclear power and had planned to raise that level to 50%, now is planning for about 20%. Only 5 of Japan's 42 operable reactors are currently in commercial service. Safety improvements in response to the tsunami are currently being implemented, and 21 reactors are undergoing regulatory reviews for possible restart. It is not clear how many of Japan's operable reactors will ultimately seek restart approval.[9] France had planned to reduce nuclear power to 50% of the country's total generation by 2025, although that goal has been delayed.[10]

Major Nuclear Energy Issues

Radioactive Waste

Highly radioactive spent nuclear fuel must regularly be removed from operating reactors and stored in adjacent pools of water. After several years of cooling, the spent fuel can be placed in dry casks for storage elsewhere on the plant site. When existing U.S. reactors were built, spent fuel had been expected to be taken away for reprocessing (separation of plutonium and uranium to make new fuel) or permanent disposal. However, reprocessing has not become commercialized in the United States, for economic and nonproliferation reasons, and central waste storage and disposal facilities have proven difficult to site. As a result, the vast majority of U.S. commercial

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electricity_generation.pdf. Levelized costs include capital costs averaged over the life of the plant, plus fuel and maintenance costs and tax credits.

[6] Georgia Power Company, *Seventeenth Semi-annual Construction Monitoring Report*, August 31, 2017, https://www.georgiapower.com/docs/VCM-17-Report-FINAL.pdf.

[7] Nuclear Regulatory Commission, "Combined License Applications for New Reactors," September 15, 2017, https://www.nrc.gov/reactors/new-reactors/col.html.

[8] World Nuclear Association, "Information Library," http://www.world-nuclear.org/information-library.aspx.

[9] World Nuclear Association, "Nuclear Power in Japan," http://www.world-nuclear.org/information-library/country-profiles/countries-g-n/japan-nuclear-power.aspx.

[10] Platts Nuclear News Flashes, "France's Environment Minister Delays 2025 Target to Reduce Nuclear Share of Generation," November 7, 2017.

spent fuel remains at the nuclear plants where it was generated—estimated at 78,800 metric tons at the end of 2017 and rising at the rate of about 2,000 metric tons per year.[11]

Recent Events

The Nuclear Waste Policy Act (P.L. 97-425, NWPA), as amended in 1987, named Yucca Mountain, NV, as the nation's sole candidate site for a permanent high-level nuclear waste repository. NWPA required the Department of Energy (DOE) to study the site and seek a license from the Nuclear Regulatory Commission (NRC) to build a repository there. Citing opposition from the State of Nevada, the Obama Administration decided to halt the Yucca Mountain project, and no funding has been appropriated for it since FY2010. However, the Trump Administration included funds to restart Yucca Mountain licensing in its FY2018 budget submission to Congress. The House-passed omnibus appropriations bill for FY2018 approved the Yucca Mountain funding request, but the Senate Appropriations Committee did not.

The Obama Administration appointed the Blue Ribbon Commission on America's Nuclear Future to develop an alternative nuclear waste policy, and its final report was issued in January 2012. DOE responded in January 2013 with a new waste strategy that called for a "consent-based" process to select nuclear waste storage and disposal sites and for a surface storage pilot facility to open by 2021.[12] DOE issued a *Draft Consent-Based Siting Process* shortly before the end of the Obama Administration.[13]

A federal appeals court on August 13, 2013, ordered NRC to continue the Yucca Mountain licensing process with previously appropriated funds.[14] In response, NRC issued the final volumes of the Yucca Mountain Safety Evaluation Report (SER), which provided the NRC staff's determination that the repository would meet all applicable standards. However, the staff said upon completing the SER that NRC should not authorize construction of the repository until all land and water rights requirements were met and a supplement to DOE's environmental impact statement (EIS) was completed.[15] NRC completed the supplemental EIS in May 2016 and made its database of Yucca Mountain licensing documents publicly available, using nearly all the remaining previously appropriated licensing funds.[16]

[11] Oak Ridge National Laboratory, CURIE database interactive map, https://curie.ornl.gov/map.

[12] DOE, *Strategy for the Management and Disposal of Used Nuclear Fuel and High-Level Radioactive Waste*, January 2013, http://energy.gov/sites/prod/files/2013%201-15%20Nuclear_Waste_Report.pdf.

[13] DOE, Draft Consent-Based Siting Process for Consolidated Storage and Disposal Facilities for Spent Nuclear Fuel and High-Level Radioactive Waste, January 12, 2017, https://energy.gov/sites/prod/files/2017/01/f34/Draft%20Consent-Based%20Siting%20Process%20and%20Siting%20Considerations.pdf.

[14] U.S. Court of Appeals for the District of Columbia Circuit, In re: Aiken County et al., No. 11-1271, writ of mandamus, August 13, 2013, http://www.cadc.uscourts.gov/internet/opinions.nsf/BAE0CF34F762EBD985257BC6004DEB18/$file/11-1271-1451347.pdf.

[15] NRC, "NRC Publishes Final Two Volumes of Yucca Mountain Safety Evaluation," news release 15-005, January 29. 2015, http://www.nrc.gov/reading-rm/doc-collections/news/2015/.

[16] NRC, Supplement to the U.S. Department of Energy's Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada, NUREG-2184, Final Report, May 2016, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr2184/; "NRC Staff Issues Volume 3 of Yucca Mountain Safety Evaluation Report," news release 14-069, October 16, 2014, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1949/v3/.

Selected Congressional Action

Sensible Nuclear Waste Disposition Act (H.R. 433, J. Wilson)

Prohibits DOE from developing a repository for only defense nuclear waste until NRC has issued a final decision on a construction permit for the Yucca Mountain repository. Introduced January 11, 2017, referred to Committee on Energy and Commerce.

Nuclear Waste Informed Consent Act (H.R. 456, Titus/S. 95, Heller)

Requires the Secretary of Energy to obtain the consent of affected state and local governments before making expenditures from the Nuclear Waste Fund for a nuclear waste repository. Both bills introduced January 11, 2017. House bill referred to Committee on Energy and Commerce; Senate bill referred to Committee on Environment and Public Works.

Interim Consolidated Storage Act of 2017 (H.R. 474, Issa)

Authorizes DOE to enter into contracts with privately owned spent fuel storage facilities. DOE would take title to all spent nuclear fuel from commercial reactors delivered to the private storage facility. Annual interest earned by the Nuclear Waste Fund could be used by DOE without further congressional appropriation to pay for private interim storage. Introduced January 12, 2017; referred to Committee on Energy and Commerce.

Nuclear Waste Policy Amendments Act of 2017 (H.R. 3053, Shimkus)

Provides land-use controls for development of Yucca Mountain repository, authorizes DOE contracts to store spent fuel at privately owned interim storage facilities, modifies funding mechanism for DOE nuclear waste program, and authorizes financial benefits for communities hosting waste facilities. Introduced June 26, 2017; referred to Committees on Energy and Commerce, Natural Resources, and Armed Services. Energy and Commerce Committee ordered reported June 28, 2017, by vote of 49-4 (H.Rept. 115-355).

Energy and Water Development Appropriations, FY2018 (H.R. 3266, Simpson/S. 1609, Alexander)

Provides funding for nuclear waste and other energy programs, as well as for water development projects and various independent agencies. H.R. 3266 was reported as an original measure by the House Committee on Appropriations July 17, 2017 (H.Rept. 115-230). It was combined with four other appropriations bills into H.R. 3219 and passed by the House on July 27, 2017. That measure was then combined with the remaining eight appropriations bills for FY2018 into H.R. 3354 and passed by the House on September 14, 2017. The House-passed omnibus bills include $120 million for DOE Yucca Mountain licensing activities ($90 million under Nuclear Waste Disposal and $30 million under Defense Nuclear Waste Disposal), plus $30 million for licensing activities by NRC. The Senate Appropriations Committee provided no funding for Yucca Mountain in its version of the FY2018 Energy and Water Development Appropriations bill (S. 1609), and instead included an authorization for a pilot program to develop an interim nuclear waste storage facility at a volunteer site (§307). The Senate panel approved the measure on July 20, 2017 (S.Rept. 115-132).

Stranded Nuclear Waste Accountability Act of 2017 (H.R. 3929, Courtney)

Authorizes DOE to make annual payments to local governments of up to $15 per kilogram of spent nuclear fuel stored at closed nuclear power plants within the governments' jurisdiction. Introduced October 3, 2017; referred to Committee on Energy and Commerce.

Sensible, Timely Relief for America's Nuclear Districts' Economic Development (STRANDED) Act (H.R. 3970, Schneider/S. 1903, Duckworth)

For communities with closed nuclear power plants that are storing spent nuclear fuel, authorizes $15 for each kilogram of nuclear waste, revives an expired tax credit for first-time homebuyers, and adds eligibility for the existing New Markets tax credit. House bill introduced October 6, 2017; referred to Committees on Energy and Commerce and Ways and Means. Senate bill introduced October 2, 2017; referred to Committee on Finance.

Removing Nuclear Waste from our Communities Act of 2017 (H.R. 4442, Lowey)

Authorizes DOE to enter into contracts to store high-level radioactive waste and spent nuclear fuel at a private-sector interim consolidated storage facility. Such storage would satisfy DOE's contractual obligations under NWPA to take spent fuel from nuclear plant sites. Introduced November 16, 2017; referred to Committee on Energy and Commerce.

Dry Cask Storage Act of 2015 (S. 1265, Markey)

Requires spent fuel at nuclear power plants to be moved from spent fuel pools to dry casks after it has sufficiently cooled, pursuant to NRC-approved transfer plans. Emergency planning zones would have to be expanded from 10 to 50 miles in radius around any reactor determined by NRC to be out of compliance with its spent fuel transfer plan. NRC would be authorized to use interest earned by the Nuclear Waste Fund to provide grants to nuclear power plants to transfer spent fuel to dry storage. Introduced May 25, 3017; referred to Committee on Environment and Public Works.

Legislative Hearing: Nuclear Waste Policy Amendments Act of 2017

Hearing by the House Committee on Energy and Commerce Subcommittee on Environment to consider draft nuclear waste legislation, April 19, 2017. The draft bill became the basis for H.R. 3053, which was subsequently approved by the Committee. Witnesses included Members of Congress, former federal officials, state utility regulators, and representatives of environmental groups, unions, and industry. Video, written statements, and other materials are at https://energycommerce.house.gov/hearings/hr-nuclear-waste-policy-amendments-act-2017/.

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Disposal of High-Level Nuclear Waste, Government Accountability Office, Key Issues website, https://www.gao.gov/key_issues/disposal_of_highlevel_nuclear_waste/issue_summary

Managing Spent Nuclear Fuel: Strategy Alternatives and Policy Implications, RAND Corporation, 2010, http://www.rand.org/pubs/monographs/MG970.html

Nuclear Plant Economic Viability

U.S. nuclear power plants are facing severe financial pressure caused primarily by competition from low-cost natural gas, growing supplies of renewable energy, and stagnant electricity demand. Six U.S. reactors were permanently closed from 2013 through 2016, and seven more are planned for closure through the mid-2020s. Plans for up to 30 new U.S. reactors announced during the past 10 years have largely been put on hold, with only 2 currently under construction.

In light of that situation, Congress is considering whether federal action is needed to keep the existing nuclear fleet operating and to encourage the construction of new reactors. A key element of that debate is the appropriate role of nuclear power, if any, in meeting national energy and environmental goals. Nuclear power supporters generally point to the technology as crucial for providing a secure, domestic source of energy with low greenhouse gas and other emissions. Opponents generally counter that safety and proliferation risks, nuclear waste hazards, and high costs outweigh those benefits.

Potential mechanisms for increased governmental support of nuclear power include loan guarantees, tax credits, clean energy mandates, emissions credits, and electricity market regulations.

Recent Events

Energy Secretary Rick Perry submitted a proposed regulation to the Federal Energy Regulatory Commission (FERC) on October 10, 2017, to ensure that coal and nuclear power plants could recover their costs in wholesale power markets. To be eligible for such cost recovery, power plants must "have a 90-day fuel supply on site in the event of supply disruptions caused by emergencies, extreme weather, or natural or man-made disasters."[17] FERC is currently considering the proposal.

Federal tax credits for electricity production from new nuclear plants would be extended by tax reform legislation (H.R. 1) approved by the House on November 16, 2017. Under current law, new nuclear plants must begin operation before January 1, 2021, to qualify for the production tax credit, which is limited to 6,000 megawatts of combined generating capacity. H.R. 1 would allow new reactors to use the credit after that date if the capacity limit had not been reached. Only two U.S. reactors are currently under construction, at the Vogtle nuclear power plant in Georgia, totaling about 2,300 megawatts of capacity, well within the limit. Construction delays have pushed the planned completion dates of the new Vogtle reactors well beyond the 2021 deadline, and the production tax credits are widely considered crucial for their financial viability.

The two new reactors at the Vogtle plant received loan guarantees from DOE totaling $8.33 billion, as authorized by Title 17 of the Energy Policy Act of 2005 (P.L. 109-58). Energy Secretary Ernest Moniz announced the issuance of $6.5 billion in loan guarantees on February 19, 2014, to two of the three utility partners in the project, Georgia Power and Oglethorpe Power. The

[17] Department of Energy, *Grid Resiliency Pricing Rule*, Notice of Proposed Rulemaking, October 10, 2017, 82 *Federal Register* 46940, https://www.gpo.gov/fdsys/pkg/FR-2017-10-10/pdf/2017-21396.pdf.

final $1.8 billion loan guarantee for another partner, Municipal Electric Authority of Georgia, was issued June 24, 2015.

Energy Secretary Rick Perry announced a conditional commitment for an additional $3.7 billion in loan guarantees to the three partners in the Vogtle project on September 29, 2017.[18] However, the Trump Administration has proposed to rescind DOE's authority to issue further Title 17 loan guarantees in FY2018. The loan guarantee rescission is included in FY2018 appropriations bills approved by the House (H.R. 3354) and the Senate Appropriations Committee (S. 1609). No other proposed nuclear plants have received any commitments for DOE loan guarantees.

Federal policy on carbon dioxide emissions could also have a significant impact on the expansion of nuclear power and the economic viability of existing reactors. Under the Trump Administration, the Environmental Protection Agency is proposing to repeal the Obama Administration's Clean Power Plan regulations,[19] which require states to reduce carbon dioxide emissions from existing power plants. Nuclear power would be a potential element in state plans for meeting the Clean Power Plan standards.

Selected Congressional Action

Nuclear Utilization of Keynote Energy Act (H.R. 1320, Kinzinger)

Caps annual fees assessed by NRC on nuclear power plants and other licensees at their FY2016 levels, unless higher fees are necessary to avoid compromising the NRC's safety and security mission. Requires NRC to use an expedited environmental review process for nuclear power plant license applications and establishes deadlines. Requires NRC to develop a regulatory framework for nuclear reactor decommissioning. Introduced March 2, 2017; referred to Committee on Energy and Commerce.

Modify the Credit for Production from Advanced Nuclear Power Facilities (H.R. 1551, Rice/S. 666, Scott)

Extends the federal tax credit for electricity production from new reactors beyond its current expiration of December 31, 2020, as long as the existing limit of 6,000 megawatts of new nuclear generating capacity has not been reached. Nontaxpaying partners in a new nuclear project could transfer the credit to a taxpaying partner. Both bills introduced March 15, 2017; referred to House Committee on Ways and Means and Senate Committee on Finance. H.R. 1551 reported by Committee (H.Rept. 115-183) and passed by the House under suspension of the rules June 20, 2017. Similar provisions included in H.R. 1 as passed by the House November 16, 2017.

Nuclear Energy Innovation and Modernization Act (S. 512, Barrasso)

Includes a provision that caps NRC fees on operating commercial reactors at the FY2015 level, adjusted for inflation, unless higher fees are necessary to avoid compromising the NRC's safety and security mission. NRC would be required to limit its requests for corporate support costs to

[18] Department of Energy, "Secretary Perry Announces Conditional Commitment to Support Continued Construction of Vogtle Advanced Nuclear Energy Project," news release, September 29, 2017, https://energy.gov/articles/secretary-perry-announces-conditional-commitment-support-continued-construction-vogtle.

[19] Environmental Protection Agency, "EPA Takes Another Step to Advance President Trump's America First Strategy, Proposes Repeal of 'Clean Power Plan,'" news release, October 10, 2017, https://www.epa.gov/newsreleases/epa-takes-another-step-advance-president-trumps-america-first-strategy-proposes-repeal.

28% of its total budget after FY2023; referred to Committee on Environment and Public Works. Approved by committee March 22, 2017 (S.Rept. 115-86).

Legislative Hearing: Nuclear Energy and Modernization Act, S. 512

Hearing by the Senate Committee on Environment and Public Works on S. 512, described above. Witnesses included representatives from the nuclear industry, the Government Accountability Office, and environmental groups. Video, written statements, and other material can be found at https://www.epw.senate.gov/public/index.cfm/hearings?ID=004FC325-6ED4-433F-8E39-D5735FD2E7AA.

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CRS Insight IN10806, *DOE's Grid Resiliency Pricing Rule*, by (name redacted)

CRS Insight IN10813, *Energy Tax Provisions in the Tax Cuts and Jobs Act (H.R. 1)*, by (name redacted) and (name redacted)

CRS Insight IN10750, *Rising Costs and Delays Doom New Nuclear Reactors in South Carolina*, by (name redacted)

CRS Report RL33558, *Nuclear Energy Policy*, by (name redacted)

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Keeping the Lights on at America's Nuclear Power Plants, Jeremy Carl and David Fedor, Shultz-Stephenson Task Force on Energy Policy, Hoover Institution Press, 2017

World Nuclear Industry Status Report 2017, Mycle Scheider Consulting, September 12, 2017, http://www.worldnuclearreport.org/-2017-.html

Advanced Nuclear Technology

Existing commercial nuclear power plants in the United States are based on light water reactor (LWR) technology, in which ordinary (light) water is used to cool the reactor and to moderate, or slow, the neutrons in the nuclear chain reaction. The federal government developed LWRs for naval propulsion in the 1950s and funded the commercialization of the technology for electricity generation. DOE and its predecessor agencies for decades have also conducted research on "advanced" reactor technologies that use different coolants and moderators, as well as fast neutron reactors that have no moderator. Proponents of advanced reactors contend that they would be safer, more efficient, and less expensive to build and operate than today's conventional LWRs. Some concepts are also intended to produce less long-lived radioactive waste than existing reactors, such as by separating the uranium, plutonium, and other elements in spent nuclear fuel and then using long-lived elements as new fuel for fast reactors.

Another characteristic of advanced reactors is that they are generally planned to be far smaller than today's commercial LWRs, which average about 1,000 megawatts (MW) of electric generating capacity. Most proposed advanced reactors would be considered "small modular

reactors" (SMRs), which DOE defines as having generating capacity of 300 MW or below. SMRs using LWR technology are also being designed. Supporters of SMRs contend that they would be small enough to be assembled in factories and shipped to reactor sites to reduce construction costs. In addition, SMRs could reduce the financial risks of building a new nuclear power plant, because each module would cost less than today's large reactors and revenues could begin when the first module was complete, rather than waiting for completion of a much larger unit.

Recent Events

Legislation that would stimulate the development of advanced nuclear technology has been passed in both houses of the 115th Congress, as described below. Key provisions would authorize the construction of demonstration reactors funded by the private sector at DOE sites and require NRC to develop plans for a new licensing framework for advanced nuclear technology. Proponents contend that NRC's existing licensing system is too focused on LWR technology and would potentially cause delays in non-LWR applications.

DOE's nuclear energy research and development program includes reactor modeling and simulation, experimental processing of spent nuclear fuel, development of advanced reactor concepts, and research on advanced nuclear fuel. The Trump Administration proposed reducing the nuclear R&D budget by about 30% in FY2018 from the FY2017 funding level—from $1.017 billion to $703 million. While substantial, that cut was less than proposed for other DOE energy R&D. The House-passed omnibus appropriations bill for FY2018 (H.R. 3219) largely rejected most of the proposed reduction, providing $969 million. The FY2018 Energy and Water Appropriations bill approved by the Senate Appropriations Committee (S. 1609) would provide $917 million. Pending final action, DOE and the rest of the federal government are being funded by a continuing resolution (P.L. 115-56).

Selected Congressional Action

Nuclear Energy Innovation Capabilities Act (H.R. 431, Weber/S. 97, Crapo)

Requires the Department of Energy to support development of nuclear fission and fusion technologies through computer modeling and simulation, and through testing and demonstration at DOE national laboratories and other sites. The Secretary of Energy would determine the need for a reactor-based fast neutron source. Bills introduced January 11, 2017; referred to House Committee on Science, Space, and Technology and Senate Committee on Energy and Natural Resources. Included as Title IV of the Department of Energy Research and Innovation Act (H.R. 589), passed by the House under suspension of the rules January 24, 2017. S. 97 passed by Committee June 21, 2017 (S.Rept. 115-115).

Advanced Nuclear Technology Development Act of 2017 (H.R. 590, Latta)

Requires NRC and DOE to enter into a memorandum of understanding to provide technical and licensing support for civilian advanced reactor projects, including advanced reactor modeling and simulation and access to DOE research facilities. NRC would be required to develop a regulatory framework for advanced reactor licensing and include the status of advanced reactor design certification applications in its annual budget requests to Congress. NRC costs for developing an advanced reactor regulatory infrastructure would not be recovered by fees on the nuclear industry. Introduced January 20, 2017; referred to Committees on Energy and Commerce and Science, Space, and Technology. Passed by House under suspension of the rules January 23, 2017. Referred to Senate Committee on Environment and Public Works.

Nuclear Energy Research Infrastructure Act of 2017 (H.R. 4378)

Authorizes DOE to construct a fast neutron research reactor by the end of 2025. Introduced November 13, 2017; referred to Committee on Science, Space, and Technology. Approved by committee November 15, 2017.

Nuclear Energy Innovation and Modernization Act (S. 512, Barrasso)

Includes requirements for NRC to create a new licensing framework for advanced reactor technologies. This would include a staged licensing process that would allow applicants to use NRC approval at each stage to help attract private-sector investment to move to the next stage. A DOE cost-sharing program for advanced reactor license applicants would also be authorized. Introduced March 2, 2017; referred to Committee on Environment and Public Works. Approved by committee March 22, 2017 (S.Rept. 115-86).

Advanced Nuclear Energy Technologies Act (S. 1457, Flake)

Requires DOE to enter into agreements to conduct at least four advanced reactor demonstration projects by 2018. The projects could include cost-sharing with private-sector partners to conduct work at DOE sites, such as national laboratories. Introduced October 3, 2017; referred to committee on Energy and Natural Resources.

Energy and Natural Resources Act of 2017 (S. 1460, Murkowski)

Includes authorization of DOE nuclear energy research and development programs, including modeling and simulation. DOE would determine the need for a fast neutron research reactor. Construction and operation of privately funded experimental reactors would be authorized at DOE sites. NRC would be required to develop a new regulatory framework for advanced reactors. Introduced June 28, 2017; placed on the Senate Legislative Calendar.

Legislative Hearing: Nuclear Energy and Modernization Act, S. 512

Hearing by the Senate Committee on Environment and Public Works on S. 512, described above. Witnesses included representatives from the nuclear industry, the Government Accountability Office, and environmental groups. Video, written statements, and other material can be found at https://www.epw.senate.gov/public/index.cfm/hearings?ID=004FC325-6ED4-433F-8E39-D5735FD2E7AA.

CRS Reports

CRS Insight IN10765, *Small Modular Nuclear Reactors: Status and Issues*, by (name redacted)

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Leading on SMRs, Nuclear Innovation Alliance, October 2017, https://docs.wixstatic.com/ugd/5b05b3_d163208371134cc590a234100429a6fd.pdf

Strategies for Advanced Reactor Licensing, Nuclear Innovation Alliance, April 2016, https://docs.wixstatic.com/ugd/5b05b3_71d4011545234838aa27005ab7d757f1.pdf

Safety

The 2011 Fukushima Dai-ichi nuclear plant disaster in Japan, triggered by a huge earthquake and tsunami, greatly increased concerns about safety in the nuclear policy debate. The accident clearly demonstrated the potential consequences of a total loss of power (or "station blackout") at today's commercial nuclear plants. Even when a reactor shuts down, as did the Fukushima plant after the initial earthquake, residual radioactivity in the reactor core continues to generate heat that must be removed, typically by electrically driven or controlled cooling systems. When the tsunami knocked out power at three of the Fukushima reactors, the buildup of heat and pressure became so great that it melted the reactors' nuclear fuel and exceeded the limits of their containment structures. Cooling was also lost in Fukushima's spent fuel storage pools, causing concern that they could overheat, although later examination indicated that they did not.

Safety requirements for nuclear power plants are established and enforced in the United States by NRC, an independent regulatory commission. NRC safety regulations address the effects of external events such as earthquakes and floods, equipment failure such as breaks in coolant pipes, and other problems that could lead to radioactive releases into the environment. Critics of nuclear power contend that NRC is often reluctant to impose necessary safety requirements that would be costly or disruptive to the nuclear industry. However, the industry has frequently contended that costly safety proposals are unnecessary and would not significantly increase large existing safety margins.

Recent Events

Following the Fukushima disaster, NRC established a task force to identify lessons applicable to U.S. reactors and recommend safety improvements. The task force's report led to NRC's first Fukushima-related regulatory requirements, on March 12, 2012. NRC ordered all reactors to develop strategies to maintain cooling and containment integrity during external events, such as floods and earthquakes, that were more severe than anticipated by the plants' designs ("beyond design basis"). In addition, NRC required that U.S. reactors of similar design to the Fukushima reactors have "reliable hardened vents" to remove excess pressure from their primary containments, and that better instrumentation be installed to monitor the condition of spent fuel pools during accidents.[20] The NRC commissioners on March 19, 2013, required NRC staff to study whether to require the newly mandated containment vents to include filters or other means to reduce the release of radioactive material if the vents have to be used. The idea of requiring filters had drawn praise from nuclear critics but opposition from the industry on cost grounds.[21] NRC voted on August 19, 2015, not to proceed with rulemaking on filtered vents.[22]

[20] Nuclear Regulatory Commission, "Actions in Response to the Japan Nuclear Accident: March 12, 2012," updated May 30, 2012, http://www.nrc.gov/reactors/operating/ops-experience/japan/timeline/03122012.html.

[21] NRC, "Consideration of Additional Requirements for Containment Venting Systems for Boiling Water Reactors with Mark I and Mark II Containments," staff requirements memorandum, SECY-12-0157, March 19, 2013, http://www.nrc.gov/reading-rm/doc-collections/commission/srm/2012/2012-0157srm.pdf; Freebairn, William, "NRC Staff Recommends Ordering Filtered Vents for 31 Power Reactors," *Inside NRC*, November 5, 2012, p. 1.

[22] Nuclear Regulatory Commission, "Hardened Vents and Filtration (for Boiling Water Reactors with Mark I and Mark II containment designs)," http://www.nrc.gov/reactors/operating/ops-experience/japan-dashboard/hardened-vents.html.

Selected Congressional Action

Hudson River Protection Act (H.R. 1504, Sean Patrick Maloney)

Prohibits the establishment of anchorage grounds for vessels carrying hazardous or flammable cargo within five miles of a nuclear power plant and other designated facilities. Introduced March10, 2017; referred to Committee on Transportation and Infrastructure.

CRS Reports

CRS Report RL33558, *Nuclear Energy Policy*, by (name redacted)

CRS Report R41694, *Fukushima Nuclear Disaster*, by (name redacted), (name redacted), and (name redacted)

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What Are the Lessons Learned from Fukushima?, Nuclear Regulatory Commission, web page, reviewed/updated July 28, 2017, http://www.nrc.gov/reactors/operating/ops-experience/japan-dashboard/priorities.html

Nuclear Safety: Countries' Regulatory Bodies Have Made Changes in Response to the Fukushima Daiichi Accident, Report to the Chairman, Subcommittee on Transportation and Infrastructure, Committee on Environment and Public Works, U.S. Senate, Government Accountability Office, GAO-14-109, March 2014, http://www.gao.gov/products/GAO-14-109

State-of-the-Art Reactor Consequence Analyses (SOARCA) Report, Nuclear Regulatory Commission, NUREG-1935, November 2012, http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1935

Security and Emergency Response

The level of security that must be provided at nuclear power plants has been a high-profile issue since the 9/11 terrorist attacks on the United States in 2001. Since those attacks, NRC issued a series of orders and regulations that substantially increased nuclear plant security requirements, although industry critics contend that those measures are still insufficient. Key measures include an increase in the level of attacks that nuclear plant security forces must be able to repel, requirements for mitigating the effects of large fires and explosions, and a requirement that new reactors be capable of withstanding aircraft crashes without releasing radioactive material. NRC also modified its planning requirements for evacuations and other emergency responses after the 9/11 attacks, and the Fukushima disaster illustrated the importance of emergency response to radioactive releases from any cause.

Recent Events

NRC issued wide-ranging revisions to its emergency preparedness regulations on November 1, 2011, dealing with duties of emergency personnel and the inclusion of hostile actions in emergency planning drills.[23] In response to Fukushima, NRC staff recommended that nuclear emergency plans be required to address events affecting multiple reactors and prolonged station

[23] NRC, "Enhancements to Emergency Preparedness Regulations," final rule, *Federal Register*, November 23, 2011, p. 72560.

blackout. NRC told nuclear power plants on March 12, 2012, to provide specific information and analysis on those issues.[24]

NRC established a Cyber Security Directorate in June 2013 to coordinate rulemaking, guidance, and oversight of cybersecurity at nuclear power plants and other regulated nuclear facilities. As part of the Directorate, NRC's Cyber Assessment Team responds to cybersecurity events at NRC-licensed facilities and coordinates threat assessments with other federal agencies.[25]

CRS Reports

CRS Report RL34331, *Nuclear Power Plant Security and Vulnerabilities*, by (name redacted)

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Backgrounder on Nuclear Security, Nuclear Regulatory Commission, web page, last reviewed/updated December 12, 2014, https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/security-enhancements.html

Protecting Our Nation, Nuclear Regulatory Commission, NUREG/BR-0314, Rev. 3, October 2013, http://pbadupws.nrc.gov/docs/ML1327/ML13270A213.pdf

Nuclear Weapons Nonproliferation

Encouraging exports of U.S. civilian nuclear products, services, and technology while making sure they are not used for foreign nuclear weapons programs has long been a fundamental goal of U.S. nuclear energy policy. Section 123 of the Atomic Energy Act requires that any country receiving U.S. nuclear technology, equipment, or materials implement a peaceful nuclear cooperation agreement with the United States. These so-called 123 agreements are intended to ensure that U.S. nuclear cooperation with other countries does not result in the production of weapons materials or otherwise encourage the proliferation of nuclear weapons.

International controls and inspections are intended to ensure the peaceful use of civilian nuclear facilities and prevent the proliferation of nuclear weapons. However, recent proposals to build nuclear power plants in as many as 18 countries[26] that have not previously used nuclear energy, including several in the Middle East and elsewhere in the less developed world, have prompted concerns that international controls may prove inadequate. Numerous recommendations have been made in the United States and elsewhere to create new incentives for nations to forgo the development of uranium enrichment and spent nuclear fuel reprocessing facilities that could produce weapons materials as well as civilian nuclear fuel.

Recent Events

Iran is currently the prime example of the tension between peaceful and weapons uses of nuclear technology. Long-standing world concern had focused on the Iranian uranium enrichment

[24] NRC, "Request for Information Pursuant to Title 10 of the Code of Federal Regulations 50.54(f) Regarding Recommendations 2.1, 2.3, and 9.3 of the Near-Term Task Force Review of Insights from the Fukushima Dai-ichi Accident," March 12, 2012, http://pbadupws.nrc.gov/docs/ML1205/ML12053A340.pdf.

[25] NRC, "Backgrounder on Cyber Security," December 2014, http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/cyber-security-bg.html.

[26] World Nuclear Association, "World Nuclear Power Reactors & Uranium Requirements," September 2017, http://www.world-nuclear.org/info/reactors.html.

program, which Iran contended was solely for peaceful purposes but which the United States and other countries suspected was for producing weapons material. The U.N. Security Council had imposed sanctions and passed several resolutions calling on Iran to suspend its enrichment program and other sensitive nuclear activities. Iran finalized a Joint Comprehensive Plan of Action (JCPOA) on July 14, 2015, with the United States and five major European countries to lift the U.N. sanctions in return for specified Iranian actions to preclude nuclear weapons development. President Trump strongly criticized the Iran agreement during the 2016 presidential campaign and announced on October 13, 2017, that the Administration would not certify that Iran was in compliance.

Recent extensions of U.S. peaceful nuclear cooperation agreements with China and South Korea generated controversy but no congressional action to block them. During negotiations on the U.S.-South Korea nuclear cooperation extension, which entered into force November 25, 2015, South Korea had sought advance U.S. consent for spent fuel reprocessing and uranium enrichment. The United States did not provide such consent, on general nonproliferation grounds and because such consent could affect other ongoing issues on the Korean peninsula. The new agreement does, however, establish a bilateral "high level commission" to further consider those issues. The extension of the U.S.-China peaceful nuclear cooperation agreement includes advance consent for reprocessing and enrichment, which raised some controversy, although both countries are internationally recognized nuclear weapons states. The agreement with China entered into force after the mandatory congressional review period ended on July 31, 2015.

Japan's nuclear cooperation agreement with the United States is scheduled to expire July 17, 2018, but will remain in force indefinitely unless terminated by either side.[27] The agreement allows Japan to reprocess spent nuclear fuel from its U.S.-designed reactors, to separate plutonium and uranium for use in new fuel. A commercial reprocessing plant at Rokkasho is scheduled to begin full operation in October 2018, although it has been frequently delayed. Some nuclear nonproliferation groups have urged the United States to use the pending renewal of the U.S.-Japan nuclear cooperation agreement as an opportunity to urge Japan not to begin its reprocessing program. They note that Japan already has substantial stockpiles of previously separated plutonium that could potentially be used for weapons as well as reactor fuel.[28]

Selected Congressional Action

Hearing: The President's Iran Decision: Next Steps

Hearing by the House Committee on Foreign Affairs, Subcommittee on the Middle East and North Africa, October 25, 2017. Examined President Trump's decision not to certify Iran as in compliance with the JCPOA. Witnesses represented nuclear nonproliferation and foreign affairs organizations. Video, testimony, and background material can be found at https://foreignaffairs.house.gov/hearing/subcommittee-hearing-presidents-iran-decision-next-steps/.

[27] National Nuclear Security Administration, "123 Agreements for Peaceful Cooperation," https://nnsa.energy.gov/aboutus/ourprograms/nonproliferation/treatiesagreements/123agreementsforpeacefulcooperation.

[28] Nonproliferation Policy Education Center, "Tokyo and Washington Have Another Nuclear Problem," August 17, 2017, http://npolicy.org/article.php?aid=1341&rid=2.

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CRS Report R41910, *Nuclear Energy Cooperation with Foreign Countries: Issues for Congress*, by (name redacted), (name redacted), and (name redacted)

CRS Report RS22937, *Nuclear Cooperation with Other Countries: A Primer*, by (name redacted) and (name redacted)

CRS Report R43333, *Iran Nuclear Agreement*, by (name redacted) and (name redacted)

CRS Report RL33192, *U.S.-China Nuclear Cooperation Agreement*, by (name redacted), (name redacte d), and (name redacted)

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