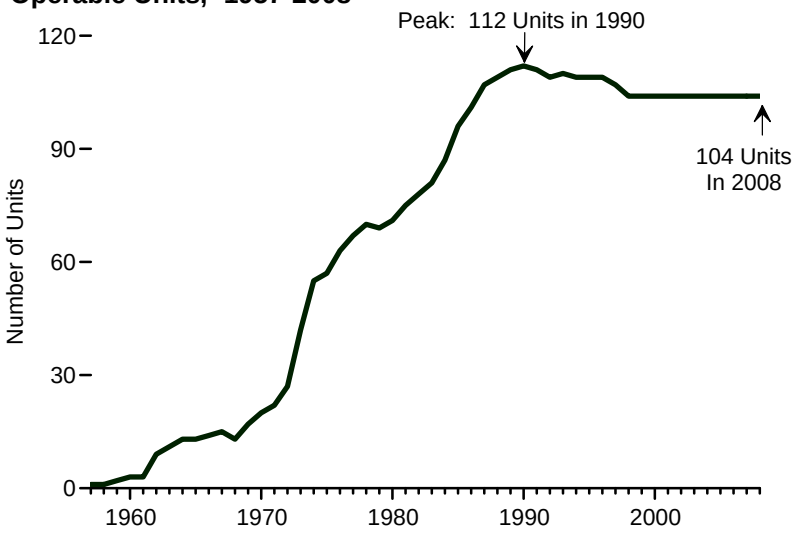
9 Nuclear Energy

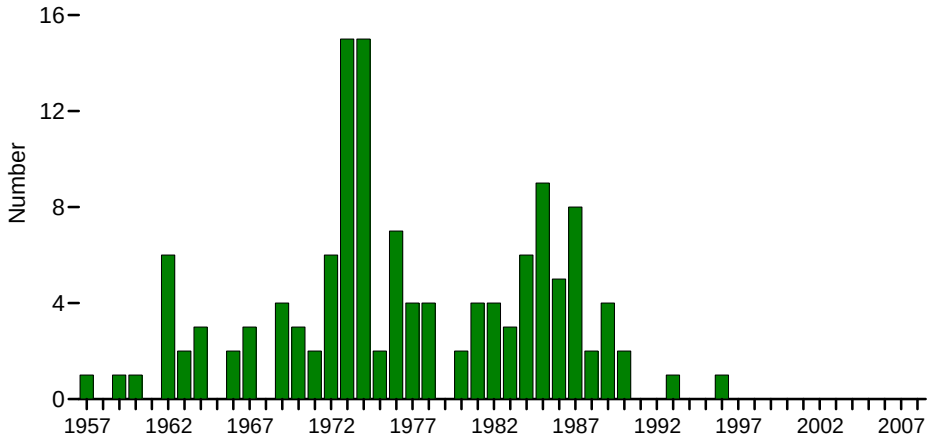
Site of Shippingport atomic power station, the first commercial nuclear power plant in the United States (rectangular reactor building and foreground); background, Beaver Valley 1 and 2 nuclear power plants and Bruce Mansfield coal-fired power plant (southwestern Pennsylvania). Source: U.S. Department of Energy.

Figure 9.1 Nuclear Generating Units

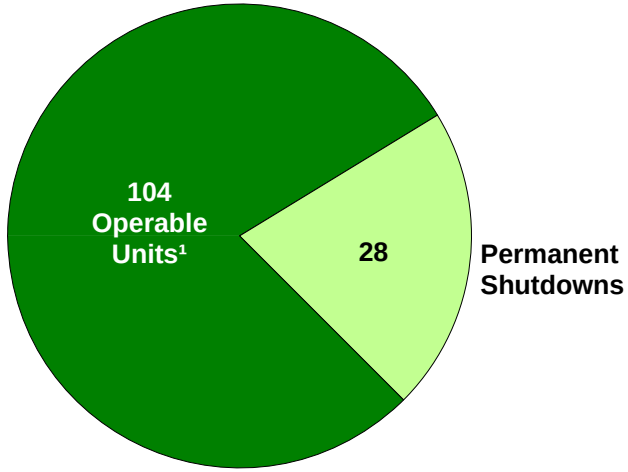
Operable Units,[1] 1957-2008



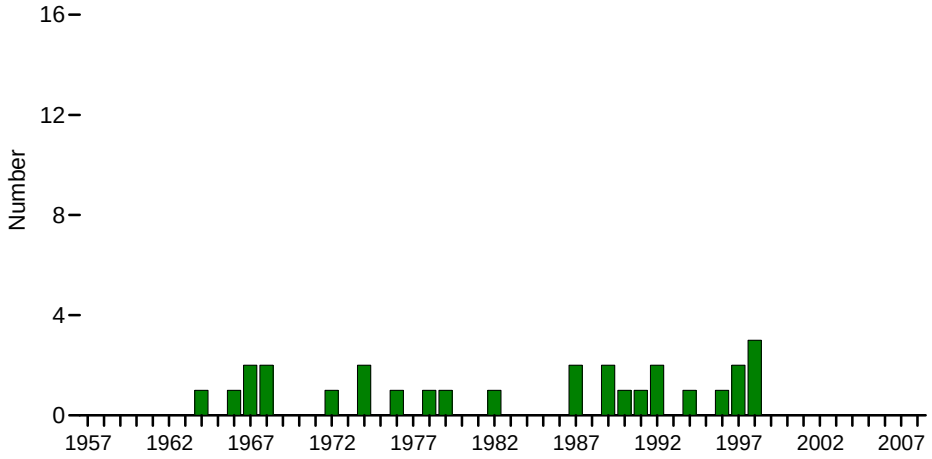
Full-Power Operating Licenses Issued,[2] 1957-2008



Status of All Nuclear Generating Units, 2008



Permanent Shutdowns by Year, 1957-2008



[1] Units holding full-power operating licenses, or equivalent permission to operate, at the end of the year.
[2] Issuance by regulatory authority of full-power operating license, or equivalent permission.

Note: Data are at end of year.
Source: Table 9.1.

Table 9.1 Nuclear Generating Units, 1955-2008

Year	Original Licensing Regulations (10 CFR Part 50) [1]			Current Licensing Regulations (10 CFR Part 52) [1]			Permanent Shutdowns	Operable Units [6]
	Construction Permits Issued [2,3]	Low-Power Operating Licenses Issued [3,4]	Full-Power Operating Licenses Issued [3,5]	Early Site Permits Issued [3]	Combined License Applications Under Review	Combined Licenses Issued [3]		
1955	1	0	0	– –	– –	– –	0	0
1956	3	0	0	– –	– –	– –	0	0
1957	1	1	1	– –	– –	– –	0	1
1958	0	0	0	– –	– –	– –	0	1
1959	3	1	1	– –	– –	– –	0	2
1960	7	1	1	– –	– –	– –	0	3
1961	0	0	0	– –	– –	– –	0	3
1962	1	7	6	– –	– –	– –	0	9
1963	1	3	2	– –	– –	– –	0	11
1964	3	2	3	– –	– –	– –	1	13
1965	1	0	0	– –	– –	– –	0	13
1966	5	1	2	– –	– –	– –	1	14
1967	14	3	3	– –	– –	– –	2	15
1968	23	0	0	– –	– –	– –	2	13
1969	7	4	4	– –	– –	– –	0	17
1970	10	4	3	– –	– –	– –	0	20
1971	4	5	2	– –	– –	– –	0	22
1972	8	6	6	– –	– –	– –	1	27
1973	14	12	15	– –	– –	– –	0	42
1974	23	14	15	– –	– –	– –	2	55
1975	9	3	2	– –	– –	– –	0	57
1976	9	7	7	– –	– –	– –	1	63
1977	15	4	4	– –	– –	– –	0	67
1978	13	3	4	– –	– –	– –	1	70
1979	2	0	0	– –	– –	– –	1	69
1980	0	5	2	– –	– –	– –	0	71
1981	0	3	4	– –	– –	– –	0	75
1982	0	6	4	– –	– –	– –	1	78
1983	0	3	3	– –	– –	– –	0	81
1984	0	7	6	– –	– –	– –	0	87
1985	0	7	9	– –	– –	– –	0	96
1986	0	7	5	– –	– –	– –	0	101
1987	0	6	8	– –	– –	– –	2	107
1988	0	1	2	– –	– –	– –	0	109
1989	0	3	4	– –	– –	– –	2	111
1990	0	1	2	– –	– –	– –	1	112
1991	0	0	0	– –	– –	– –	1	111
1992	0	0	0	– –	– –	– –	2	109
1993	0	1	1	– –	– –	– –	0	110
1994	0	0	0	– –	– –	– –	1	109
1995	0	1	0	– –	– –	– –	0	109
1996	0	0	1	– –	– –	– –	1	109
1997	0	0	0	0	0	0	2	107
1998	0	0	0	0	0	0	3	104
1999	0	0	0	0	0	0	0	104
2000	0	0	0	0	0	0	0	104
2001	0	0	0	0	0	0	0	104
2002	0	0	0	0	0	0	0	104
2003	0	0	0	0	0	0	0	104
2004	0	0	0	0	0	0	0	104
2005	0	0	0	0	0	0	0	104
2006	0	0	0	0	0	0	0	104
2007	0	0	0	3	R5	0	0	104
2008	0	0	0	0	12	0	0	104
Total	177	132	132	3	17	0	28	– –

[1] Data in columns 1-3 are based on the U.S. Nuclear Regulatory Commission (NRC) regulation 10 CFR Part 50. Data in columns 4-6 are based on the NRC regulation 10 CFR Part 52. See Note 1, "Pending Actions on Nuclear Generating Units," at end of section.

[2] Issuance by regulatory authority of a permit, or equivalent permission, to begin construction. Under current licensing regulations, the construction permit is no longer issued separately from the operating license.

[3] Numbers reflect permits or licenses issued in a given year, not extant permits or licenses.

[4] Issuance by regulatory authority of license, or equivalent permission, to conduct testing but not to operate at full power.

[5] Issuance by regulatory authority of full-power operating license, or equivalent permission (note that some units receive full-power licenses the same year they receive low-power licenses). Units initially undergo low-power testing prior to commercial operation.

[6] Total of nuclear generating units holding full-power licenses, or equivalent permission to operate, at the end of the year (the number of operable units equals the cumulative number of units holding full-power licenses minus the cumulative number of permanent shutdowns).

R=Revised. – – = Not applicable.

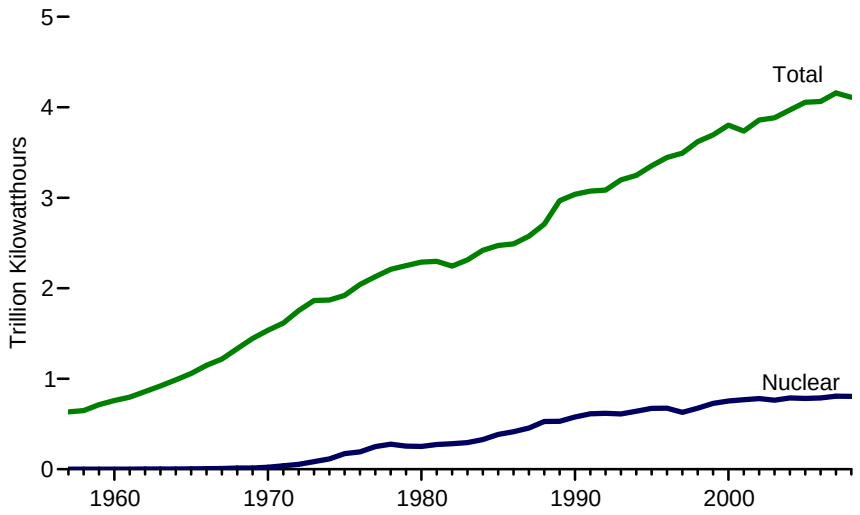
Note: See Note 2, "Coverage of Nuclear Energy Statistics," at end of section.

Web Page: For related information, see http://www.eia.doe.gov/fuelnuclear.html.

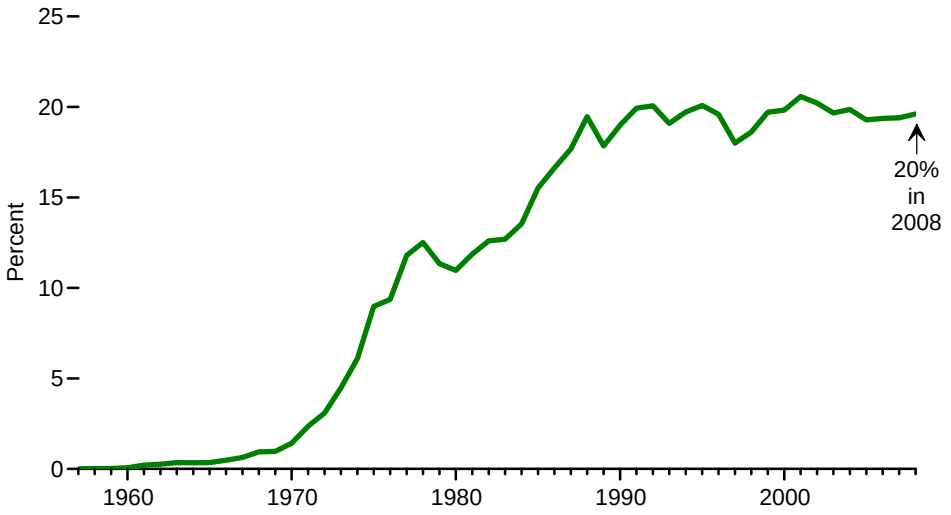
Sources: See end of section.

Figure 9.2 Nuclear Power Plant Operations

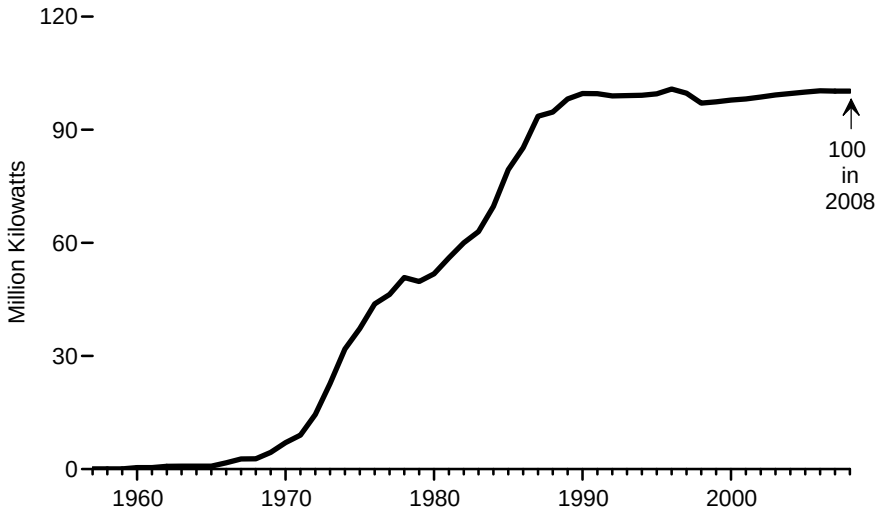
Total Electricity and Nuclear Electricity Net Generation, 1957-2008



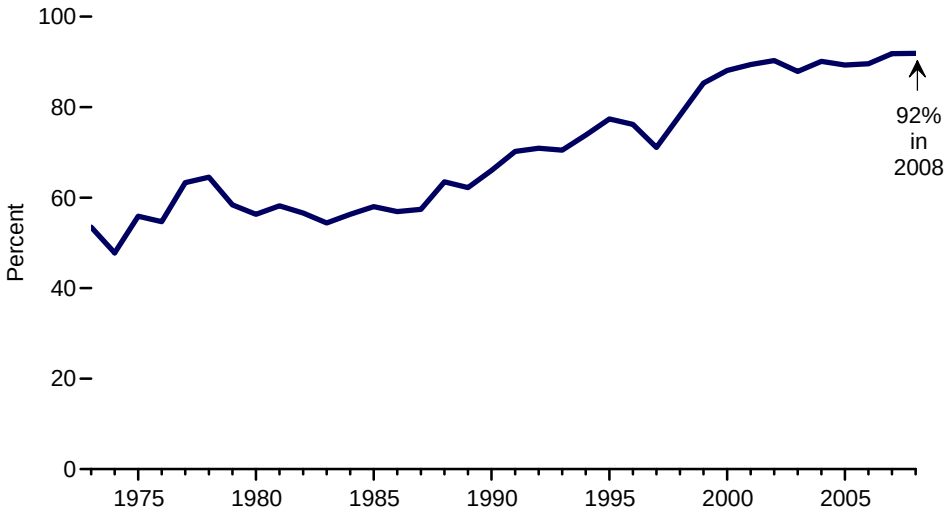
Nuclear Share of Total Electricity Net Generation, 1957-2008



Net Summer Capacity of Operable Units, 1957-2008



Capacity Factor, 1973-2008



Sources: Tables 8.1 and 9.2.

Table 9.2 Nuclear Power Plant Operations, 1957-2008

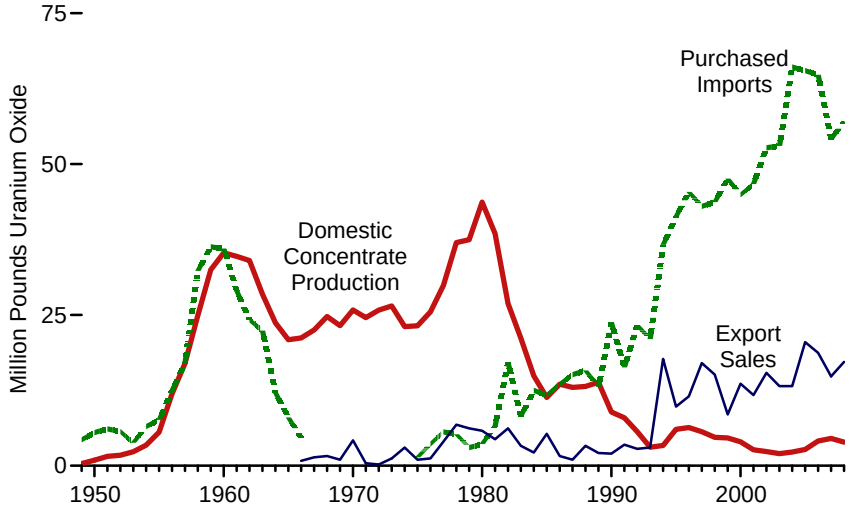
Year	Nuclear Electricity Net Generation	Nuclear Share of Total Electricity Net Generation	Net Summer Capacity of Operable Units [1]	Capacity Factor [2]
	Billion Kilowatthours	Percent	Million Kilowatts	Percent
1957	(s)	(s)	0.1	NA
1958	.2	(s)	.1	NA
1959	.2	(s)	.1	NA
1960	.5	.1	.4	NA
1961	1.7	.2	.4	NA
1962	2.3	.3	.7	NA
1963	3.2	.3	.8	NA
1964	3.3	.3	.8	NA
1965	3.7	.3	.8	NA
1966	5.5	.5	1.7	NA
1967	7.7	.6	2.7	NA
1968	12.5	.9	2.7	NA
1969	13.9	1.0	4.4	NA
1970	21.8	1.4	7.0	NA
1971	38.1	2.4	9.0	NA
1972	54.1	3.1	14.5	NA
1973	83.5	4.5	22.7	53.5
1974	114.0	6.1	31.9	47.8
1975	172.5	9.0	37.3	55.9
1976	191.1	9.4	43.8	54.7
1977	250.9	11.8	46.3	63.3
1978	276.4	12.5	50.8	64.5
1979	255.2	11.3	49.7	58.4
1980	251.1	11.0	51.8	56.3
1981	272.7	11.9	56.0	58.2
1982	282.8	12.6	60.0	56.6
1983	293.7	12.7	63.0	54.4
1984	327.6	13.5	69.7	56.3
1985	383.7	15.5	79.4	58.0
1986	414.0	16.6	85.2	56.9
1987	455.3	17.7	93.6	57.4
1988	527.0	19.5	94.7	63.5
1989	529.4	17.8	98.2	62.2
1990	576.9	19.0	99.6	66.0
1991	612.6	19.9	99.6	70.2
1992	618.8	20.1	99.0	70.9
1993	610.3	19.1	99.0	70.5
1994	640.4	19.7	99.1	73.8
1995	673.4	20.1	99.5	77.4
1996	674.7	19.6	100.8	76.2
1997	628.6	18.0	99.7	71.1
1998	673.7	18.6	97.1	78.2
1999	728.3	19.7	97.4	85.3
2000	753.9	19.8	97.9	88.1
2001	768.8	20.6	98.2	89.4
2002	780.1	20.2	98.7	90.3
2003	763.7	19.7	99.2	87.9
2004	788.5	19.9	99.6	90.1
2005	782.0	19.3	100.0	89.3
2006	787.2	19.4	100.3	89.6
2007	R806.4	19.4	R100.3	R91.8
2008P	806.2	19.6	100.3	91.9

[1] At end of year. See "Generator Net Summer Capacity" in Glossary.
[2] See "Generator Capacity Factor" in Glossary.
R=Revised. P=Preliminary. NA=Not available. (s)=Less than 0.05.
Note: See Note 2, "Coverage of Nuclear Energy Statistics," at end of section.
Web Page: For related information, see http://www.eia.doe.gov/fuelnuclear.html.

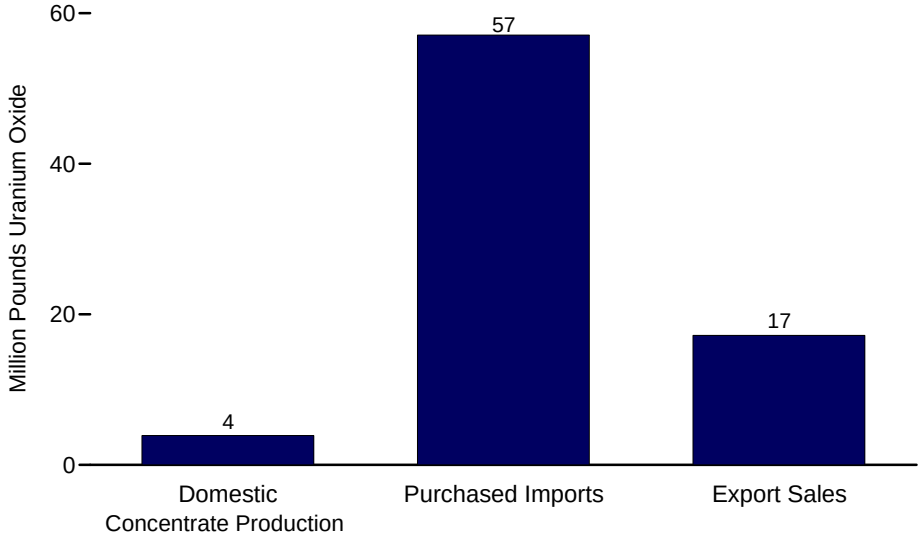
Sources: **Nuclear Electricity Net Generation** and **Nuclear Share of Electricity Net Generation:** Table 8.2a. **Net Summer Capacity of Operable Units:** • 1949-2007: Table 8.11a. • 2008—Energy Information Administration (EIA), *Monthly Energy Review* (March 2009), Table 8.1. **Capacity Factor:** EIA, *Monthly Energy Review* (March 2009), Table 8.1. Annual capacity factors are weighted averages of monthly capacity factors.

Figure 9.3 Uranium Overview

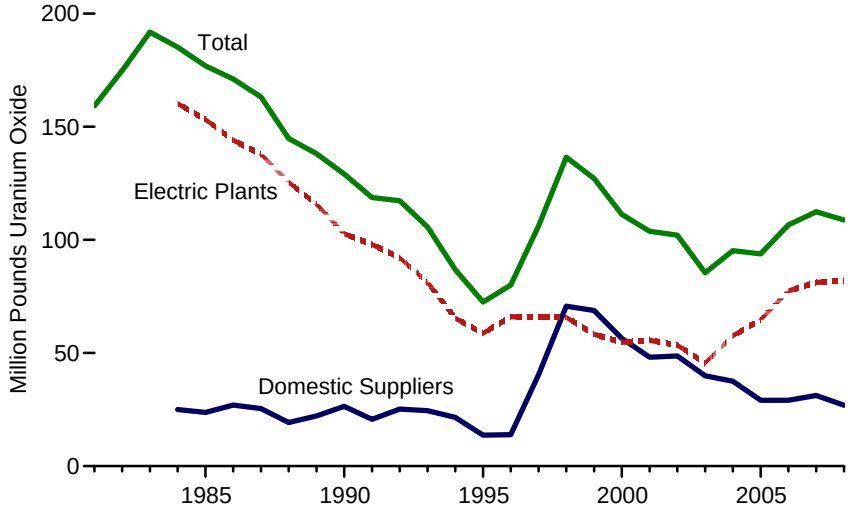
Production and Trade, 1949-2008



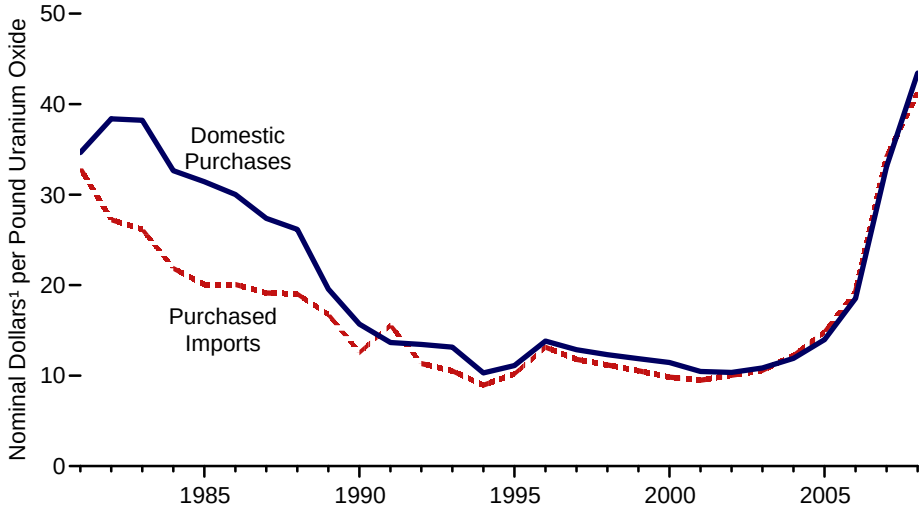
Production and Trade, 2008



Inventories, End of Year 1981-2008



Average Prices, 1981-2008



[1] See "Nominal Dollars" in Glossary.
Note: See "Uranium Oxide" in Glossary.

Source: Table 9.3.

Table 9.3 Uranium Overview, Selected Years, 1949-2008

Year	Domestic Concentrate Production [1]	Purchased Imports [2]	Export [2] Sales	Electric Plant Purchases From Domestic Suppliers	Loaded Into U.S. Nuclear Reactors [3]	Inventories			Average Price	
						Domestic Suppliers	Electric Plants	Total	Purchased Imports	Domestic Purchases
	Million Pounds Uranium Oxide								Nominal Dollars [4] per Pound Uranium Oxide	
1949	0.36	4.3	0.0	NA	NA	NA	NA	NA	NA	NA
1950	.92	5.5	.0	NA	NA	NA	NA	NA	NA	NA
1955	5.56	7.6	.0	NA	NA	NA	NA	NA	NA	NA
1960	35.28	36.0	.0	NA	NA	NA	NA	NA	NA	NA
1965	20.88	8.0	.0	NA	NA	NA	NA	NA	NA	NA
1970	25.81	.0	4.2	NA	NA	NA	NA	NA	– –	NA
1971	24.55	.0	.4	NA	NA	NA	NA	NA	– –	NA
1972	25.80	.0	.2	NA	NA	NA	NA	NA	– –	NA
1973	26.47	.0	1.2	NA	NA	NA	NA	NA	– –	NA
1974	23.06	.0	3.0	NA	NA	NA	NA	NA	– –	NA
1975	23.20	1.4	1.0	NA	NA	NA	NA	NA	NA	NA
1976	25.49	3.6	1.2	NA	NA	NA	NA	NA	NA	NA
1977	29.88	5.6	4.0	NA	NA	NA	NA	NA	NA	NA
1978	36.97	5.2	6.8	NA	NA	NA	NA	NA	NA	NA
1979	37.47	3.0	6.2	NA	NA	NA	NA	NA	NA	NA
1980	43.70	3.6	5.8	NA	NA	NA	NA	NA	NA	NA
1981	38.47	6.6	4.4	32.6	NA	NA	NA	159.2	32.90	34.65
1982	26.87	17.1	6.2	27.1	NA	NA	NA	174.8	27.23	38.37
1983	21.16	8.2	3.3	24.2	NA	NA	NA	191.8	26.16	38.21
1984	14.88	12.5	2.2	22.5	NA	25.0	160.2	185.2	21.86	32.65
1985	11.31	11.7	5.3	21.7	NA	23.7	153.2	176.9	20.08	31.43
1986	13.51	13.5	1.6	18.9	NA	27.0	144.1	171.1	20.07	30.01
1987	12.99	15.1	1.0	20.8	NA	25.4	137.8	163.2	19.14	27.37
1988	13.13	15.8	3.3	17.6	NA	19.3	125.5	144.8	19.03	26.15
1989	13.84	13.1	2.1	18.4	NA	22.2	115.8	138.1	16.75	19.56
1990	8.89	23.7	2.0	20.5	NA	26.4	102.7	129.1	12.55	15.70
1991	7.95	16.3	3.5	26.8	34.6	20.7	98.0	118.7	15.55	13.66
1992	5.65	23.3	2.8	23.4	43.0	25.2	92.1	117.3	11.34	13.45
1993	3.06	21.0	3.0	15.5	45.1	24.5	81.2	105.7	10.53	13.14
1994	3.35	36.6	17.7	22.7	40.4	21.5	65.4	86.9	8.95	10.30
1995	6.04	41.3	9.8	22.3	51.1	13.7	58.7	72.5	10.20	11.11
1996	6.32	45.4	11.5	23.7	46.2	13.9	66.1	80.0	13.15	13.81
1997	5.64	43.0	17.0	19.4	48.2	40.4	65.9	106.2	11.81	12.87
1998	4.71	43.7	15.1	21.6	38.2	70.7	65.8	136.5	11.19	12.31
1999	4.61	47.6	8.5	21.4	58.8	68.8	58.3	127.1	10.55	11.88
2000	3.96	44.9	13.6	24.3	51.5	56.5	54.8	111.3	9.84	11.45
2001	2.64	46.7	11.7	27.5	52.7	48.1	55.6	103.8	9.51	10.45
2002	2.34	52.7	15.4	22.7	57.2	48.7	53.5	102.1	10.05	10.35
2003	[5,E]2.00	53.0	13.2	21.7	62.3	39.9	45.6	85.5	10.59	10.84
2004	2.28	66.1	13.2	28.2	50.1	37.5	57.7	95.2	12.25	11.91
2005	2.69	65.5	20.5	27.3	58.3	29.1	64.7	93.8	14.83	13.98
2006	4.11	64.8	18.7	27.9	51.7	29.1	77.5	106.6	19.31	18.54
2007	4.53	54.1	14.8	18.5	[R]45.5	[R]31.2	[R]81.2	[R]112.4	34.18	33.13
2008	3.90	57.1	17.2	20.4	[P]51.3	[P]26.9	[P]81.9	[P]108.8	41.30	43.43

[1] See "Uranium Concentrate" in Glossary.

[2] Import quantities through 1970 are reported for fiscal years. Prior to 1968, the Atomic Energy Commission was the sole purchaser of all imported uranium oxide. Trade data prior to 1982 were for transactions conducted by uranium suppliers only. For 1982 forward, transactions by uranium buyers (consumers) have been included. Buyer imports and exports prior to 1982 are believed to be small.

[3] Does not include any fuel rods removed from reactors and later reloaded.

[4] See "Nominal Dollars" in Glossary.

[5] Value has been rounded to avoid disclosure of individual company data.

R=Revised. P=Preliminary. E=Estimate. NA=Not available. – – = Not applicable.

Note: See "Uranium Oxide" in Glossary.

Web Pages: • For all data beginning in 1949, see http://www.eia.doe.gov/emeu/aer/nuclear.html. • For related information, see http://www.eia.doe.gov/fuelnuclear.html.

Sources: • 1949-1966—U.S. Department of Energy, Grand Junction Office, *Statistical Data of the Uranium Industry,* Report No. GJO-100, annual reports. • 1967-2002—Energy Information Administration (EIA), *Uranium Industry Annual,* annual reports. • 2003 forward—EIA, "2008 Domestic Uranium Production Report" (May 2009), Table 3; EIA, "2008 Uranium Marketing Annual Report" (May 2009), Tables 5, 18, 19, 21, and 22; and EIA, Form EIA-858, "Uranium Marketing Annual Survey.

Nuclear Energy

Note 1. Pending Actions on Nuclear Generating Units. Much of Table 9.1 is based on the U.S Nuclear Regulatory Commission (NRC) regulation 10 CFR Part 50, which has in most instances been supplanted by 10 CFR Part 52 following the passage of the Energy Policy Act of 1992 and procedural reforms initiated in 1989 by the NRC. (This statement applies to permit and license procedures only.)

In 2007, the NRC issued three Early Site Permits (ESPs) under 10 CFR Part 52—for Clinton (Illinois); Grand Gulf (Mississippi); and North Anna (Virginia). As of December 31, 2008, the ESP application for Vogtle (Georgia) was under review. No new ESP applications have been submitted since August 2006.

In 2007, the NRC had five Combined License (COL) applications under review—for Bellefonte 3 and 4 (Alabama); Calvert Cliffs 3 (Maryland); North Anna 3 (Virginia); and South Texas Project 3 and 4 (Texas), and William States Lee III (South Carolina). As of December 2008, an additional 12 COL applications were either under review or had been submitted to the NRC—for Bell Bend (Pennsylvania); Callaway 2 (Missouri); Comanche Peak 3 and 4 (Texas); Fermi 3 (Michigan); Grand Gulf 2 (Mississippi); Shearon Harris 2 and 3 (North Carolina); Levy County 1 and 2 (Florida); Nine Mile Point 3 (New York); River Bend 2 (Louisiana); Virgil C. Summer 2 and 3 (South Carolina); Victoria County 1 and 2 (Texas); and Vogtle 3 and 4 (Georgia). Of the 12 new COL applications, Bell Bend, Levy, Victoria, and William States Lee III are the only sites that do not yet have any reactors. These 17 COL applications represent a total of 26 reactors. In addition to the COL applications currently under review, Watts Bar 2 is currently under construction. Issued a construction permit for Watts Bar 2 in 1973, the Tennessee Valley Authority plans to complete construction and bring the unit on line in 2012. This is the only reactor that is anticipated to apply for the license separate of construction permit.

As of December 31, 2008, 14 applications for license extensions were under review by the NRC. The oldest application still pending, first submitted in July 2005, was for the oldest commercial reactor still in service, the Mark 1 Boiling Water Reactor at Oyster Creek. The most recent application, submitted on December 18, 2008, was for the Crystal River 3 plant (Florida). On April 8, 2009, the NRC granted a 20-year license extension to Oyster Creek, reducing the number of applications currently under review to 13.

For more information on nuclear reactors, see http://www.nrc.gov/reactors.html.

Note 2. Coverage of Nuclear Energy Statistics. In 1997, the Energy Information Administration undertook a major revision of Table 9.1 to more fully describe the history of the U.S. commercial nuclear power industry. The time frame was extended back to the birth of the industry in 1953 and the data categories were revised for greater relevance to current industry conditions and trends. To acquire the data for the revised categories, it was necessary to develop a reactor unit database employing different sources than those used previously for Table 9.1 and still used for Table 9.2.

The data in Table 9.1 apply to commercial nuclear power units, which means that the units contributed power to the commercial electricity grid. A total of 259 units ever ordered was identified. Although most orders were placed by electric utilities, several units are or were ordered, owned, and operated wholly or in part by the Federal Government, including BONUS (Boiling Nuclear Superheater Power Station), Elk River, Experimental Breeder Reactor 2, Hallam, Hanford N, Piqua, and Shippingport.

A reactor is generally defined as operable in Table 9.1 while it possessed a full-power license from the Nuclear Regulatory Commission or its predecessor the Atomic Energy Commission, or equivalent permission to operate, at the end of the year. The definition is liberal in that it does not exclude units retaining full-power licenses during long, non-routine shutdowns. For example:

- In 1985, the five Tennessee Valley Authority units (Browns Ferry 1, 2, and 3 and Sequoyah 1 and 2) were shut down under a regulatory forced outage. Browns Ferry 1 was authorized by the NRC to restart in 2008, while the other units restarted in 1991, 1995, 1988, and 1988, respectively. All five units were counted as operable during the shutdowns.
- Shippingport was shut down from 1974 through 1976 for conversion to a light-water breeder reactor, but is counted as operable until its retirement in 1982.
- Calvert Cliffs 2 was shut down in 1989 and 1990 for replacement of pressurizer heater sleeves but is counted as operable during those years.

Exceptions to the rule are Shoreham and Three Mile Island 2. Shoreham was granted a full-power license in April 1989, but was shut down two months later and never restarted. In 1991, the license was changed to Possession Only. Although not operable at the end of the year, Shoreham is treated as operable during 1989 and shut down in 1990, because counting it as operable and shut down in the same year would introduce a statistical discrepancy in the tallies. A major accident closed Three Mile Island 2 in 1979, and although the unit retained its full-power license for several years, it is considered permanently shut down since that year.

Table 9.1 Sources: Operable Units: • 1955-1982–Compiled from various sources, primarily U.S. Department of Energy (DOE), Office of Nuclear Reactor Programs, "U.S. Central Station Nuclear Electric Generating Units: Significant Milestones." • 1983 forward–Energy Information Administration (EIA), Form EIA-860, "Annual Electric Generator Report," and predecessor forms. **All Other Data:** • 1955-1997–U.S. Atomic Energy Commission, *1973 Annual Report to Congress, Volume 2, Regulatory Activities*; Nuclear Energy Institute, *Historical Profile of U.S. Nuclear Power Development* (1988); EIA, *Commercial Nuclear Power 1991* (September 1991); DOE, *Nuclear Reactors Built, Being Built, and Planned: 1995*; U.S. Nuclear Regulatory Commission (NRC), *Information Digest* (1997 and 1998) and "Plant Status Report"; and various utility, Federal, and contractor officials. • 1998 forward–NRC, *Information Digest*, annual reports.