**Nuclear power in the United States**

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NRC regions and locations of nuclear reactors, 2008



Nuclear power compared to other sources of electricity in the US, 1949-2011

As of 2009[update], **nuclear power in the United States** is provided by 104 commercial reactors (69 pressurized water reactors and 35 boiling water reactors) licensed to operate at 65 nuclear power plants, producing a total of 806 TWh of electricity, which was 19.6% of the nation's total electric energy generation in 2008. The United States is the world's largest supplier of commercial nuclear power.

In terms of history, all US nuclear power plants, and almost all reactors,began to be built in 1974 or earlier; following the Three Mile Island accident in 1979 and changing economics, many planned projects were canceled. Of the 104 reactors now operating in the U.S., ground was broken on all of them in 1974 or earlier. There has been no new ground-breaking on nuclear plants in the United States since 1974, though a number of reactor units started before 1974 have been completed since then.

In recent developments, there has been some revival of interest in nuclear power in the 2000s, with talk of a "nuclear renaissance", supported particularly by the Nuclear Power 2010 Program (established 2002) – see prospective nuclear units in the United States. A number of applications were made, but facing economic challenges, and later in the wake of the 2011 Japanese nuclear accidents, most of these projects have been canceled, and as of 2012[update], "nuclear industry officials say they expect just five new reactors to enter service by 2020 – Southern's two Vogtle reactors, two at Summer in South Carolina and one at Watts Bar in Tennessee"; these are all at existing plants.

In 2013, four aging, uncompetitive, reactors were permanently closed: San Onofre 2 and 3 in California, Crystal River 3 in Florida, and Kewaunee in Wisconsin. The state of Vermont is trying to close Vermont Yankee, in Vernon. New York State is seeking to close Indian Point Nuclear Power Plant, in Buchanan, 30 miles from New York City.

**History**



The Shippingport reactor was the first full-scale PWR nuclear power plant in the United States.



President Jimmy Carter leaving Three Mile Island for Middletown, Pennsylvania, April 1, 1979



A clean-up crew working to remove contamination at Three Mile Island

Research into the peaceful uses of nuclear materials in the US began shortly after the end of the Second World War under the auspices of the Atomic Energy Commission, created by the United States Atomic Energy Act of 1946. Medical scientists were interested in the effect of radiation upon the fast-growing cells of cancer, and materials were given to them, while the military services led research into other peaceful uses.

In particular, the US Navy took the lead, seeing the opportunity to have ships that could steam around the world at high speeds without refueling being necessary for several decades, and the possibility of turning submarines into true full-time underwater vehicles. So, the Navy sent their "man in Engineering", then Captain Hyman Rickover, well known for his great technical talents in electrical engineering, power on board, and propulsion systems in addition to his skill in project management, to the AEC to start the Naval Reactors project. Rickover's work with the AEC led to the development of the Pressurized Water Reactor (PWR), the first naval model of which was installed in the submarine *USS Nautilus*. This made the boat capable of operating under water full-time - demonstrating this principle by reaching the North Pole and surfacing through the Polar ice cap.

From the successful naval reactor program, plans were quickly developed for the use of reactor steam to drive turbines turning generators. On May 26, 1958 the first commercial nuclear power plant in the United States, Shippingport nuclear power plant, was opened by President Dwight D. Eisenhower as part of his Atoms for Peace program. As nuclear power continued to grow throughout the 1960s, the Atomic Energy Commission anticipated that more than 1,000 reactors would be operating in the United States by 2000.[7] As the industry continued to expand, the Atomic Energy Commission's development and regulatory functions were separated in 1974; the Department of Energy absorbed research and development, while the regulatory branch was spun off and turned into an independent commission known as the U.S. Nuclear Regulatory Commission (USNRC or simply NRC).

Argonne National Laboratory was assigned by the United States Atomic Energy Commission the lead role in developing commercial nuclear energy beginning in the 1940s. Between then and the turn of the 20th to 21st century, Argonne designed, built, and operated fourteen reactors at its site southwest of Chicago, and another fourteen reactors at the National Reactors Testing Station in Idaho. These reactors included initial experiments and test reactors that were the progenitors of today’s pressurized water reactors (including naval reactors), boiling water reactors, heavy water reactors, graphite-moderated reactors, and liquid-metal cooled fast reactors, one of which was the first reactor in the world to generate electricity. Argonne and a number of other AEC contractors built a total of 52 reactors at the National Reactor Testing Station. Two were never operated; with the exception of the Neutron Radiography Facility, all of the other reactors were shut down by 2000.

In the early afternoon of December 20, 1951, Argonne director Walter Zinn and fifteen other Argonne staff members witnessed a row of four light bulbs light up in a nondescript brick building in the eastern Idaho desert. Electricity from a generator connected to Experimental Breeder Reactor I (EBR-I) flowed through them. This was the first time that a usable amount of electrical power had ever been generated from nuclear fission. Only days afterward, the reactor produced all the electricity needed for the entire EBR complex. One ton of natural uranium can produce more than 40 million kilowatt-hours of electricity — this is equivalent to burning 16,000 tons of coal or 80,000 barrels of oil. More central to EBR-I’s purpose than just generating electricity, however, was its role in proving that a reactor could create more nuclear fuel as a byproduct than it consumed during operation. In 1953, tests verified that this was the case.

There has been considerable anti-nuclear opposition to the use of nuclear power in the U.S. The first U.S. reactor to face public opposition was Fermi 1 in 1957. It was built approximately 30 miles from Detroit and there was opposition from the United Auto Workers Union. Pacific Gas & Electric planned to build the first commercially viable nuclear power plant in the USA at Bodega Bay, north of San Francisco. The proposal was controversial and conflict with local citizens began in 1958. The conflict ended in 1964, with the forced abandonment of plans for the power plant. Historian Thomas Wellock traces the birth of the anti-nuclear movement to the controversy over Bodega Bay. Attempts to build a nuclear power plant in Malibu were similar to those at Bodega Bay and were also abandoned.

Nuclear accidents continued into the 1960s with a small test reactor exploding at the Stationary Low-Power Reactor Number One in Idaho Falls in January 1961 and a partial meltdown at the Enrico Fermi Nuclear Generating Station in Michigan in 1966. In his 1963 book *Change, Hope and the Bomb*, David Lilienthal criticized nuclear developments, particularly the nuclear industry's failure to address the nuclear waste question. J. Samuel Walker, in his book *Three Mile Island: A Nuclear Crisis in Historical Perspective*, explains that the growth of the nuclear industry in the U.S. occurred in the 1970s as the environmental movement was being formed. Environmentalists saw the advantages of nuclear power in reducing air pollution, but were critical of nuclear technology on other grounds. They were concerned about nuclear accidents, nuclear proliferation, high cost of nuclear power plants, nuclear terrorism and radioactive waste disposal.

By the end of the 1970s it became clear that nuclear power would not grow nearly as dramatically as once believed. This was particularly galvanized by the Three Mile Island accident in 1979. Eventually, more than 120 reactor orders were ultimately cancelled and the construction of new reactors ground to a halt. Al Gore has commented on the historical record and reliability of nuclear power in the United States:

Of the 253 nuclear power reactors originally ordered in the United States from 1953 to 2008, 48 percent were canceled, 11 percent were prematurely shut down, 14 percent experienced at least a one-year-or-more outage, and 27 percent are operating without having a year-plus outage. Thus, only about one fourth of those ordered, or about half of those completed, are still operating and have proved relatively reliable.

Amory Lovins has also commented on the historical record of nuclear power in the United States:

Of all 132 U.S. nuclear plants built (52% of the 253 originally ordered), 21% were permanently and prematurely closed due to reliability or cost problems, while another 27% have completely failed for a year or more at least once. The surviving U.S. nuclear plants produce ~90% of their full-time full-load potential, but even they are not fully dependable. Even reliably operating nuclear plants must shut down, on average, for 39 days every 17 months for refueling and maintenance, and unexpected failures do occur too.

A cover story in the February 11, 1985, issue of *Forbes magazine* commented on the overall management of the nuclear power program in the United States:

The failure of the U.S. nuclear power program ranks as the largest managerial disaster in business history, a disaster on a monumental scale … only the blind, or the biased, can now think that the money has been well spent. It is a defeat for the U.S. consumer and for the competitiveness of U.S. industry, for the utilities that undertook the program and for the private enterprise system that made it possible.

The NRC reported "(...the Three Mile Island accident...) was the most serious in U.S. commercial nuclear power plant operating history, even though it led to no deaths or injuries to plant workers or members of the nearby community." The World Nuclear Association reports that "...more than a dozen major, independent studies have assessed the radiation releases and possible effects on the people and the environment around TMI since the 1979 accident at TMI-2. The most recent was a 13-year study on 32,000 people. None has found any adverse health effects such as cancers which might be linked to the accident."Other nuclear power incidents within the US (defined as safety-related events in civil nuclear power facilities between INES Levels 1 and 3) include those at the Davis-Besse Nuclear Power Plant, which was the source of two of the top five highest conditional core damage frequency nuclear incidents in the United States since 1979, according to the U.S. Nuclear Regulatory Commission.

Despite many technical studies which asserted that the probability of a severe nuclear accident was low, numerous surveys showed that the public remained "very deeply distrustful and uneasy about nuclear power". Some commentators have suggested that the public's consistently negative ratings of nuclear power are reflective of the industry's unique connection with nuclear weapons:

[One] reason why nuclear power is seen differently to other technologies lies in its parentage and birth. Nuclear energy was conceived in secrecy, born of war, and first revealed to the world in horror. No matter how much proponents try to separate the peaceful atom from the weapons atom, the connection is firmly embedded in the mind of the public.

Several US nuclear power plants closed well before their design lifetimes, due to successful campaigns by anti-nuclear activist groups. These include Rancho Seco in 1989 in California and Trojan in 1992 in Oregon. Humboldt Bay in California closed in 1976, 13 years after geologists discovered it was built on a fault (the Little Salmon Fault). Shoreham Nuclear Power Plant was completed but never operated commercially as an authorized Emergency Evacuation Plan could not be agreed on due the political climate after the Three Mile Island accident and Chernobyl disaster. The last permanent closure of a US nuclear power plant was in 1997.

US nuclear reactors were originally licensed to operate for 40-year periods. In the 1980s, the NRC determined that there were no technical issues that would preclude longer service. Over half of US nuclear reactors are over 30 years old and almost all are over twenty years old. As of 2011[update], more than 60 reactors have received 20-year extensions to their licensed lifetimes, with more than a dozen applications still under review. The average capacity factor for all US reactors has improved from below 60% in the 1970s and 1980s, to 92% in 2007, more than compensating for the retirement of older reactors.

**Safety and accidents**

Main articles: Nuclear safety in the U.S. and Nuclear power plant accidents in the United States.

Regulation of nuclear power plants in the United States is done by the Nuclear Regulatory Commission, which divides the nation into 4 administrative divisions.

As of February 2009, the NRC requires that the design of new power plants ensures that the reactor containment would remain intact, cooling systems would continue to operate, and spent fuel pools would be protected, in the event of an aircraft crash. This is an issue that has gained attention since the September 11, 2001, terrorist attacks. The regulation does not apply to the 104 commercial reactors now operating. However, the containment structures of nuclear power plants are among the strongest structures ever built by mankind; independent studies have shown that existing plants would easily survive the impact of a large commercial jetliner without loss of structural integrity.

The nuclear industry in the United States has maintained one of the best industrial safety records in the world with respect to all kinds of accidents. For 2008, the industry hit a new low of 0.13 industrial accidents per 200,000 worker-hours. This is improved over 0.24 in 2005, which was still a factor of 14.6 less than the 3.5 number for all manufacturing industries. Private industry has an accident rate of 1.3 per 200,000 worker hours.

More than a quarter of U.S. nuclear plant operators "have failed to properly tell regulators about equipment defects that could imperil reactor safety", according to a Nuclear Regulatory Commission report.

In March 2011, nuclear experts told Congress that spent-fuel pools at US nuclear power plants are too full. They say the entire US spent-fuel policy should be overhauled in light of the Fukushima I nuclear accidents.

David Lochbaum, chief nuclear safety officer with the Union of Concerned Scientists, has repeatedly questioned the safety of the Fukushima I Plant's General Electric Mark 1 reactor design, which is used in almost a quarter of the United States' nuclear fleet.

About one third of reactors in the US are boiling water reactors, the same technology which was involved in the Fukushima Daiichi nuclear disaster in Japan. There are also eight nuclear power plants located along the seismically active West coast. Twelve of the American reactors that are of the same vintage as the Fukushima Daiichi plant are in seismically active areas. Earthquake risk is often measured by "Peak Ground Acceleration", or PGA, and the following nuclear power plants have a two percent or greater chance of having PGA over 0.15g in the next 50 years: Diablo Canyon, Calif.; San Onofre, Calif.; Sequoyah, Tenn.; H.B. Robinson, SC.; Watts Bar, Tenn.; Virgil C. Summer, SC.; Vogtle, GA.; Indian Point, NY.; Oconee, SC.; and Seabrook, NH.

The U.S. Nuclear Regulatory Commission reports that radioactive tritium has leaked from 48 of the 65 nuclear sites in the United States.

| **Nuclear power plant accidents in the U.S. with more than US$140 million in property damage**  |
| --- |
| **Date** | **Plant** | **Location** | **Description** | **Cost(in millions2006 $)** |
| 01979-03-28March 28, 1979 | Three Mile Island | Londonderry Township, Pennsylvania | Loss of coolant and partial core meltdown, see Three Mile Island accident and Three Mile Island accident health effects | 7003240000000000000 US$2,400 |
| 01985-03-09March 9, 1985 | Browns Ferry | Athens, Alabama | Instrumentation systems malfunction during startup, which led to suspension of operations at all three Units | 7003183000000000000 US$1,830 |
| 01986-04-11April 11, 1986 | Pilgrim | Plymouth, Massachusetts | Recurring equipment problems force emergency shutdown of Boston Edison’s plant | 7003100100000000000 US$1,001 |
| 01987-03-31March 31, 1987 | Peach Bottom | Delta, Pennsylvania | Units 2 and 3 shutdown due to cooling malfunctions and unexplained equipment problems | 7002400000000000000 US$400 |
| 01987-12-19December 19, 1987 | Nine Mile Point | Scriba, New York | Malfunctions force Niagara Mohawk Power Corporation to shut down Unit 1 | 7002150000000000000 US$150 |
| 01996-02-20February 20, 1996 | Millstone | Waterford, Connecticut | Leaking valve forces shutdown of Units 1 and 2, multiple equipment failures found | 7002254000000000000 US$254 |
| 01996-09-02September 2, 1996 | Crystal River | Crystal River, Florida | Balance-of-plant equipment malfunction forces shutdown and extensive repairs | 7002384000000000000 US$384 |
| 02002-02-16February 16, 2002 | Davis-Besse | Oak Harbor, Ohio | Severe corrosion of reactor vessel head forces 24-month outage | 7002143000000000000 US$143 |
| 02010-02-01February 1, 2010 | Vermont Yankee | Vernon, Vermont | Deteriorating underground pipes leak radioactive tritium into groundwater supplies | 7002700000000000000 US$700 |
| 02013-06-07June 7, 2013 | SONGS | San Onofre, California | Upgraded Steam Generators show premature wear resulting in unplanned shutdown and decommissioning | 7003120000000000000 US$500 |

**Fuel cycle**



US Civilian Nuclear Power Reactors
2009 Sources of Uranium

**Uranium mining**

Main article: Uranium mining in the United States

The United States has the 4th largest uranium reserves in the world. Domestic production increased until 1980, after which it declined sharply due to low uranium prices. In 2001 the United States mined only 5% of the uranium consumed by its nuclear power plants. The remainder was imported, principally from Russia and Australia. After 2001, however, uranium prices steadily increased, which prompted increased production and revived mines.

**Uranium enrichment**

The United States Enrichment Corporation (USEC) performs all enrichment activities for U.S. commercial nuclear plants, using 11.3 million SWUs per year at its Paducah, Kentucky site. The USEC plant still uses gaseous diffusion enrichment, which has now been proved to be inferior to centrifuge enrichment. However, the capital cost of such a plant is so high that the plant will go through a few more years of operation before being replaced by a modern centrifuge plant.

Currently, demonstration activities are underway in Oak Ridge, Tennessee for a future centrifugal enrichment plant. The new plant will be called the American Centrifuge Plant, which has an estimate cost of 2.3 billion USD.

**Reprocessing**

Nuclear reprocessing has been politically controversial because of the potential to contribute to nuclear proliferation, the potential vulnerability to nuclear terrorism, the political challenges of repository siting, and because of its high cost compared to the once-through fuel cycle. The Obama administration has disallowed reprocessing of nuclear waste, citing nuclear proliferation concerns.

**Waste disposal**

Recently, as plants continue to age, many on-site spent fuel pools have come near capacity, prompting creation of dry cask storage facilities as well. Several lawsuits between utilities and the government have transpired over the cost of these facilities, because by law the government is required to foot the bill for actions that go beyond the spent fuel pool.

There are some 65,000 tons of nuclear waste now in temporary storage throughout the U.S.[52] Since 1987, Yucca Mountain, in Nevada, had been the proposed site for the Yucca Mountain nuclear waste repository, but the project was shelved in 2009 following years of controversy and legal wrangling. An alternative plan has not been proffered.

At places like Maine Yankee, Connecticut Yankee and Rancho Seco, reactors no longer operate, but the spent fuel remains in small concrete-and-steel silos that require maintenance and monitoring by a guard force. Sometimes the presence of nuclear waste prevents re-use of the sites by industry.

Without a long-term solution to store nuclear waste, a nuclear renaissance in the U.S. remains unlikely. Nine states have "explicit moratoria on new nuclear power until a storage solution emerges".

Some nuclear power advocates argue that the United States should develop factories and reactors that will recycle some of the spent fuel. But the Blue Ribbon Commission on America’s Nuclear Future said in 2012 that "no existing technology was adequate for that purpose, given cost considerations and the risk of nuclear proliferation".

**Water use in nuclear power production**



Sources of electricity in the U.S. in 2009. Nuclear sources account for 20% of electricity produced.

Once-through cooling systems, while once common, have come under attack for the possibility of damage to the environment. Wildlife can become trapped inside the cooling systems and killed, and the increased water temperature of the returning water can impact local ecosystems. US EPA regulations favors recirculating systems, even forcing some older power plants to replace existing once-through cooling systems with new recirculating systems.

A 2008 study by the Associated Press found that of the 104 nuclear reactors in the U.S., "... 24 are in areas experiencing the most severe levels of drought. All but two are built on the shores of lakes and rivers and rely on submerged intake pipes to draw billions of gallons of water for use in cooling and condensing steam after it has turned the plants’ turbines," much like all Rankine cycle power plants. During the 2008 southeast drought, reactor output was reduced to lower operating power or forced to shut down for safety.

The Palo Verde Nuclear Generating Station is located in a desert and purchases reclaimed wastewater for cooling.

**Plant decommissioning**

The price of energy inputs and the environmental costs of every nuclear power plant continue long after the facility has finished generating its last useful electricity. Both nuclear reactors and uranium enrichment facilities must be decommissioned, returning the facility and its parts to a safe enough level to be entrusted for other uses. After a cooling-off period that may last as long as a century, reactors must be dismantled and cut into small pieces to be packed in containers for final disposal. The process is very expensive, time-consuming, dangerous for workers, hazardous to the natural environment, and presents new opportunities for human error, accidents or sabotage.

The total energy required for decommissioning can be as much as 50% more than the energy needed for the original construction. In most cases, the decommissioning process costs between US $300 million to US$5.6 billion. Decommissioning at nuclear sites which have experienced a serious accident are the most expensive and time-consuming. In the U.S. there are 13 reactors that have permanently shut down and are in some phase of decommissioning, but none of them have completed the process.

**Organizations**

**Fuel vendors**

The following companies have active Nuclear fuel fabrication facilities in the United States. These are all light water fuel fabrication facilities because only LWRs are operating in the US. The US currently has no MOX fuel fabrication facilities, though Duke Energy has expressed intent of building one of a relatively small capacity.

* Areva

Areva (formerly Areva NP) runs fabrication facilities in Lynchburg, Virginia and Richland, Washington. It also has a Generation III+ plant design, EPR (formerly the Evolutionary Power Reactor), which it plans to market in the US.

* Westinghouse Electric Company

Westinghouse operates a fuel fabrication facility in Columbia, South Carolina, which processes 1,600 metric tons Uranium (MTU) per year. It previously operated a nuclear fuel plant in Hematite, Missouri but has since closed it down.

* General Electric

GE pioneered the BWR technology that has become widely used throughout the world. It formed the *Global Nuclear Fuel* joint venture in 1999 with Hitachi and Toshiba and later restructured into *GE-Hitachi Nuclear Energy*. It operates the fuel fabrication facility in Wilmington, North Carolina, with a capacity of 1,200 MTU per year.

**Industry and academic**

The American Nuclear Society (ANS) scientific and educational organization that has academic and industry members. The organization publishes a large amount of literature on nuclear technology in several journals. The ANS also has some offshoot organizations such as North American Young Generation in Nuclear (NA-YGN).

The Nuclear Energy Institute (NEI) is an industry group whose activities include lobbying, experience sharing between companies and plants, and provides data on the industry to a number of outfits.

**Anti-nuclear power groups**

Some sixty anti-nuclear power groups are operating, or have operated, in the United States. These include: Abalone Alliance, Clamshell Alliance, Greenpeace USA, Institute for Energy and Environmental Research, Musicians United for Safe Energy, Nuclear Control Institute, Nuclear Information and Resource Service, Public Citizen Energy Program, Shad Alliance, and the Sierra Club.

**Debate about nuclear power in the U.S.**



February 2005 opinion poll on US nuclear power.
2005 Poll:Blue represents those in favor of nuclear power, gray represents undecided, yellow represents opposed to nuclear power

See also: Nuclear power debate

There has been considerable public and scientific debate about the use of nuclear power in the United States, mainly from the 1960s to the late 1980s, but also since about 2001 when talk of a nuclear renaissance began. There has been debate about issues such as nuclear accidents, radioactive waste disposal, nuclear proliferation, nuclear economics, and nuclear terrorism.

Some scientists and engineers have expressed reservations about nuclear power, including: Barry Commoner, S. David Freeman, John Gofman, Arnold Gundersen, Mark Z. Jacobson, Amory Lovins, Arjun Makhijani, Gregory Minor, and Joseph Romm. Mark Z. Jacobson, professor of civil and environmental engineering at Stanford University, has said: "If our nation wants to reduce global warming, air pollution and energy instability, we should invest only in the best energy options. Nuclear energy isn't one of them". Arnold Gundersen, chief engineer of Fairewinds Associates and a former nuclear power industry executive, has questioned the safety of the Westinghouse AP1000, a proposed third-generation nuclear reactor. John Gofman, a nuclear chemist and doctor, raised concerns about exposure to low-level radiation in the 1960s and argued against commercial nuclear power in the U.S. In “Nuclear Power: Climate Fix or Folly,” Amory Lovins, a physicist with the Rocky Mountain Institute, argued that expanded nuclear power "does not represent a cost-effective solution to global warming and that investors would shun it were it not for generous government subsidies lubricated by intensive lobbying efforts".

Environmentalist Patrick Moore spoke out against nuclear power in 1976, but today he supports it, along with renewable energy sources. In Australian newspaper *The Age*, he writes "Greenpeace is wrong — we must consider nuclear power". He argues that any realistic plan to reduce reliance on fossil fuels or greenhouse gas emissions need increased use of nuclear energy.

Environmentalist Stewart Brand wrote the book *Whole Earth Discipline*, which examines how nuclear power and some other technologies can be used as tools to address global warming. Bernard Cohen, Professor Emeritus of Physics at the University of Pittsburgh, calculates that nuclear power is many times safer than other forms of power generation.

In August 2011, the head of America's largest nuclear utility said that this was not the time to build new nuclear plants, not because of political opposition or the threat of cost overruns, but because of the low price of natural gas. John Rowe, head of Exelon, said “Shale [gas] is good for the country, bad for new nuclear development".

In his 2012 state-of-the-union address, Barack Obama said that America needs “an all-out, all-of-the-above strategy that develops every available source of American energy.” President Obama boasted about a Michigan wind turbine factory, America's healthy supplies of natural gas and widespread oil exploration. He urged Congress to pass tax incentives for energy efficiency and clean energy and to end oil-company subsidies. But Mr Obama made no mention of nuclear power.

According to the Union of Concerned Scientists in March 2013 over one-third of U.S. nuclear power plants suffered safety-related incidents over the past three years, and nuclear regulators and plant operators need to improve inspections to prevent such events

**Recent developments**

See also: Nuclear renaissance

In the 2000s there was a renewed interest in nuclear power in the US. This was facilitated in part by the federal government with the Nuclear Power 2010 Program, which coordinates efforts for building new nuclear power plants, and the Energy Policy Act which makes provisions for nuclear and oil industries.

A series of Gallup polls from 1994 to 2009 found support for nuclear energy in the United States varying from 46% to 59%, with significant opinion differences between genders, income groups, and political affiliation.

The prospect of a "nuclear renaissance" has revived debate about the nuclear waste issue. There is an "international consensus on the advisability of storing nuclear waste in deep underground repositories", but no country in the world has yet opened such a site. The Obama administration has disallowed reprocessing of nuclear waste, citing nuclear proliferation concerns.

Following the 2011 Japanese nuclear accidents, the U.S. Nuclear Regulatory Commission has announced it will launch a comprehensive safety review of the 104 nuclear power reactors across the United States, at the request of President Obama. The Obama administration "continues to support the expansion of nuclear power in the United States, despite the crisis in Japan". Following the Fukushima Daiichi nuclear disaster, public support for building nuclear power plants in the U.S. dropped to 43%, slightly lower than it was immediately after the Three Mile Island accident in 1979, according to a CBS News poll. A survey conducted in April 2011 found that 64 percent of Americans opposed the construction of new nuclear reactors. A survey sponsored by the Nuclear Energy Institute, conducted in September 2011, found that "62 percent of respondents said they favor the use of nuclear energy as one of the ways to provide electricity in the United States, with 35 percent opposed".

In late 2011 and early 2012, construction of four new nuclear reactor units at two exiting plants were approved, the first such in 34 years. As of December 2011, construction by Southern Company on two new nuclear units has begun, Units 3 and 4 at the existing Vogtle Electric Generating Plant, and they are expected to be delivering commercial power by 2016 and 2017, respectively. Shortly thereafter, Units 2 and 3 at the SCANA Virgil C. Summer Nuclear Generating Station in South Carolina were approved, and are scheduled to come online in 2017 and 2018, respectively.

A number of other reactors are or were under consideration – a third reactor at the Calvert Cliffs Nuclear Power Plant in Maryland, a third and fourth reactor at South Texas Nuclear Generating Station (now canceled), together with two other reactors in Texas, four in Florida, and one in Missouri. However, these have all been postponed or canceled. But, looking ahead, experts see continuing challenges that will make it very difficult for the nuclear power industry to expand beyond a small handful of reactor projects that "government agencies decide to subsidize by forcing taxpayers to assume the risk for the reactors and mandating that ratepayers pay for construction in advance".

**2008**

On August 26, 2008, it was reported that The Shaw Group and Westinghouse would construct a factory at the Port of Lake Charles at Lake Charles, Louisiana to build components for the Westinghouse AP1000 nuclear reactor. On October 23, 2008, it was reported that Northrop Grumman and Areva were planning to construct a factory in Newport News, Virginia to build nuclear reactors.

**2009**

As of March 9, 2009, the U.S. Nuclear Regulatory Commission had received applications for permission to construct 26 new nuclear power reactors with applications for another 7 expected. Six of these reactors have actually been ordered. In addition, the Tennessee Valley Authority petitioned to restart construction on the first two units at Bellefonte. However not all of this new capacity will necessarily be built, with some applications being made to keep future options open and reserving places in a queue for government incentives available for up to the first three plants based on each innovative reactor design.

In May 2009, John Rowe, chairman of Exelon, which operates 17 nuclear reactors, said he would cancel or delay construction of two new reactors in Texas without federal loan guarantees. U.S. nuclear power developers are increasingly looking for new partners to share the high costs and risks of building new reactors.

As of July 2009[update], the proposed Victoria County Nuclear Power Plant has been delayed, as the project proved difficult to finance. As of April 2009[update], AmerenUE has suspended plans to build its proposed plant in Missouri because the state Legislature would not allow it to charge consumers for some of the project's costs before the plant's completion. The New York Times has reported that without that "financial and regulatory certainty," the company has said it could not proceed. Previously, MidAmerican Energy Company decided to "end its pursuit of a nuclear power plant in Payette County, Idaho." MidAmerican cited cost as the primary factor in their decision.

**2010**

As of 2010, demand for nuclear power softened in America, and some companies withdrew their applications for licenses to build. In September 2010, Matthew Wald from the *New York Times* reported that "the nuclear renaissance is looking small and slow at the moment".

On February 16, 2010, President Barack Obama announced loan guarantees for two new reactors at Georgia Power's Vogtle Electric Generating Plant. If the project goes forward, these would be the first plants built in the United States since the 1970s. The reactors are "just the first of what we hope will be many new nuclear projects," said Carol Browner, director of the White House Office of Energy and Climate Change Policy.

Also in February 2010, the Vermont Senate voted 26 to 4 to block operation of the Vermont Yankee Nuclear Power Plant after 2012, citing radioactive tritium leaks, misstatements in testimony by plant officials, a cooling tower collapse in 2007, and other problems. By state law, the renewal of the operating license must be approved by both houses of the legislature for the nuclear power plant to continue operation.

Other than the Vogtle project, ground has been broken on just one other location, in South Carolina at SCANA's VC Summer nuclear plant, as of September 2010. The prospects of a proposed project in Texas, South Texas 3 & 4, have been dimmed by disunity among the partners. Two other reactors in Texas, four in Florida and one in Missouri have all been "moved to the back burner, mostly because of uncertain economics". Constellation Energy has "pulled the plug" on building a new reactor at its Calvert Cliffs Nuclear Power Plant due to the Department of Energy's requirement of an upfront credit subsidy of $880 million in order for Constellation to receive a $7.5 billion loan from the Department. Matthew Wald from the *New York Times* has reported that "the nuclear renaissance is looking small and slow at the moment".

In December 2010, *The Economist* reported that the demand for nuclear power is softening in America. In recent years, utilities have shown an interest in about 30 new reactors, but the number with any serious prospect of being built as of the end of 2010 is now about a dozen, as some companies have withdrawn their applications for licenses to build. Exelon has withdrawn its application for a license for a twin-unit nuclear plant in Victoria County, Texas, citing lower electricity demand projections. The decision has left the country’s largest nuclear operator without a direct role in what the nuclear industry hopes is a nuclear renaissance. Ground has been broken on two new nuclear plants with a total of four reactors. The Obama administration is seeking the expansion of a loan guarantee program but as of December 2010 has been unable to commit all of the loan guarantee money already approved by Congress. Since talk a few years ago of a “nuclear renaissance”, gas prices have fallen and old reactors are getting license extensions. The only reactor under construction in America, at Watts Bar, Tennessee, is an old unit, begun in 1973, whose construction was suspended in 1988, and was resumed in 2007. It may be completed in 2012. Of the 104 reactors now operating in the U.S., ground was broken on all of them in 1974 or earlier.

**2011**

Following the 2011 Japanese nuclear accidents, the reports and images from the Fukushima I nuclear accident—containment buildings exploding, uncontrolled fires, radiation readings so high the plant workers fled for their lives, helicopters dropping sea water in a desperate attempt to stop the disaster, entire cities evacuated—filled American televisions, raising questions about the safety of nuclear power plants in the U.S. The U.S. Nuclear Regulatory Commission has announced it will launch a comprehensive safety review of the 104 nuclear power reactors across the United States, at the request of President Obama. The Obama administration "continues to support the expansion of nuclear power in the United States, despite the crisis in Japan".

What had been growing acceptance of nuclear power in the United States was eroded sharply following the 2011 Japanese nuclear accidents, with support for building nuclear power plants in the U.S. dropping slightly lower than it was immediately after the Three Mile Island accident in 1979, according to a CBS News poll. Only 43 percent of those polled after the Fukushima nuclear emergency said they would approve building new power plants in the United States. A Washington Post-ABC poll conducted in April 2011 found that 64 percent of Americans opposed the construction of new nuclear reactors.

As of April 2011, a total of 45 groups and individuals are formally asking the U.S. Nuclear Regulatory Commission (NRC) to suspend all licensing and other activities at 21 proposed nuclear reactor projects in 15 states until the NRC completes a thorough post-Fukushima reactor crisis examination. The petitioners also are asking the NRC to supplement its own investigation by establishing an independent commission comparable to that set up in the wake of the serious, though less severe, 1979 Three Mile Island accident.

Following the Fukushima accidents, costs are likely to go up for currently operating and new nuclear power plants, due to increased requirements for on-site spent fuel management and elevated design basis threats. License extensions for existing reactors will face additional scrutiny, with outcomes depending on the degree to which plants can meet new requirements, and some of the extensions already granted for more than 60 of the 104 operating U.S. reactors could be revisited. On-site storage, consolidated long-term storage, and geological disposal of spent fuel is "likely to be reevaluated in a new light because of the Fukushima storage pool experience".

In 2011, London-based bank HSBC said: "With Three Mile Island and Fukushima as a backdrop, the US public may find it difficult to support major nuclear new build and we expect that no new plant extensions will be granted either. Thus we expect the clean energy standard under discussion in US legislative chambers will see a far greater emphasis on gas and renewables plus efficiency".

As of December 2011, construction by Southern Company on two new nuclear units at their Vogtle plant has begun, and they are expected to be delivering commercial power by 2016 and 2017. But, looking ahead, experts see continuing challenges that will make it very difficult for the nuclear power industry to expand beyond a small handful of reactor projects that "government agencies decide to subsidize by forcing taxpayers to assume the risk for the reactors and mandating that ratepayers pay for construction in advance". Mark Cooper suggests that the cost of nuclear power, which already had risen sharply in 2010 and 2011, could "climb another 50 percent due to tighter safety oversight and regulatory delays in the wake of the reactor calamity in Japan".

**2012**

In January 2012, the San Onofre Nuclear Generating Station was shutdown for refueling and heavy servicing when premature wear was found in the Steam Generators which had been replaced in 2010-2011.

In February 2012, the US Nuclear Regulatory Commission approved the construction license of the two proposed reactors at the Vogtle plant. NRC Chairman Gregory Jaczko cast the lone dissenting vote on plans to build and operate the two new nuclear power reactors, citing safety concerns stemming from Japan's 2011 Fukushima nuclear disaster, and saying "I cannot support issuing this license as if Fukushima never happened".

One week after Southern received the license to begin major construction on the two new reactors, a dozen environmental and anti-nuclear groups are suing to stop the Plant Vogtle expansion project, saying "public safety and environmental problems since Japan's Fukushima Daiichi nuclear reactor accident have not been taken into account". The lawsuit was dismissed in July, 2012.

On August 18, 2011, the TVA board of directors voted to move forward with the construction of the unit one reactor at the Bellefonte Nuclear Generating Station. But as of March 2012, many contractors have been laid off and the ultimate cost and timing for Bellefonte 1 will depend on work at another reactor TVA is completing - Watts Bar 2 in Tennessee. In February 2012, TVA said the Watts Bar 2 project was running over budget and behind schedule.

According to a 2012 Pew Research Center poll, 44 percent of Americans favor and 49 percent oppose the promotion of increased use of nuclear power.

In August 2012, Exelon stated that economic and market conditions, especially low natural gas prices, made the "construction of new merchant nuclear power plants in competitive markets uneconomical now and for the foreseeable future". In early 2013 UBS noted that some smaller reactors operating in deregulated markets may become uneconomic to operate and maintain, due to competition from generators using low priced natural gas, and may be retired early. The 556 MWe Kewaunee Power Station is being closed 20 years before license expiry for these economic reasons.

**2013**

In 2013, four aging, uncompetitive, reactors were permanently closed: San Onofre 2 and 3 in California, Crystal River 3 in Florida, and Kewaunee in Wisconsin. The state of Vermont is trying to close Vermont Yankee, in Vernon. New York State is seeking to close Indian Point Nuclear Power Plant, in Buchanan, 30 miles from New York City.