UNITED STATES OF AMERICA

(UPDATED 2011)

1. GENERAL INFORAMTION

The United States of America's (U.S.) nuclear power industry is the largest in the world. In 2009, the U.S. generated 799 billion kilowatt-hours of nuclear electricity. France, the second largest producer, generated about half that amount. The industry includes most phases of the fuel cycle, from uranium exploration and mining to nuclear waste disposal, but does not include reprocessing. Many services and supplies to the U.S. nuclear power industry are imported. Most of the U.S. nuclear power industry is privately owned and managed, although Federal, State, municipal and regional agencies own and manage nine operable power reactors (out of 104 reactors nationwide) and have partial ownership of other reactors.

1.1. GENERAL OVERVIEW

1.1.1 GOVERNMENTAL SYSTEM

The United States is a constitutional federal republic, which includes fifty states and one federal district. The government is composed of three branches: executive, legislative and judicial. The executive branch is led by the President. The legislative branch is composed of a bicameral Congress, which includes the Senate and House of Representatives. The judicial branch includes the Supreme Court as well as lower federal courts.

1.1.2 GEOGRAPHY AND CLIMATE

The U.S. extends over the midsection of North America, stretching from the Atlantic Ocean to the Pacific Ocean plus Alaska and Hawaii. The total area of the U.S. is over 3.5 million square miles[1] (9.2 million square kilometres). Climate varies greatly across the nation. Average annual temperatures range from 9 degrees Fahrenheit (-13 degrees Celsius) in Barrow, Alaska, to 78 degrees Fahrenheit (26 degrees Celsius) in Death Valley, California. Rainfall varies from less than 2 inches annually at Death Valley to about 460 inches at Mount Waialeale in Hawaii. Most of the U.S. has seasonal temperature changes and moderate precipitation. The Midwest, the Middle Atlantic States and the New England states experience warm summers and cold, snowy winters. Summers are long, hot, and often humid in the South while winters are mild. Along the Pacific Coast, and in some other

[1] http://quickfacts.census.gov/qfd/states/00000.html

areas near large bodies of water, the climate is relatively mild all year. Hawaii is tropical. The moderate climate in much of the U.S. has encouraged widespread population settlement.

1.1.3 POPULATION

The population in the U.S. as of April 2010 was nearly 309 million people (Table 1). Population density is nearly 34 persons per square kilometre, with almost 80% living in urban areas. Economic statistics for the U.S. are regularly published by the U.S. Department of Commerce's Bureau of Economic Statistics. Table 2 shows the historical Gross Domestic Product (GPD) statistics. The energy situation in the U.S. is provided in the U.S. Energy Information Administration's (EIA) regularly updated United States Energy Profile. Table 3 shows the U.S. energy reserves and Table 4 the historical energy statistics.

TABLE 1. POPULATION INFORMATION

	1970	1980	1990	2000	2005	2008	2009	2010
Population (millions)	205.0	227.2	249.5	281.4	295.8	304.4	307.0	308.8
Population density (inhabitants/km^2)	22.19	24.72	27.15	30.71	32.26	33.19	33.51	33.70
Urban population as a % of total	73%	74%	75%	79%	N/A	N/A	N/A	N/A

Source:

1970, 1980, 1990 Population: http://www.census.gov/popest/archives/1990s/popclockest.txt

2000-2009 Population http://factfinder.census.gov/servlet/GCTTable?_bm=y&-geo_id=01000US&-_box_head_nbr=GCT-T1&-ds_name=PEP_2009_EST&-_lang=en&-format=US-40&-_sse=on

2010 data: http://2010.census.gov/2010census/data/

Urban population for 1970, 1980, and 1990:
http://www.census.gov/population/censusdata/urpop0090.txt

Population growth rate (%) 2008 to 2009	0.90%
Area (1000 km^2)	9161.9

Source:
Growth rate: http://www.census.gov/popest/states/NST-pop-chg.html
Land area: http://quickfacts.census.gov/qfd/states/00000.html
Urban population:
http://factfinder.census.gov/servlet/GCTTable?_bm=y&-geo_id=01000US&-_box_head_nbr=GCT-P1&-ds_name=DEC_2000_SF1_U&-redoLog=false&-format=US-1&-mt_name=DEC_2000_SF1_U_GCTP1_US1&-CONTEXT=gct

1.1.4 ECONOMIC DATA

TABLE 2. GROSS DOMESTIC PRODUCT (GDP)

	1980	1990	2000	2005	2009
GDP [1] (millions current US $)	2,788,100	5,800,500	9,951,500	12,638,400	14,119,000
GDP [2] (millions of constant 2005 US $)	5,839,000	8,033,900	11,226,000	12,638,400	12,880.60
GDP per capita (current US$/capita)	12,272	23,248	35,364	42,726	45,990

1.2 ENERGY INFORMATION

The U.S. has a market-driven economy. Decisions affecting resources, prices, technology development, and other matters pertaining to energy are made by the private sector within the context of government regulations and laws. Federal and local governments encourage the development and use of selected energy resources through funding of research and development, tax allowances, service charges, regulations, and demonstration projects. Many of the main features of federal energy policy are established by the Energy Policy Act of 1992 (EPACT1992) and the Energy Policy Act of 2005 (EPACT2005). These federal laws establish energy efficiency standards, nuclear power incentives, alternate fuels development, and renewable energy incentives.

Energy statistics and projections for the U.S. are regularly published by the U.S. Energy Information Administration (EIA). An EIA publications list is available through http://www.eia.doe.gov/bookshelf.html. Publications include regular energy, electricity, and nuclear statistics and short and long term energy projections.

1.2.1 *Estimated Available Energy*

TABLE 3. ESTIMATED ENERGY RESERVES

	Estimated energy reserves in physical units					
	Solid (1)	Liquid (2)	Gas (2)	Uranium (3)	Hydro (4)	Other Renewable
Total amount in specific units	487,700	25.5	244,700	1,227	0.233	N/A
	Million tons	Billion bbls	Billion ft^3	Mn. Lbs U3O8 ($100/lb)	TW	N/A
Total amount in Exajoule (EJ)	10,276	156.0	265.1	N/A	N/A	N/A

(1) Annual Energy Review 2009, Table 4.11, Demonstrated Reserve Base. Conversion using 2008 Total Production value 19.973 million Btu/ton from Table A5.
(2) Annual Energy Review 2009, Table 4.2, Proved Reserves. Petroleum conversion using 5.8 million Btu/bbl, Table A2. Natural gas conversion using 1027 Btu/ft^3.
(3) U.S. Uranium Reserves Estimates Report, July 2010 - This total represents reasonably assured resources (2009 estimates) that are available at $100/lb U3O8 or less.

(4) EIA submission to World Energy Council Questionnaire, September 2009

1.2.2 *ENERGY STATISTICS*

TABLE 4. ENERGY STATISTICS

(Quadrillion Btu)

	1970	1980	1990	2000	2005	2009
Energy consumption						
Total[1]	67.84	78.12	84.65	98.97	100.45	94.58
Solids[2]	13.64	17.86	21.8	25.42	25.38	22.08
Liquids[3]	29.52	34.2	33.66	38.5	40.97	36.81
Gases[4]	21.8	20.24	19.6	23.82	22.56	23.36
Energy production						
Total[5]	63.5	67.23	70.87	71.49	69.59	72.97
Solids[6]	16.04	21.06	25.22	25.74	26.29	25.48
Liquids[7]	20.40*	18.25*	15.68	12.59	11.53	12.8
Gases[8]	21.67	19.91	18.33	19.66	18.56	21.5
Net import (Import - Export)						
- Total[9]	5.71	12.1	14.07	24.97	30.15	22.85

Note: The energy statistics presented in this table do not include consumption or production related to nuclear and renewable energy (including hydro, geothermal, wind, and solar). As a result, the totals for consumption and production can be higher than the sum of the energy sources specifically included in the table.

[1] Source: Annual Energy Review 2009, Table 1.3.

[2] Solid fuel consumption = coal, coke, biomass wood and biomass waste. Source:

Annual Energy Review 2009, Tables 1.3 and 10.1.

(3) Liquids for consumption = petroleum and biofuels. Source: Annual Energy Review 2009, Table 1.3 and Table 10.1. There are no biofuel numbers in Table 1.3.

(4) Gases for consumption = NG. Source: Annual Energy Review 2009, Table 1.3.

(5) Source: Annual Energy Review 2009, Table 1.2.

(6) Solid for production = coal, biomass wood, biomass waste. Sources: Annual Energy Review 2009, Tables 1.2 and 10.1.

(7) Liquids for production = petroleum and biofuels. Biofuel data not available in 1970 and 1980. Source: AER Annual Energy Review 2009, Tables 1.2 and 10.1.

(8) Gases for production = natural gas. Source: Annual Energy Review 2009, Table 1.2.

(9) All imports – all exports. Source: Annual Energy Review 2009, Table 1.4.

1.2.3. Energy Policy

The U.S. energy industry is a market-based system in which various aspects of participation are regulated. Regulatory policy varies according to state, although there is federal oversight of interstate commerce.

1.3. The Electricity System

The electricity system in the U.S. consists of generation, transmission, distribution systems, and end users. The relationships between these market participants vary by state and region. There is interstate trade, but there is no single system or market structure. Some states have regulated markets in which generation, transmission, and distribution of electric power is provided by a single company. Other states have unbundled the generation, transmission, and distribution activities and allow for competitive market participation.

1.3.1. Policy and Decision Making Process

Public policy toward electric utilities is implemented through legislation and regulation of the industry. The decision making process in the industry is decentralized, because electricity generation is decentralized and generators are, mostly, privately-owned, though subject to Federal and State laws and regulations. There are at least eight major pieces of Federal legislation that cover factors including the structure of the industry, interstate commerce (transmission), environmental issues, and operating procedures (see Section 3.2 for a brief description of these laws). Federal involvement in electric power regulation is based on a clause of the U.S. Constitution that only the Federal Government may regulate interstate commerce. Thus, not only does the Federal Government regulate interstate commerce, but State governments are prohibited from doing so. Federal regulation thus complements State and local regulation by focusing on the interstate activities of electricity producers, but leaves the regulation of intrastate activities to the States and other jurisdictions.

Three laws, the Federal Power Act, the Public Utility Regulatory Policies Act (PURPA) of 1978, and the EPACT have formed the basis for Federal regulation of wholesale electric power transactions. The Federal Energy Regulatory Commission (FERC) is the primary agency responsible for this Federal regulation. EPACT instructed FERC to order wholesale wheeling of electricity and authorized FERC to set transmission rates. Within the U.S., California originated the concept of separating operators from owners of transmission systems. FERC endorsed the idea in 1996 when it issued FERC Order 888 that defined rules under which utilities might operate their transmission systems, while allowing for a competitive wholesale electricity market (i.e., open access rules). This encouraged the creation of regional transmission groups or Independent System Operators (ISOs) under FERC jurisdiction. FERC Order 889 of 1996 established electronic open-access same-time information systems (OASIS) for available transmission capacity to give all customers equal, timely access to information.

The States regulate most activities of privately-owned electric utilities. Federal, state, municipal, co-operative, and other utilities are often not directly regulated. Public Utility Commissions (PUCs), which exist in most States regulate the prices for electricity that privately-owned utilities might charge to retail customers while other States allow market or market-like mechanisms to play a role in electricity pricing. After competition in the wholesale market was permitted through Federal legislation, interest arose in retail competition, especially in regions of the country where prices significantly exceeded the national average (i.e., California and the New England States). The process has not been smooth and consistent and several States have stepped back from initial market reforms. Several other States have taken a more deliberative approach toward deregulation, especially following unanticipated price spikes in California and elsewhere, and others have withdrawn from initial ambitious targets. The stable level of deregulated activity equals to 7-8 percent of retail sales.

1.3.2. Structure of the Electric Power Sector

The U.S. electric power industry is a combination of traditional commercial electric utilities and less traditional electricity-producing, transmission, distribution, and marketing entities. Utilities include investor-owned, publicly owned, Federal, and co-operative firms. Historically, the larger companies were vertically integrated though structures have changed in many regions from regulated service monopolies to more complex, unbundled arrangements. PURPA and the continued deregulation of the industry encouraged the emergence of many types of non-utility power producers and marketers. These now number several thousand.

Approximately 60 percent of the electricity generated in the electric power sector in U.S. is generated by investor-owned utilities. These utilities are, for the most part, franchised monopolies that have an obligation to provide electricity to all customers within a service area. Most provide for transmission and distribution of electricity. Their shares are publicly traded and their areas of business operation are expanding into new areas, sometimes unrelated to the provision of electricity or even energy. The role of utilities in electricity generation varies by jurisdiction though there has been a trend toward more competitive generation and transmission of electricity.

A number of utilities in the U.S. are publicly-owned with the most visible being the federally-owned Tennessee Valley Authority (TVA), one of the nation's largest utilities. TVA is also one of the larger nuclear power generating organizations. Several other federal publicly-owned utilities also exist with responsibilities varying widely and often crossing state borders. Publicly-owned utilities also include municipal operations, public power districts, irrigation districts, and various State organizations. Many municipal electric utilities only distribute power, though some larger ones produce and transmit electricity as well. Federal Government utilities primarily produce electric power for the wholesale market.

Numerous co-operative electric utilities were established to provide electricity to their members. The Rural Electrification Administration of the U.S. Department of Agriculture was established in 1936 to extend electric service to rural communities and farms. Co-operatives are incorporated under State law and are usually directed by an elected board of directors.

Non-utility power producers include co-generators, small power producers, and independent power producers. These lack a designated franchise service area though they might provide power to specific clients under contract. Many are generally referred to as qualifying facilities (QFs) because they receive certain benefits under PURPA. To receive status as a QF, the co-generator must meet certain ownership, operating, and efficiency criteria established by the FERC such as producing electricity and other forms of useful thermal energy for industrial, commercial, heating, or cooling purposes.

Independent Power Producers (IPPs) in the U.S. include wholesale electricity producers that are often unaffiliated with franchised utilities in the area in which they sell power. Utility-owned facilities within some jurisdictions might be required to behave as if they were IPPs. The EPACT established a new class of IPPs - exempt wholesale generators (EWGs) or "merchant plants". EPACT exempted EWGs from the corporate and geographic restrictions of earlier legislation. Public utilities are allowed to own IPP facilities through holding companies and have formed subsidiaries to develop and operate independent power projects throughout the world. IPPs and Combined Heat and Power (CHPs) plants make up 42 percent of net summer capacity in the electric power sector.

The historical pattern of an industry dominated by electric utilities continues, but has shifted toward a much more significant role for non-utilities, including affiliates of former utilities. The distinction between utility and non-utility has thus become very difficult to make.

1.3.3. *Main Indicators*

The EIA publishes data related to the electric power industry and to the energy industry in general. Forecasts and projections to 2035 for the U.S. are published in the Annual Energy Outlook. Historical data are provided in the Annual Energy Review. Current publication information is also available.

Electricity data (Table 5) and energy related ratios (Table 6) follow.

TABLE 5. ELECTRICITY PRODUCTION, CONSUMPTION AND CAPACITY

	1970	1980	1990	2000	2005	2009
Capacity of electrical plants						
Total	N/A	N/A	735	813	978	1,025
Coal	N/A	N/A	307	315	313	314
Petroleum	N/A	N/A	78	62	59	57
Natural Gas	N/A	N/A	141	220	383	401
Other Gases	N/A	N/A	2	2	2	2
Nuclear	7	52	100	98	100	101
Hydroelectric (convent)	64	82	74	79	78	79
Other Renewables	N/A	N/A	13	16	21	49
Hydro Pumped Storage	N/A	N/A	19	20	21	22
Other	N/A	N/A	1	1	1	1
Electricity production (TWh)						

Total	1,531	2,281	2,901	3,797	4,048	3,950
Coal	704	1,162	1,572	1,966	2,013	1,756
Petroleum	184	246	119	111	122	39
Natural Gas	373	346	309	601	761	921
Other Gases	N/A	N/A	1	14	13	11
Nuclear	22	251	577	754	782	799
Hydroelectric (convent)	248	276	290	276	270	273
Other Renewables	N/A	N/A	37	81	87	144
Hydro Pumped Storage	N/A	N/A	-4	-6	-7	-5
Other	N/A	N/A	0	0	7	12

TABLE 6. ENERGY RELATED RATIOS

	1970	1980	1990	2000	2005	2009
Energy consumption per capita (million Btu/capita)(1)	330.9	343.8	339.3	351.7	339.6	308.1
Electricity per capita (kWh/capita)(2)	7,488	10,079	12,176	13,511	13,710	12,866
Electricity production/Energy production (%)(3)	8.30%	11.60%	14.60%	18.30%	19.50%	18.47%

Nuclear/Total electricity (%)[4]	1.40%	11.00%	19.00%	19.80%	19.30%	20.23%
Ratio of external dependency (%)[5]	8.40%	15.50%	16.60%	25.20%	30.00%	24.20%

(1) Consumption: Table 1.3 of the 2009 Annual Energy Review. Population from table 1

(2) Electricity: Table 2.1 of the 2009 Electric Power Annual. Population from Table 1

(3) Electricity Production: Table 2.1 of the 2009 Electric Power Annual. Energy Production: Table 1.1 of the 2009 Annual Energy Review

(4) Nuclear and Total Electricity Production: Table 2.1 of the Electric Power Annual

(5) Net import / Total energy consumption. 2009 Annual Energy Review Tables 1.3 and 1.4.

2. NUCLEAR POWER SITUATION

2.1. HISTORICAL DEVELOPMENT AND CURRENT NUCLEAR POWER ORGANIZATIONAL STRUCTURE

2.1.1. OVERVIEW

The early growth of the U.S. commercial nuclear power followed President Eisenhower's Atoms for Peace program that encouraged civilian nuclear power applications while retaining a strong nuclear weapons technology. The Atomic Energy Act of 1954 made possible several demonstration and development reactor programs and created the Atomic Energy Commission (AEC) to supervise nuclear developments. Also in 1954, the AEC proposed a "Five Year Power Reactor Development Program," which called for building five separate reactor technologies. The program prepared the way for private industrial participation in the nuclear power field. Numerous joint industry-government study groups were established to examine power reactor concepts. The first large commercial nuclear power station in the U.S. began operating in Shippingport, Pennsylvania during 1957.

Utilities placed many orders for large reactor systems between the mid-1960s until roughly the time of the Three Mile Island event in 1979. The process of placing orders had however actually begun to decline prior to Three Mile Island as many projects were cancelled or deferred as anticipated electricity demand growth slowed, nuclear construction costs grew, and safety procedures were re-examined. A large number of construction projects continued after 1979 though sometimes schedules were deliberately drawn out to match regulatory and market conditions. Some of these projects were also later cancelled. The last new reactor in the U.S., Watts Bar 1, was completed in 1996. As early as 2001 the Nuclear Regulatory Commission (NRC) began to express a belief that nuclear construction might resume in the U.S.. This statement coincided with the inclusion of new nuclear construction objectives in the U.S. Administration's Energy Policy statement of 2001. The Energy Policy Act of 2005 also included incentives to new nuclear construction, including production tax credits, loan guarantees, and insurance against regulatory delays.

Currently, one construction permit (Watts Bar 2) remains in effect. TVA is proceeding with the completion of Watts Bar 2, which is scheduled for commercial operation in August 2012. On July 13, 2007, the Calvert Cliffs plant applied to the NRC to build and operate an Economic Power Reactor (U.S. name, also known as European Power Reactor). This was the first application for a new reactor in more than two decades and the first to be submitted under NRC's new system, a Combined License (COL) application. Previously, the construction permit and operating license were applied for separately. As of December 31, 2010, the NRC is reviewing COL applications from 17 applicants, involving 26 reactors. Under a Limited Work Authorization, preliminary construction has already begun for two reactors at the Alvin Vogtle plant in Georgia. In addition, TVA is contemplating whether to complete work on two partially completed reactors at Bellefonte, Alabama.

2.1.2. Current Organizational Chart

An extensive industrial base supports the operation of nuclear power plants in the U.S., including reactor manufactures, numerous companies supplying major system components, both mechanical and electrical, and companies supplying equipment and services to plants.

2.2. Nuclear Power Plants: Overview

2.2.1. Status and Performance of Nuclear Power Plants

The nuclear power industry grew to its present size following construction programs initiated during the 1960's and early 1970's that anticipated nuclear power would become a low cost source of electricity. Increases in nuclear generating capacity during 1969-1996 made nuclear power the second largest source of electricity generation in the U.S., following coal. Nuclear power has supplied nearly 20 percent of U.S. electricity generation for over a decade and a half. Better utilization of generating capacity permitted nuclear power to maintain this relative position despite the end of new plant construction during the 1990s and extended shutdowns of several reactors for maintenance and refitting especially during the late 1990's. Several nuclear reactors were permanently closed during the 1990s, though many were small or prototype units. The last reactors closed were during 1998. Firms that wish to leave the nuclear power generating business have since found more gain selling their reactor assets than closing them.

The lack of any new reactor in the next five years and the unlikelihood of increasing plant efficiencies mean that nuclear power's share of electric generating capacity in the U.S. will decline. However, operational and management improvements at nuclear plants have increased their annual electric generation. Annual nuclear electricity generation has more than tripled since 1980 to 799 billion kWh in 2009. (http://www.eia.doe.gov/cneaf/electricity/epm/epmxlfile1_1.xls). The positive nuclear power record has been influenced by growth in reactor productivity as measured by an increase in capacity factors from 56% in 1980 to 66% in 1990 and around 91% at present. Many individual units have achieved 91% or higher capacity factors.

There were 104 licensed nuclear reactors in the U.S at the end of 2010. Reactors are located at 65 sites (plants) with most located in the eastern half of the country. Reactors had a total net summer capacity of 101,004 MWe by the beginning of 2009. Table 7a shows the current status of operating nuclear power plants, and Table 7b shows the status of shutdown nuclear power plants Additional data on nuclear power plants may be found at U.S. Nuclear Statistics.

Nearly 50 years of operational experience and steadily improving licensee performance have changed the way that the U.S. regulates nuclear power to a more risk-informed and performance-based approach. To encourage a sustained high level of safety performance of U.S. nuclear plants, important oversight processes have incorporated risk insights from quantitative risk analysis. Efforts also continue to revise regulations to focus requirements on plant programs and activities that are most risk significant.

2.2.2. Plant Upgrading, Plant Life Management and License Renewals

An increasing need for additional power in the U.S. along with improved economic and safety performance have led most licensees to seek to extend their operating licenses for an additional 20 years beyond their initial 40-year limits. Sixty-one reactors have had their operating licenses extended. Another twenty-two reactors have license extension applications pending before the NRC. The NRC publishes the updated status of such applications on its website. A review of this list indicates that some of the oldest units in the U.S. have yet to apply.

Licensees have also implemented power uprates throughout their history as a means to increase the output of their reactors. Power uprates are classified by the Nuclear Regulatory Commission (NRC) in three groups: (1) measurement uncertainty recapture uprates of less than 2 percent implement enhanced techniques for calculating reactor power, (2) stretch power uprates are typically less than 7 percent and do not usually involve major plant modification, and (3) extended power uprates, larger than stretch power uprates, require significant modification to major balance-of-plant equipment. Extended uprates have been approved for increases of as much as 20 percent, though these might take place over several stages of plant modification.

As of September, 2010, the NRC has approved 135 power uprates adding about 5810 MWe to the generating capacity in the U.S. This is equivalent to more than 5 average sized nuclear power plants. The NRC publishes information on anticipated uprates on http://www.nrc.gov/reactors/operating/licensing/power-uprates.html#status.

TABLE 7. STATUS AND PERFORMANCE OF NUCLEAR POWER PLANTS

Reactor Name	**Type**	**2009 Summer Capacity**	**Operator**	**Reactor Supplier**	**Construction Date**	**Grid Date**	**Capacity Factor**
		Net MW(e) [1]					**Percent** [2]
Arkansas Nuclear-1	PWR	842	Entergy Nuclear South	Babcock&Wilcox	10/1/1968	8/17/1974	99
Arkansas Nuclear-2	PWR	993	Entergy Nuclear South	Combustion Eng.	7/1/1971	12/26/1978	90
Beaver Valley-1	PWR	892	FirstEnergy Nuclear Operating Co.	Westinghouse	6/1/1970	6/14/1976	92
Beaver Valley-2	PWR	885	FirstEnergy Nuclear Operating Co.	Westinghouse	5/1/1974	8/17/1987	88
Braidwood-1	PWR	1,178	Exelon Generation Co, LLC	Westinghouse	8/1/1975	7/12/1987	95
Braidwood-2	PWR	1,152	Exelon Generation Co, LLC	Westinghouse	8/1/1975	5/25/1988	93
Browns Ferry-1	BWR	1,066	Tennessee Valley Authority (TVA)	General Electric	5/1/1967	10/15/1973	94
Browns Ferry-2	BWR	1,104	Tennessee Valley Authority (TVA)	General Electric	5/1/1967	8/28/1974	81
Browns Ferry-3	BWR	1,105	Tennessee Valley Authority (TVA)	General Electric	7/1/1968	9/12/1976	95
Brunswick-1	BWR	938	Progress Energy	General Electric	9/1/1969	12/4/1976	98
Brunswick-2	BWR	920	Progress Energy	General Electric	9/1/1969	4/29/1975	80
Byron-1	PWR	1,164	Exelon Generation Co., LLC	Westinghouse	4/1/1975	3/1/1985	94

Byron-2	PWR	1,136	Exelon Generation Co., LLC	Westinghouse	4/1/1975	2/6/1987	102
Callaway-1	PWR	1,190	AmerenUE	Westinghouse	9/1/1975	10/24/1984	98
Calvert Cliffs-1	PWR	855	Constellation Energy Nuclear Group, LLC	Combustion Eng.	6/1/1968	1/3/1975	101
Calvert Cliffs-2	PWR	850	Constellation Energy Nuclear Group, LLC	Combustion Eng.	6/1/1968	12/7/1976	94
Catawba-1	PWR	1,129	Duke Power Company	Westinghouse	5/1/1974	1/22/1985	91
Catawba-2	PWR	1,129	Duke Power Company	Westinghouse	5/1/1974	3/18/1986	90
Clinton-1	BWR	1,065	Exelon Generation Co, LLC	General Electric	10/1/1975	4/24/1987	95
Columbia-2*	BWR	1,131	Energy Northwest	General Electric	8/1/1972	5/27/1984	67
Comanche Peak-1	PWR	1,209	Luminant Generation	Westinghouse	10/1/1974	4/24/1990	100
Comanche Peak-2	PWR	1,158	Luminant Generation	Westinghouse	10/1/1974	4/9/1993	94
Cooper	BWR	774	Entergy Nuclear Nebraska	General Electric	6/1/1968	5/10/1974	85
Crystal River-3	PWR	860	Progress Energy	Babcock&Wilcox	6/1/1967	1/30/1977	72
Reactor Name	**Type**	**2009 Summer Capacity**	**Operator**	**Reactor Supplier**	**Construction Date**	**Grid Date**	**Capacity Factor**
		Net MW(e) [1]					**Percent** [2]
Davis Besse-1	PWR	894	FirstEnergy Nuclear Operating Co.	Babcock&Wilcox	9/1/1970	8/28/1977	97

Diablo Canyon-1	PWR	1,122	Pacific Gas & Electric Company	Westinghouse	8/1/1968	11/11/1984	82
Diablo Canyon-2	PWR	1,118	Pacific Gas & Electric Company	Westinghouse	12/1/1970	10/20/1985	84
Donald Cook-1	PWR	1,009	American Electric Power Co. Inc.	Westinghouse	3/1/1969	2/10/1975	3
Donald Cook-2	PWR	1,060	American Electric Power Co. Inc.	Westinghouse	3/1/1969	3/22/1978	87
Dresden-2	BWR	867	Exelon Generation Co., LLC	General Electric	1/1/1966	4/13/1970	91
Dresden-3	BWR	867	Exelon Generation Co., LLC	General Electric	10/1/1966	7/22/1971	97
Duane Arnold-1	BWR	601	NextEra Energy Resources Duane Arnold, LLC	General Electric	6/1/1970	5/19/1974	89
Enrico Fermi-2	BWR	1,106	Detroit Edison Company	General Electric	5/1/1969	9/21/1986	76
Farley-1	PWR	851	Southern Nuclear Operating Co.	Westinghouse	10/1/1970	8/18/1977	90
Farley-2	PWR	860	Southern Nuclear Operating Co.	Westinghouse	10/1/1970	5/25/1981	96
Fitzpatrick	BWR	855	Entergy Nuclear Northeast	General Electric	9/1/1968	2/1/1975	99
Fort Calhoun-1	PWR	478	Omaha Public Power District	Combustion Eng.	6/1/1968	8/25/1973	88
Grand Gulf-1	BWR	1,251	Entergy Nuclear South	General Electric	5/1/1974	10/20/1984	100
H.B. Robinson-2	PWR	724	Progress Energy	Westinghouse	4/1/1967	9/26/1970	102
Hatch-1	BWR	876	Southern Nuclear Operating Company	General Electric	9/1/1968	11/11/1974	67
Hatch-2	BWR	883	Southern Nuclear Operating Company	General Electric	2/1/1972	9/22/1978	95
Hope Creek-1	BWR	1,161	PSEG Nuclear, LLC	General Electric	3/1/1976	8/1/1986	99

Indian Point-2	PWR	1,022	Entergy Nuclear Northeast	Westinghouse	10/1/1966	6/26/1973	99
Indian Point-3	PWR	1,040	Entergy Nuclear Northeast	Westinghouse	11/1/1968	4/27/1976	85
Kewaunee	PWR	556	Dominion Generation	Westinghouse	8/1/1968	4/8/1974	93
LaSalle-1	BWR	1,118	Exelon Generation Co, LLC	General Electric	9/1/1973	9/4/1982	99
LaSalle-2	BWR	1,120	Exelon Generation Co, LLC	General Electric	10/1/1973	4/20/1984	93
Limerick-1	BWR	1,130	Exelon Generation Co, LLC	General Electric	4/1/1970	4/13/1985	101

Reactor Name	**Type**	**2009 Summer Capacity**	**Operator**	**Reactor Supplier**	**Construction Date**	**Grid Date**	**Capacity Factor**
		Net MW(e) [1]					**Percent** [2]
Limerick-2	BWR	1,134	Exelon Generation Co, LLC	General Electric	4/1/1970	9/1/1989	94
McGuire-1	PWR	1,100	Duke Power Company	Westinghouse	4/1/1971	9/12/1981	104
McGuire-2	PWR	1,100	Duke Power Company	Westinghouse	4/1/1971	5/23/1983	94
Millstone-2	PWR	869	Dominion Generation	Combustion Eng.	11/1/1969	11/9/1975	82
Millstone-3	PWR	1,233	Dominion Generation	Westinghouse	5/1/1974	2/12/1986	96
Monticello	BWR	572	Northern States Power Company	General Electric	6/1/1967	3/5/1971	83

Nine Mile Point-1	BWR	621	Constellation Energy Nuclear Group, LLC	General Electric	4/1/1965	11/9/1969	92
Nine Mile Point-2	BWR	1,143	Constellation Energy Nuclear Group, LLC	General Electric	8/1/1975	8/8/1987	99
North Anna-1	PWR	903	Dominion Generation	Westinghouse	2/1/1971	4/17/1978	92
North Anna-2	PWR	903	Dominion Generation	Westinghouse	11/1/1970	8/25/1980	100
Oconee-1	PWR	846	Duke Power Company	Babcock&Wilcox	11/1/1967	5/6/1973	85
Oconee-2	PWR	846	Duke Power Company	Babcock&Wilcox	11/1/1967	12/5/1973	103
Oconee-3	PWR	846	Duke Power Company	Babcock&Wilcox	11/1/1967	9/18/1974	94
Oyster Creek	BWR	615	Exelon Generation Co, LLC	General Electric	1/1/1964	9/23/1969	92
Palisades	PWR	778	Entergy Nuclear	Combustion Eng.	2/1/1967	12/31/1971	90
Palo Verde-1	PWR	1,311	Arizona Public Service Company	Combustion Eng.	5/1/1976	6/10/1985	101
Palo Verde-2	PWR	1,314	Arizona Public Service Company	Combustion Eng.	6/1/1976	5/20/1986	83
Palo Verde-3	PWR	1,317	Arizona Public Service Company	Combustion Eng.	6/1/1976	11/28/1987	83
Peach Bottom-2	BWR	1,122	Exelon Generation Co, LLC	General Electric	1/1/1968	12/18/1974	101
Peach Bottom-3	BWR	1,112	Exelon Generation Co, LLC	General Electric	1/1/1968	9/1/1974	89

Perry-1	BWR	1,240	FirstEnergy Nuclear Operating Co.	General Electric	10/1/1974	12/19/1986	70
Pilgrim-1	BWR	685	Entergy Nuclear Northeast	General Electric	8/1/1968	7/19/1972	90
Point Beach-1	PWR	512	NextEra Energy Resources Point Beach, LLC	Westinghouse	7/1/1967	11/6/1970	98
Point Beach-2	PWR	515	NextEra Energy Resources Point Beach, LLC	Westinghouse	7/1/1968	8/2/1972	84
Prairie Island-1	PWR	551	Northern States Power Company	Westinghouse	5/1/1968	12/4/1973	75
Reactor Name	**Type**	**2009 Summer Capacity**	**Operator**	**Reactor Supplier**	**Construction Date**	**Grid Date**	**Capacity Factor**
		Net MW(e) [1]					**Percent** [2]
Prairie Island-2	PWR	545	Northern States Power Company	Westinghouse	5/1/1969	12/21/1974	97
Quad Cities-1	BWR	882	Exelon Generation Co, LLC	General Electric	2/1/1967	4/12/1972	89
Quad Cities-2	BWR	892	Exelon Generation Co, LLC	General Electric	2/1/1967	5/23/1972	99
R.E. Ginna	PWR	581	Constellation Generation	Westinghouse	4/1/1966	12/2/1969	91
River Bend-1	BWR	974	Entergy Nuclear South	General Electric	3/1/1977	12/3/1985	92
Salem-1	PWR	1,174	PSEG Nuclear, LLC	Westinghouse	1/1/1968	12/25/1976	99
Salem-2	PWR	1,158	PSEG Nuclear, LLC	Westinghouse	1/1/1968	6/3/1981	93
San Onofre-2	PWR	1,070	Southern California Edison Co.	Combustion	3/1/1974	9/20/1982	60

				Eng.			
San Onofre-3	PWR	1,080	Southern California Edison Co.	Combustion Eng.	3/1/1974	9/25/1983	104
Seabrook-1	PWR	1,247	NextEra Energy Resources Seabrook, LLC	Westinghouse	7/1/1976	5/29/1990	81
Sequoyah-1	PWR	1,152	Tennessee Valley Authority (TVA)	Westinghouse	5/1/1970	7/22/1980	89
Sequoyah-2	PWR	1,126	Tennessee Valley Authority (TVA)	Westinghouse	5/1/1970	12/23/1981	89
Shearon Harris-1	PWR	900	Progress Energy	Westinghouse	1/1/1974	1/19/1987	94
South Texas-1	PWR	1,280	STP Nuclear Operating Company	Westinghouse	9/1/1975	3/30/1988	90
South Texas-2	PWR	1,280	STP Nuclear Operating Company	Westinghouse	9/1/1975	4/11/1989	101
St. Lucie-1	PWR	839	Florida Power & Light Company	Combustion Eng.	7/1/1970	5/7/1976	101
St. Lucie-2	PWR	839	Florida Power & Light Company	Combustion Eng.	6/1/1976	6/13/1986	76
Surry-1	PWR	799	Dominion Generation	Westinghouse	6/1/1968	7/4/1972	94
Surry-2	PWR	799	Dominion Generation	Westinghouse	6/1/1968	3/10/1973	92
Susquehanna-1	BWR	1,185	PPL Susquehanna, LLC	General Electric	11/1/1973	11/16/1982	101
Susquehanna-2	BWR	1,190	PPL Susquehanna, LLC	General Electric	11/1/1973	7/3/1984	86
Three Mile Island-1	PWR	805	Exelon Generation Co, LLC	Babcock&Wilcox	5/1/1968	6/19/1974	84
Turkey Point-3	PWR	693	Florida Power & Light Company	Westinghouse	4/1/1967	11/2/1972	86

Turkey Point-4	PWR	693	Florida Power & Light Company	Westinghouse	4/1/1967	6/21/1973	89

Reactor Name	**Type**	**2009 Summer Capacity**	**Operator**	**Reactor Supplier**	**Construction Date**	**Grid Date**	**Capacity Factor**
		Net MW(e) [1]					**Percent** [2]
Virgil C. Summer- 1	PWR	966	South Carolina Electric & Gas Co.	Westinghouse	3/1/1973	11/16/1982	81
Vogtle-1	PWR	1,150	Southern Nuclear Operating Company	Westinghouse	8/1/1976	3/27/1987	91
Vogtle-2	PWR	1,152	Southern Nuclear Operating Company	Westinghouse	8/1/1976	4/10/1989	101
Waterford-3	PWR	1,168	Entergy Nuclear South	Combustion Eng.	11/1/1974	3/18/1985	87
Watts Bar-1	PWR	1,123	Tennessee Valley Authority (TVA)	Westinghouse	12/1/1972	2/6/1996	94
Wolf Creek	PWR	1,160	Wolf Creek Nuclear Operations Corp.	Westinghouse	1/1/1977	6/12/1985	86

[1] Summer Capacity (Net): The maximum output (excluding electricity used for station's internal operations, expressed in Megawatts (electricity). Note that nuclear power can also be expressed in Megawatts (thermal).

[2] Capacity Factor: The ratio of power actually generated to the maximum potential generation expressed as a percent. The factor is calculated by multiplying the summer capacity by the number of hours in a day (24) by the number of days in a year (365 or 366). That total is

then divided into the amount of actual generation and multiplied by 100 to get a percent.

Table 7b. Status of Shutdown Nuclear Power Plants

Reactor Name	Type	Capacity Net MW(e)	Operator	License Terminated	License Status	Reactor Supplier	Construction Date	Grid Date	S
Big Rock Point	BWR	67	Consumers Power Co.	Yes	IFSFI Only	General Electric	5/1/1960	12/8/1962	8/
Bonus	BWR	17	Department of Energy Puerto Rico Water Resources		Entomb	GNEPRWRA	1/1/1960	8/14/1964	6
CVTR	PHWR	17	Carolinas-Virginia Nuclear Power Assoc.	Yes	Shutdown	Westinghouse	1/1/1960	12/18/1963	1
Dresden-1	BWR	197	Exelon		Safstor	General Electric	5/1/1956	4/15/1960	10
Elk River	BWR	22	Rural Cooperative Power Assn.		Decon	Allis-Chalmers	1/1/1959	8/24/1963	2
Enrico Fermi-1	FBR	65	Detroit Edison Co.		Safstor/Decon	UEC	8/1/1956	8/5/1966	11
Fort St. Vrain	HTGR	330	Public Service Co. of Colorado	Yes	Shutdown	General Atomics	9/1/1968	12/11/1976	8/
GE Vallecitos	BWR	24	General Electric		Safstor	General Electric	1/1/1956	10/19/1957	1
Haddam Neck	PWR	560	Connecticut Yankee Atomic Power Co.	Yes	ISFSI Only	Westinghouse	5/1/1964	8/7/1967	1
Hallam	SCGM	75	Atomic Energy Commission Nebraska Public Power District		Entomb	General Electric	1/1/1959	9/1/1963	9
Humboldt Bay	BWR	63	Pacific Gas & Electric Co.		Decon	General Electric	11/1/1960	4/18/1963	7
Indian Point-1	PWR	257	Entergy Nuclear South		Safstor	Babcock&Wilcox	5/1/1956	9/16/1962	10

Lacrosse	BWR	48	Dairyland Power Cooperative		Safstor	Allis-Chalmers	3/1/1963	4/26/1968	4/
Maine Yankee	PWR	860	Maine Yankee Atomic Power Co.	Yes	ISFSI Only	Combustion Eng.	10/1/1968	11/8/1972	8
Millstone-1	BWR	641	Dominion Generation		Safstor	General Electric	5/1/1966	11/29/1970	7
Pathfinder	BWR	59	Nuclear Management Co.	Yes	Decon	Allis-Chalmers	1/1/1959	7/25/1966	1
Peach Bottom-1	HTGR	40	Exelon		Safstor	General Atomics	2/1/1962	1/27/1967	1
Piqua	OCM	11	City of Piqua Government		Entomb	General Electric	1/1/1960	7/1/1963	1
Rancho Seco-1	PWR	873	Sacramento Municipal Utility District		Decon	Babcock&Wilcox	4/1/1969	10/13/1974	6
San Onofre-1	PWR	436	Southern California Edison Co.		Decon	Westinghouse	5/1/1964	7/16/1967	11
Saxton	PWR	3	Saxton Nuclear Experimental Reactor Corp.	Yes	Shutdown	General Electric	1/1/1960	3/1/1967	5
Shippingport	PWR	60	Department of Energy Duquesne Light Co.	Yes	Shutdown	Westinghouse	1/1/1954	12/2/1957	1

Reactor Name	Type	Capacity Net MW(e)	Operator		Status	Reactor Supplier	Construction Date	Grid Date	Shutdown Date
Shoreham	BWR	820	Long Island Power Authority	Yes	Shutdown	General Electric	11/1/1972	8/1/1986	5/1/1989
Three Mile Island-2	PWR	880	General Public Utilities		Safstor [1]	Babcock&Wilcox	11/1/1969	4/21/1978	3/28/1979
Trojan	PWR	1,095	Portland General Electric Co.	Yes	ISFSI Only	Westinghouse	2/1/1970	12/23/1975	11/9/1992
Yankee NPS	PWR	167	Yankee Atomic Electric Co.	Yes	ISFSI Only	Westinghouse	11/1/1957	11/10/1960	10/1/1991
Zion-1	PWR	1,040	Exelon		Safstor	Westinghouse	12/1/1968	6/28/1973	1/1/1998
Zion-2	PWR	1,040	Exelon		Safstor	Westinghouse	12/1/1968	12/26/1973	1/1/1998

[1] According to the NRC, Unit 2 has been placed in post-defueling monitored storage until Unit 1 ceases operation, at which time both units will be decommissioned. Unit 2 holds a possession only license.

Decon =
Decontaminate

Safstor = Safe Storage

http://www.nrc.gov/reading-rm/doc-collections/fact-sheets/decommissioning

http://www.nrc.gov/info-finder/decommissioning/power-reactor/

2.3. FUTURE DEVELOPMENT OF NUCLEAR POWER

2.3.1. NUCLEAR POWER DEVELOPMENT STRATEGY

The future of nuclear power will depend on several factors including resolution of nuclear waste disposal issues, reduction of nuclear construction costs, greater regulatory certainty, development of favorable government policies, and the relative costs of other energy options.

The mission of the U.S. Department Energy's (DOE) Office of Nuclear Energy is to advance nuclear power as a resource capable of meeting the Nation's energy, environmental, and national security needs by resolving technical, cost, safety, proliferation resistance, and security barriers through research, development, and demonstration as appropriate. To achieve its mission, the Office of Nuclear Energy is pursuing five strategic goals.

Extend the useful life, improve the performance, and maintain the safety of the current fleet of nuclear power plants. This is the objective of the Light Water Reactor Sustainability Program.

Enable new nuclear power plants to be built for electricity production and improve the affordability of nuclear energy. The Nuclear Plant 2010 (NP2010) Program is a joint government/industry cost-shared effort to identify sites for new nuclear power plants, develop and bring to market advanced nuclear plant technologies, evaluate the business case for building new nuclear power plants and demonstrate untested regulatory processes. Two project areas are active: GEH detailed design work and Nustart COL application development.

Reduce the carbon footprint of transportation and industry. The heat generated by nuclear energy can be harnessed for process heat, thus reducing or eliminating the need to burn fossil fuels for this purpose. Developing this capability is one objective of the Next Generation Nuclear Plant (NGNP) initiative, which is part of the Generation IV program.

Develop a sustainable fuel cycle. The Fuel Cycle Research and Development Program is developing ways to make used fuel less radiotoxic, recycle it, and create widely acceptable solutions to the challenges of nuclear waste.

Prevent proliferation. Developing techniques and materials to prevent proliferation are objectives of our Fuel Cycle Research and Development program.

The U.S. Nuclear Regulatory Commission (NRC) has streamlined its licensing process for future nuclear power reactors.

Design Certifications for New Reactors. The streamlined process encourages standard or pre-approved designs. Issuance of a design certification is now independent of applications for a construction permit or an operating license. Design certifications are valid for 15 years and can be renewed for an additional 10 to 15 years. As of December 2010, the NRC issued Design

Certifications for four designs (ABWR, System 80+, AP600, AP1000) and is reviewing several new designs as well as amendments to previously certified designs.

Early Site Permit Applications. Approval of one or more nuclear power plant sites is independent of applications for a construction permit or an operating license. An Early Site Permit (ESP) is valid for 10 to 20 years and can be renewed for an additional 10 to 20 years. As of December 2010, the NRC issued 4 ESPs and is reviewing 2 ESP applications.

Combined License Application. A Combined Construction and Operating License (COL) may now be issued. A COL is valid for 40 years and may be extended for an additional 20 years. As of September 2010, the NRC received 18 COL applications, one of which was withdrawn. Table 8 provides a list of planned nuclear power plants.

Stabilization of the licensing process should shorten construction lead-times and improve the economics of new reactor technology.

From a legislative perspective, the Energy Policy Act of 2005 included the renewal of the Price Anderson Act and incentives for building the first advanced nuclear power plants. Incentives also included loan guarantees, production tax credits, and standby support insurance related to regulatory delays. The incentives are at various stages of development.

Nuclear Power Loan Guarantees – Congress granted DOE authority to issue $20.5 billion in guaranteed loans. DOE issued solicitations for $18.5 billion in loan guarantees for new nuclear power facilities and $2 billion for the "front end" of the nuclear fuel cycle on June 30, 2008. DOE offered a $2 billion loan to AREVA for an enrichment plant. DOE and Southern Nuclear Operating Company have reached a deal on a conditional commitment agreement for $8.33 billion in loan guarantees for the construction and operation of two AP1000 reactors at Vogtle.

Production Tax Credits – With regard to production tax credits, the U.S. Internal Revenue Service (IRS) issued Bulletin 2006-18 in May 2006. However, the U.S. Department of the Treasury/IRS may issue additional guidance on Tax Credits for new nuclear plants. As of October 2010, no date had been set for such additional guidance. The first 6,000 MWe of deployed nuclear power would be eligible for a $18/MWh tax credit.

Standby Support (Risk Insurance) – The standby support incentive was formalized via a final rule in August 2006. No contract has been issued. The DOE is authorized to issue insurance to six reactors to cover delays in operations attributed to NRC licensing reviews or litigation.

Research and development, streamlining the licensing process and current legislative incentives contribute to the current U.S. nuclear power plant development strategy.

Table 8. Planned Nuclear Power Plants

Station/Project Name	Type	Number of Units	Capacity ME(e)	Application Submitted	Application Status
Bell Bend	US-EPR	1	1,600	10/20/2008	Under Review
Bellefonte, Units 3 & 4	AP 1000	2	2,234	10/30/2007	Under Review
Callaway, Unit 2	US-EPR	1	1,600	7/24/2008	Review Suspended
Calvert Cliffs, Unit 3	US-EPR	1	1,600	7/13/2007	Under Review
Comanche Peak, Units 3 & 4	US-APWR	2	3,400	9/19/2008	Under Review
Fermi, Unit 3	ESBWR	1	1,520	9/13/2008	Under Review
Grand Gulf, Unit 3	ESBWR	1	1,520	2/27/2008	Review Suspended
Levy County, Units 1 & 2	AP 1000	2	2,234	7/30/2008	Under Review
Nine Mile Point, Unit 3	US-EPR	1	1,600	9/30/2008	Review Suspended
North Anna, Unit 3	US-APWR	1	1,500	11/27/2007*	Under Review
River Bend Station, Unit 3	ESBWR	1	1,520	9/25/2008	Review Suspended
Shearon Harris, Units 2 & 3	AP 1000	2	2,234	2/19/2008	Under Review
South Texas Project, Units 3 & 4	ABWR	2	2,700	9/20/2007	Under Review
Turkey Point, Units 6 & 7	AP 1000	2	2,234	6/30/2009	Under Review
Virgil C. Summer, Units 2 & 3	AP 1000	2	2,234	3/31/2008	Under Review*
Vogtle, Units 3 & 4	AP 1000	2	2,234	3/31/2008	Under Review
William States Lee III, Units 1 & 2	AP 1000	2	2,234	12/13/2007	Under Review

[1] ABWR, Advanced Boiling Water Reactor; AP 1000, Advanced Passive 1000 reactor; EPR, Evolutionary Power Reactor; ESBWR, is interpreted as Economic Simplified Boiling Reactor for the U.S. version, and the US-APWR, U.S. Advanced Pressurized Water Reactor.

* An Early Site Permit (ESP) has also been filed. An ESP was approved by the Nuclear Regulatory Commission for North Anna on 11/27/2007 and both an ESP and Limited Work Authorization were approved for Vogtle on 8/26/2009.

2.4. ORGANIZATIONS INVOLVED IN THE CONSTRUCTION OF NUCLEAR POWER PLANTS

A large number of companies in the U.S. provide equipment and services to the nuclear power industry covering the entire nuclear fuel cycle. Four companies supplied nuclear steam supply systems now operating in the U.S. Westinghouse Corporation built the majority of pressurized water reactors (PWR) though Combustion Engineering (CE) and Babcock & Wilcox (B&W) also built PWRs. B&W also supplied nuclear steam generators, replacement nuclear steam generators, and nuclear heat exchangers. Westinghouse and CE are now part of Westinghouse, while Areva now owns elements of B&W's nuclear technology. General Electric (GE) designed all presently operating boiling water reactors (BWR) in the U.S.

Reactors that are to be sold in the U.S. must either have their designs certified by the NRC or have the equivalent of design certification occur during the COL application process. Two new reactor designs are certified by the NRC for construction in the U.S.: the Westinghouse AP600 and AP1000; and the GE Hitachi Advanced Boiling Water Reactor (ABWR). Several reactor designs are either undergoing NRC certification or pre-certification reviews, including GE Hitachi's ESBWR reactor, Mitsubishi Heavy Industry Ltd.'s U.S. Advanced Pressurized Water Reactor (US-APWR) and Areva's U.S. Evolutionary Pressurized Water Reactor (US-EPR). Steam generators for PWRs and some high quality steel castings are no longer made in the U.S. for nuclear reactors. Domestic suppliers in the U.S. must often compete with imports.

To help assure high quality products, the American Society of Mechanical Engineers (ASME) certifies nuclear equipment suppliers. To obtain a nuclear certificate of authorization, a company must comply with quality assurance requirements set forth by the ASME. This program is open to foreign companies. Presently over 200 foreign and U.S. companies hold ASME nuclear certificates of authorization.

The American Nuclear Society's annual Buyer's Guide, published in their journal Nuclear News provides a partial list of equipment and service providers to the nuclear industry, including architect-engineering and construction firms.

2.5. ORGANIZATIONS INVOLVED IN THE OPERATION OF NUCLEAR POWER PLANTS

The 104 operable nuclear reactors in the U.S. are mostly privately owned and operated though nine are operated by government-owned entities. Other nuclear power plants have non-managing participation by municipal and cooperative electricity supply firms. Thirty-two companies or management organizations are licensed by the NRC to operate reactors. Tables 7a and 7b identify the operators of nuclear reactors in the U.S.

2.6. Organizations Involved in the Decommissioning of Nuclear Power Plants

Companies that operate nuclear power plants are responsible for decommissioning and for providing the funding to do so. The NRC establishes the regulations for and provides oversight of nuclear power plant decommissioning. Several other Federal agencies also oversee specific aspects of the decommissioning process. These agencies include the U.S. Environmental Protection Agency, the U.S. Department of Transportation, and the U.S. Occupational Safety and Health Administration. State agencies are also involved in their capacity as regulators of worker and public health and safety. The DOE, the Electric Power Research Institute and the decommissioning industry cooperate to develop decontamination techniques.

2.7. Fuel Cycle and Waste Management

All activities of the commercial nuclear fuel cycle are conducted in the U.S., except reprocessing. Spent fuel reprocessing for waste management in the U.S. has been discouraged by public policy, and the once-through fuel cycle is the present policy along with an active research and development program on advanced fuel cycle alternatives. Each fuel cycle stage is subject to competition and supply from international sources which in many cases dominate the industry segment. At present the U.S. nuclear fuel supply is highly dependent on imports for mined uranium concentrates, uranium conversion, and enrichment. Virtually all fuel fabrication requirements are met by domestic sources. EIA publishes data on the nuclear fuel cycle.

2.7.1. Uranium Production and Conversion

There were one uranium mill and three uranium in-situ leach plants in production in the U.S. in the fourth quarter 2009. During 2009, 3.7 million pounds of uranium concentrate (U3O8) were produced in the U.S. Canada is the major source of concentrate imports though supplies have also come from Australia, Russia, Kazakhstan, Uzbekistan, Namibia, and a few additional locations. The U.S. has one uranium conversion plant located at Metropolis, Illinois.

Data on uranium is published on http://www.eia.doe.gov/cneaf/nuclear/dupr/dupr.html and http://www.eia.doe.gov/cneaf/nuclear/umar/umar.html.

2.7.2. Uranium Enrichment

The uranium enrichment business in the U.S. was transferred in 1993 from DOE to a government-owned company, the U.S. Enrichment Corporation (USEC) Inc. USEC was created in 1992 under the EPACT to make the U.S. more competitive in the global enrichment industry. USEC was privatized in 1998 via an initial public offering of common stock. USEC operates an enrichment facility (leased from DOE) at Paducah, Kentucky. A second facility at Portsmouth, Ohio has stopped operations. The facilities used gaseous diffusion technology that is seen as dated and expensive. Both USEC and a second group, Louisiana Energy Services (LES), are licensing more modern facilities, gas centrifuge enrichment facilities. USEC has developed a DOE gas centrifuge technology demonstration facility to be built at Piketon, Ohio. LES proposes to use Urenco Technology currently used in Europe for a facility to be built in New Mexico.

The Russian Federation and U.S. signed a 20-year, government-to-government agreement in February 1993 for the conversion of 500 metric tons of Russian highly enriched (HEU) from nuclear warheads to low-enriched uranium (LEU). The LEU value at the time was $12 billion ($8 billion for enrichment and $4 billion for natural uranium and conversion components). By the end of 2004, of 6,824 metric tons of LEU derived from 231.5 metric tons of HEU were delivered to USEC, the U.S. executive agent for the HEU Agreement. (The Megatons to Megawatts Program) This represents the equivalent of over 9,300 nuclear warheads, and over 46 percent of the agreed 500 MTU of weapons derived HEU. USEC is responsible for the purchase of the enrichment component of the HEU-derived LEU. Under an Agreement signed in March 1999 the natural uranium and conversion components are purchased by a partnership of three uranium suppliers (Cameco, Cogema and RWE Nukem) known as the Western Consortium. Russia has recently indicated that it will not renew the arrangement after it expires in 2013.

Enrichment services have also been imported from facilities in the United Kingdom, France, Germany, the Netherlands, Russia, and elsewhere.

2.7.3. *FUEL FABRICATION*

Three companies (Areva, Global Nuclear Fuels, and Westinghouse) fabricate uranium fuel in the U.S. for light-water reactor fuel. Plants are located in Columbia, South Carolina; Wilmington, North Carolina; Richland, Washington; and Lynchburg, Virginia.

2.7.4. *NUCLEAR WASTE MANAGEMENT*

Commercial nuclear power reactors currently store most of their spent fuel on-site at the nuclear plant, although a small amount has been shipped to off-site facilities. The spent fuel inventory in the U.S. was 60 thousand metric tons of uranium as of December 2008. EIA projects that by 2010, the reactors in the U.S. will be discharging ~2,000 metric tons annually and the spent nuclear fuel (SNF) discharged over the decade would amount to approximately 23 thousand metric tons of uranium.

The Nuclear Waste Policy Act (NWPA) of 1982, as amended in 1987, provides for the siting, construction, and operation of a deep geologic repository for disposal of SNF and HLW. The amendments in 1987 directed DOE to focus solely on Yucca Mountain as the future site of a geologic repository. The NWPA limits the emplacement of waste at the geologic repository to 70,000 MTHM. SNF and HLW disposed of at the repository were expected to include about 63,000 MTHM of commercial spent fuel, about 2,333 MTHM of DOE spent fuel, and the equivalent of about 4,667 MTHM (or MTHM-equivalent) of DOE HLW from defense-related activities.

In 2002, DOE determined that the Yucca Mountain site would be suitable for a repository, and in July 2002, the President and Congress accepted that recommendation and directed that DOE submit a license application to the NRC. In June 2008, DOE submitted a license application to NRC to receive authorization to begin construction of a repository at Yucca Mountain, and in September 2008, the NRC formally docketed the application.

President Obama announced in March 2009 that the proposed permanent repository at Yucca Mountain "was no longer an option," and that a "blue-ribbon commission" would be created to evaluate alternatives to Yucca Mountain. In March 2010, the Blue Ribbon Commission on America's Nuclear Future met for the first time. In light of the decision not to proceed with the Yucca Mountain repository, the Commission will conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle. The Commission will provide advice and make recommendations on issues including alternatives for the storage, processing, and disposal of civilian and defense spent nuclear fuel and high-level radioactive waste. The Commission is made up of 15 members who have a range of expertise and experience in nuclear issues, including scientists, industry representatives, and respected former elected officials. The Commission will produce an interim report in 2011 and a final report in 2012. In the interim, the NRC has ceased its review of the Yucca Mountain license application, and issued related to the decision not to proceed with the Yucca Mountain repository are being reviewed by the U.S. Court of Appeals for the District of Columbia Circuit.

2.8. Research and Development

2.8.1. R&D Organizations

Both private industry and the Federal Government conduct research and development (R&D) for the nuclear industry. Private companies actively investigating reactor technology, enrichment technology, and nuclear fuel design. One of the main institutions for private research funding is through the Electric Power Research Institute (EPRI). EPRI, through membership fees, conducts R&D in many nuclear-related areas as well as other areas of the electric power industry.

The Federal Government supports R&D through specific budget allocations for the NRC and for the DOE Office of Nuclear Energy. Private companies, under contract with DOE, operate a series of national laboratories. DOE includes 26 laboratories and institutes, many of which are involved with the nuclear fuel cycle.

In response to a 1997 Presidential Advisory Committee recommendation, the DOE created the Nuclear Energy Research Initiative (NERI) in 1998 to overcome the principal technical and scientific obstacles to the future use of nuclear energy in the U.S.

NERI also helps preserve the nuclear science and engineering infrastructure within the U.S. universities, laboratories, and industry to advance the state of nuclear energy technology and to maintain a competitive position worldwide. The original NERI program addressed a wide spectrum of R&D topics:

- proliferation-resistant reactors or fuel cycles;
- new reactor designs with higher efficiency, reduced cost, and enhanced safety;
- smaller reactors for applications where larger reactors may not be advantageous;
- new techniques for on-site and surface storage and for permanent disposal of nuclear waste;
- advanced nuclear fuel and;
- fundamental nuclear science and technology.

The NERI program was refocused in 2004 to allow universities to participate prominently in the principal DOE programs that address advanced nuclear energy systems.

2.8.2. Development of Advanced Nuclear Technologies

The DOE Office of Nuclear Energy collaborates on two of the six advanced nuclear energy technology concepts identified in the Technology Roadmap (December 2002); the concepts are being pursued at varying levels of effort based on their technology status and potential to meet program and national goals. The two concepts are the Sodium-Cooled Fast Reactors (SFR) and the Very-High Temperature Reactor (VHTR). Research and development (R&D) on the SFR is being conducted under the Fuel Cycle Research and Development Program (FCRD). VHTR R&D is being conducted under the Generation IV Nuclear Energy Systems by the Office of Gas Reactor Deployment.

The objective of the Generation IV International Forum (GIF) and the U.S. Generation IV program is to develop and demonstrate advanced nuclear energy systems that meet future needs for safe, sustainable, environmentally responsible, economical, proliferation-resistant and physically secure energy. The GIF has thirteen Members, who are signatories of its founding document, the GIF Charter. Argentina, Brazil, Canada, France, Japan, the Republic of Korea, the Republic of South Africa, the United Kingdom and the U.S. signed the GIF Charter in July 2001. Subsequently, it was signed by Switzerland in 2002, Euratom in 2003, and the People's Republic of China and the Russian Federation, both in 2006.

The goals of the GIF provided the basis for identifying and selecting six nuclear energy systems for further development. The six selected systems employ a variety of reactor, energy conversion and fuel cycle technologies. Their designs feature thermal and fast neutron spectra, closed and open fuel cycles and a wide range of reactor sizes from very small to very large. Depending on their respective degrees of technical maturity, the Generation IV systems are expected to become available for commercial introduction in the period between 2015 and 2030 or beyond.

In addition, R&D has been initiated under the International Nuclear Energy Research Initiative (I-NERI). This is an international, research-oriented collaboration that supports advancement of nuclear science and technology in the U.S. and the world. Innovative research performed under the I-NERI umbrella addresses key issues affecting the future use of nuclear energy and its global deployment by improving cost performance, enhancing safety, and increasing proliferation resistance of future nuclear energy systems.

The NRC's international program activities are wide-ranging. They encompass nuclear policy formulation, international safety cooperation and assistance, international technical information exchange, and cooperative safety research. These activities support NRC's domestic mission, as well as broader U.S. domestic and international interests. Maintaining a program of international cooperation enhances the safe, secure, and environmentally acceptable civilian uses of nuclear materials in both the U.S. and throughout the world. As a regulator of the world's largest civilian nuclear program, the NRC's extensive experience contributes to international programs in areas such as nuclear reactor safety, nuclear safety research, radiation protection, nuclear materials safety and safeguards, waste management, and decommissioning of nuclear facilities. The NRC helped found the International Nuclear Regulatory Association (INRA) in 1977, an organization of senior regulators from nations operating a substantial majority of the world's commercial nuclear reactors. The NRC also benefits significantly from the regulatory experience and safety research programs of other countries.

The U.S. has also actively participated in the policy and implementation aspects of nuclear initiatives under the Group of Eight (G8) industrialized nations, the Group of 24 Nuclear Safety Coordination (G-24NUSAC) mechanism, and the Nuclear Safety Account administered by the European Bank for Reconstruction and Development (EBRD/NSA). These institutions have focused on coordinating multi-layered international efforts to enhance nuclear safety in countries with Soviet-designed nuclear power reactors. The NRC works with other nations with major nuclear power programs to further nuclear safety research. These nations include France, Germany, Japan, and the United Kingdom.

The NRC has concluded technical information exchange and general safety cooperation arrangements with the regulatory authorities of 34 countries plus Taiwan. These arrangements serve as communications channels for the prompt and reciprocal notification of safety problems that could affect both U.S. and foreign plants. They also provide the framework for bilateral cooperation in nuclear safety, safeguards, waste management, and environmental protection as well as for NRC's assistance activities to help other countries improve both their regulatory skills and their health and safety practices.

NRC currently participates in cooperative research with other countries, directly through bilateral agreements as well as multilateral agreements with OECD - NEA member States, and the European Union (EU). These programs examine key technical safety issues in regulating the safety of existing and proposed U.S. commercial nuclear facilities and in the use of nuclear materials. At present, NRC manages and coordinates approximately 90 bilateral and multilateral energy agreements with 25 countries which include, but are not limited to, research activities in the areas of: Thermal-Hydraulic Code Application and Maintenance, Severe Accident Research Program, Probabilistic Risk Assessment Program, Steam Generator Tube Integrity Program (SGTI), Instrumentation and Controls, Human Factors, Nuclear Fuels Research, Advanced Reactor Design, Fire Modeling Research, and Aging Research of Safety Components and Wire Systems. NRC also includes support for the Agency for International Development (USAID)-related work for Russia, assisting the Russian Regulatory organization (GAN) in developing analytical risk assessment methods and evaluation techniques for light water reactors.

The U.S. continues nuclear safety cooperation with countries of the former Soviet Union and countries of central and Eastern Europe. These activities strengthen their regulatory organizations, train foreign inspectors, and work toward operational safety and risk reduction. Countries receiving assistance include Armenia and Kazakhstan.

The U.S. played a leading role in resolving implementation issues for the International Convention on Nuclear Safety, which entered into force in October 1996. The U.S. also participated in the successful negotiation of the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management, as well as the Convention on Supplementary Compensation for Nuclear Damage.

2.8.3. INTERNATIONAL COOPERATION AND INITIATIVES

The U.S. government collaborates with international partners to support the safe, secure, and peaceful use of nuclear energy. It works both bilaterally and multilaterally to accomplish this work.

Bilaterally, the DOE collaborates in civil nuclear research and development and related issues through several vehicles, including the I-NERI, negotiated action plans and working groups, and the International Nuclear Cooperation (INC) framework.

Multilaterally, the U.S. cooperates with international partners through the Generation IV International Forum, the Nuclear Energy Agency, the International Atomic Energy Agency (IAEA) and the International Framework for Nuclear Energy Cooperation (formerly the Global Nuclear Energy Partnership, or GNEP). In 2009, the GNEP partner countries agreed to transform the partnership by adopting a new Statement of Mission, endorsement of which is the sole requirement for invited countries to become full participants in the organization. To reflect the transformation, the name was changed from GNEP to the International Framework for Nuclear Energy Cooperation (IFNEC). The IFNEC Statement of Mission reads as follows: “The International Framework for Nuclear Energy Cooperation provides a forum for cooperation among participating states to explore mutually beneficial approaches to ensure the use of nuclear energy for peaceful purposes proceeds in a manner that is efficient and meets the highest standards of safety, security and non-proliferation. Participating states would not give up any rights and voluntarily engage to share the effort and gain the benefits of economical, peaceful nuclear energy.”

IFNEC supports U.S. call, made in his April 5, 2009 speech in Prague, for a new framework for civil nuclear cooperation, including an international fuel bank, so that countries can access peaceful nuclear power without increasing the risks of proliferation.

2.9. Human Resources Development

The U.S. has turned around the trend of declining enrollment at nuclear engineering schools over the past five years. The work force in the nuclear power industry is aging and it is feared that many professional skills might vanish as the staff at nuclear power and research facilities, universities and national laboratories retire. Without any active program of construction in the nuclear power industry, it is not clear what level of trained personnel will be required by the industry in the future. The long term trend toward a decline in the number of university programs offering nuclear engineering degrees reversed course in the late 1990's and several schools have added programs in the past few years.

The DOE's Office of Nuclear Energy has an active program to encourage the development of academic programs related to nuclear power. The American Nuclear Society, a professional organization, also promotes the improvement of academic work related to nuclear power at higher education institutions.

3. NATIONAL LAWS AND REGULATIONS

3.1. Regulatory Framework

3.1.1. Regulatory Authority

The NRC is the principal regulator of the nuclear power industry. The NRC's mission is to regulate the Nation's civilian use of by-product, source, and special nuclear materials to ensure adequate protection of public health and safety, to promote the common defense and security, and to protect the environment. The NRC has regulatory responsibility for:

- Commercial reactors for generating electric power and nonpower reactors used for research, testing, and training
- Uranium enrichment facilities and nuclear fuel fabrication facilities
- Uses of nuclear materials in medical, industrial, and academic settings and facilities that produce nuclear fuel
- Transportation, storage, and disposal of nuclear materials and waste, and decommissioning of nuclear facilities from service

3.1.2. Licensing Process

The Energy Policy Act of 1992 (EPACT1992) specified a new nuclear power plant licensing process. Under the new licensing procedure, an applicant who seeks to build a new reactor, can use off-the shelf reactor designs that have been previously approved and certified by the NRC. After reviewing the application and holding public hearings, the NRC may issue a combined construction and operating license (the previous process separated these licenses and which were issued at different times). When the applicant uses an NRC-certified design, safety issues related to the design will have been already resolved, and the main concern will be the quality of reactor construction.

Before authorizing power operation at a reactor, the NRC performs comprehensive testing and acceptance procedures. The new licensing process is codified in part 52 of Title 10, Code of Federal Regulations and is ready for use after certification of the new designs is completed. The new license procedure results in a more predictable process and less financial risk to the applicant.

In 2008, NRC finalized its rule for the licensing of a geologic repository at Yucca Mountain, Nevada in 10 CFR Part 63, following the revision of the Environmental Protection Agency's 40 CFR Part 197 in that same year.

The revised 10 CFR 70 became effective on October 18, 2000. The revised safety regulations for special nuclear material provide a risk informed and performance-based regulatory approach that includes: (1) the identification of performance requirements for prevention of accidents or mitigation of their consequences; (2) the performance of an Integrated Safety Analysis (ISA) to identify potential accidents at the facility and the items relied on for safety; (3) the implementation of measures to ensure that the items relied on for safety are available and reliable to perform their functions when needed; (4) the maintenance of the safety bases, including the reporting of changes to the NRC; and (5) the allowance for licensees to make certain changes to their safety program and Fabrication Facility and gas centrifuge uranium enrichment facilities will be reviewed for compliance with 10 CFR 70.

3.2. Main National Laws and Regulations in Nuclear Power

The U.S. Congress has enacted several laws, which delineate a comprehensive regulatory program governing the design, construction, and operation of nuclear energy plants. Transportation and disposal of radioactive waste is a major concern of the industry and the public, and there is specific legislation to address such activities as well.

Legislation outlined in Section 3.2.1 affects the U.S. nuclear industry but also covers the entire electric power industry. The legislation outlined in Section 3.2.2 affects the nuclear power industry specifically. These lists are not exhaustive; additional national legislation affecting the nuclear industry also exists. Although the Federal Government has an extensive role in the nuclear industry, there is also a regulatory role for the individual states and some local jurisdictions.

3.2.1. Important Legislation Affecting the Electric Power Industry

The Federal Power Act of 1935 (Title II of PUHCA)

This act was passed at the same time as PUHCA. It provides for a Federal mechanism, as required by the Commerce Clause of the Constitution, for interstate electricity regulation. Prior to this, electricity generation, transmission, and distribution were usually a series of intrastate transactions.

The Public Utility Regulatory Policies Act of 1978 (PURPA) (Public Law 95-617)

PURPA sought to promote conservation of electric energy in response to the unstable energy climate of the late 1970's. PURPA created a new class of non-utility generators, small power producers, from which, along with qualified co-generators, utilities were required to buy power.

The Energy Tax Act of 1978 (ETA) (Public Law 95-618)

ETA, like PURPA, was passed in response to the unstable energy climate of the 1970's. ETA encouraged the conversion of boilers to coal and investment in cogeneration equipment and solar and wind technologies by allowing a tax credit on top of the investment tax credit. ETA was later expanded to include other renewable technologies. These incentives were curtailed in the mid-1980s as a result of tax reform legislation.

The Clean Air Act Amendments of 1990 (Public Law 101-549)

These amendments established a new emissions-reduction program that sought to reduce annual sulfur dioxide emissions by 10 million tons and annual nitrogen oxide emission by 2 million tons from 1980 levels for all man-made sources. Generators of electricity were to be responsible for large portions of the sulfur dioxide and nitrogen oxide reductions. The program employed a unique, market-based approach to sulfur dioxide emission reductions, while relying on more traditional methods for nitrogen oxide reductions. This legislation continues to evolve and specific targets change with national policies.

The Energy Policy Act of 1992 (EPACT) (Public Law 102-486)

EPACT created a new category of electricity producer, the exempt wholesale generator, which circumvented PUHCA's impediments to non-utility electricity generation. EPACT also allowed FERC to open the national electricity transmission system to wholesale suppliers. Seven of EPACT's 30 Titles contain provision related specifically to nuclear power and/or uranium.

The Energy Policy Act of 2005 (EPACT2005)

Provisions affecting nuclear power included the renewal of the Price Anderson Act and incentives for building the first advanced nuclear power plants. Incentives include production tax credits, loan guarantees, and standby support insurance related to regulatory delays.

The Energy Independence and Security Act of 2007

Provided incentives for increased in vehicle fuel efficiency; support for biofuels development; end-use efficiency improvements; and greenhouse gas reductions through implementation of new technologies.

The American Recovery and Reinvestment Act of 2009 (ARRA 2009)

Directed funding for energy efficiency and renewable energy as well as loan guarantees for renewable energy, including nuclear power.

Source: Country Information

Important Legislation Affecting the Nuclear Power Industry

Atomic Energy Act of 1954, as amended (Public Law 83-703)

The Atomic Energy Act of 1954 encouraged private enterprise to develop and utilize nuclear energy for peaceful purposes. This act amended the Atomic Energy Act of 1946 to allow non-federal ownership of nuclear production and utilization facilities if an operating license was obtained from the AEC. This act enabled the development of the commercial nuclear power industry in the U.S..

Energy Reorganization Act of 1974 (Public Law 93-438)

This Act separated the licensing and related functions of the AEC from energy development and related functions. The NRC succeeded AEC as an independent regulatory authority to assure the safety and licensing of nuclear reactors and other facilities associated with processing, transport and handling of nuclear materials.

Low-level Radioactive Waste Policy Act of 1980, as amended (Public Law 96-573)

This Act was an important step toward the development of new disposal capacity for low-level radioactive waste (LLW). Each state was made responsible for providing, by itself or in co-operation with other states, for the disposal of LLW generated within the state. The Act authorizes the states to form compacts to establish and operate regional LLW disposal facilities, subject to NRC licensing approval.

Nuclear Waste Policy Act of 1982, as amended (Public Law 97-425)

This Act established Federal responsibility for the development of repositories for the disposal of high-level radioactive waste and spent nuclear fuel. This Act was amended in 1987 to require the DOE to begin evaluating the suitability of Yucca Mountain in Nevada as the nation's permanent high-level waste repository. That process was complete and approved by Congress during 2002. Also during 2002 Congress overrode objections to the Yucca Mountain facility by the state of Nevada. Judicial and political hurdles to the Yucca Mountain facility remain.

Source: Country Information

Two important issues of national concern are the disposal of spent fuel and decommissioning of retired nuclear plants. The Federal Government collects a fee of one mill (one-tenth of a cent) per kilowatt-hour from companies for nuclear-generated electricity under a general contract with nuclear-generating firms. This money goes into the Nuclear Waste Fund, which pays for all aspects of nuclear waste disposal, including the geologic repository, transportation of the waste, and support of State and local government involvement in the project. The DOE annually evaluates the adequacy of the fees collected for nuclear waste disposal. Expenditures of all waste fund monies are subject to Congressional oversight and authorization. While these charges are passed on to consumers in a regulated environment, they are treated as costs under competitive electricity provision.

The NRC has established procedures for site release and minimum funding levels for decommissioning. Under NRC rules, the minimum financial assurance that licensees must provide to decommission each reactor is determined by a sliding scale that considers primarily the type and size (as measured in megawatts-thermal) of a reactor. Required decommissioning funds for individual reactors amount to several hundred million dollars for each unit. Controversies have arisen at specific sites regarding whether funding is sufficient or in excess and whether decommissioning funds are the property of the ratepayers or of the reactor owners. The resolution of these issues has varied from reactor to reactor.

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APPENDIX 1: INTERNATIONAL, MULTILATERAL AND BILATERAL AGREEMENTS

Agreements for co-operation provide the legal framework of U.S. trade with other countries in the peaceful uses of nuclear energy. Agreements establish binding national commitments enforceable under international law, and set the ground rules for civilian nuclear commerce among nations. The guiding principle is that the U.S. will co-operate in peaceful nuclear trade as long as the other signatory abides by the agreement's conditions governing the safeguarded and continued peaceful use of nuclear material and technology transferred from the U.S., and grants the U.S. certain consent rights over such material's use, alteration, and retransfer.

The U.S. has entered into agreements with other countries for peaceful nuclear co-operation. Similar agreements have been entered with international organizations including the European Atomic Energy Agency (EURATOM), and the IAEA. The U.S. has also entered into trilateral agreements with IAEA and other countries for the safeguards to equipment, devices, and materials supplied under bilateral agreements for co-operation in the use of commercial nuclear power.

APPENDIX 2: MAIN ORGANIZATIONS, INSTITUTIONS AND COMPANIES INVOLVED IN NUCLEAR POWER RELATED ACTIVITIES

NATIONAL NUCLEAR ENERGY AUTHORITY

U.S. Department of Energy 1000 Independence Ave. S.W. Washington, DC 20585	Tel: 202-586-6210 Fax: 202-586-6789 http://www.energy.gov

NATIONAL REGULATORY AUTHORITY

U.S. Nuclear Regulatory Commission One White Flint North 11555 Rockville Pike Rockville, MD 20852-2730	Tel: 301-415-7000 Fax: 301-415-2395 http://www.nrc.gov

OTHER ORGANIZATIONS

Operators and Owners of Nuclear Power Plants

Ameren UE	http://www.ameren.com
American Electric Power (AEP)	http://www.aep.com
Constellation	http://www.constellation.com
Detroit Edison	http://www.detroitedison.com
Dominion Nuclear	http://www.dom.com/about/stations/nuclear/index.jsp
Duke Power	http://www.duke-energy.com
Energy Northwest	http://www.energy-northwest.com
Entergy Nuclear	http://www.entergy-nuclear.com
Exelon	http://www.exeloncorp.com
First Energy	http://www.firstenergycorp.com/welcome

FPL Nuclear	http://www.fpl.com/
Nebraska Public Power District	http://www.nppd.com/
Omaha Public Power District	http://www.oppd.com
Pacific Gas & Electric	http://www.pge.com
Pennsylvania Power & Light	http://www.pplweb.com
Progress Energy	http://www.progressenergy.com
PSE&G	http://www.pseg.com
SCANA	http://www.scana.com
South Texas Nuclear Operating Company	http://www.stpnoc.com
Southern Californian Edison	http://www.sce.com/sc3/default.htm
Southern Nuclear Operations	http://www.southerncompany.com/
Tennessee Valley Authority (TVA)	http://www.tva.gov
TXU	http://www.txu.com/
Wolf Creek Nuclear Operating Corporation	http://www.wcnoc.com/start.cfm

Nuclear Research Institutes

Argonne National Laboratory	http://www.anl.gov
Armed Forces Radiobiology Research Institute (AFRRI)	http://www.afrri.usuhs.mil
Brookhaven National Laboratory	http://www.bnl.gov
Electric Power Research Institute	http://www.epri.com
Idaho National Laboratory	http://www.inl.gov
Lawrence Berkeley Laboratory	http://www.lbl.gov
Lawrence Livermore National Laboratory	http://www.llnl.gov

Los Alamos National Laboratory	http://www.lanl.gov/worldview
Los Alamos Neutron Science Center (LANSCE)	http://www.lansce.lanl.gov/index_ext.htm
Oak Ridge National Laboratory	http://www.ornl.gov/ornlhome/home.htm
Sandia National Laboratory	http://www.sandia.gov
Savannah River Site	http://www.srs.gov

Hardware Manufacturers, Vendors and Service Providers

Canberra (US based company)	http://www.canberra.com
GE Reuter-Stokes (General Electric)	http://www.ge.com/powersystems/reuter-stokes/index.htm
NFS Radiation Protection Systems	http://www.nfsrps.com
Areva	http://www.areva.com
World Nuclear Fuel Market (WNFM)	http://www.wnfm.com

Other Companies

AEA Technology Engineering Services	http://www.aeatech.com
Anchor/Darling Valve Company	http://www.anchordarling.com
Argonne National Laboratory	http://www.anl.gov
Applied Technical Services	http://www.atslab.com/
Anderson Greenwood Crosby	http://www.andersongreenwood.com
Babcock and Wilcox Company	http://www.babcock.com
Atwood and Morrill Company	http://www.atmor.com
Bartlett Nuclear Incorporated	http://www.bartlettinc.com
Bechtel Power	http://www.bechtel.com
Black and Veatch Corporation	http://www.bv.com

Brown and Root Power	http://www.kbr.com
Buffalo Forge Company	http://www.bmt-usa.com
CBI Services	http://www.cbi.com
Chem-Nuclear Systems Incorporated	http://www.chemnuclear.com
Canberra Industries Incorporated	http://www.canberra.com/About/asia.asp
Chempump	http://www.chempump.com
Chesterton International	http://www.chesterton.com
Conax Buffalo Corporation	http://www.conaxbuffalo.com
John Cranes	http://www.johncrane.com
Dresser Industries Incorporated	http://www.dresser.com
Edlow International Company	http://edlow.com
ERIN Engineering & Research Inc.	http://www.erineng.com
Fluor Daniel	http://www.flour.com
Foster Wheeler Energy Corporation	http://www.fwc.com
Foxboro Invensys	http://www.invensys.com
	http://www.foxboro.com
Framatome ANP	http://www.framatome-anp.com
GE Nuclear Energy	http://www.gepower.com/home/index.htm
General Atomics	http://www.ga.com
General Physic Corporation	http://www.gpworldwide.com
Goulds Pumps Incorporated	http://www.goulds.com
Morrison Knudsen Corporation	http://www.morrisonknudsen.com
MPR Associates Incorporated	http://mpr.com
NAC International	http://www.nacintl.com
Newport News Industrial	http://nni.nns.com
Rosemount Nuclear Instruments Inc.	http://www.rosemount.com

SAIC	http://www.saic.com
Sargent and Lundy	http://www.sargentlundy.com/home
Shaw A/DE Incorporated	http://www.shawelec.com
USEC	http://www.usec.com
Westinghouse Electric Corporation	http://www.westinghouse.com

Consultants and Engineering

Electric Power Services Inc.	http://www.epsint.com
Engineering Information Inc.	http://www.ei.org
(Commercial Internet Portal)	
General Atomics	http://www.gat.com
NAC International	http://www.nacintl.com
New York Nuclear and Washington Nuclear	http://www.nynco.com
The Uranium Exchange Company	http://www.uxc.com
Westinghouse	http://www.westinghouse.com
BNFL Inc. (U.S. subsidiary of British Nuclear Fuels plc)	http://www.bnfl.com/website.nsf
Compagnie Générale des Matières Nucléaires (COGEMA)	http://www.cogema-inc.com
NUKEM Nuclear Technologies	http://www.nukem.com
Welding Services Inc.	http://www.weldingservices.com

Professional Organizations

American Nuclear Society (ANS)	http://www.ans.org
Federation of American Scientists (FAS)	http://www.fas.org
Nuclear Energy Institute	http://www.nei.org

Universities

Clemson University	http://www.clemson.edu
Colorado State University	http://welcome.colostate.edu
Cornell University	http://www.cornell.edu
Duke University	http://www.duke.edu
Georgia Institute of Technology	http://www.gatech.edu
Idaho State University	http://www.isu.edu
Kansas State University	http://www.ksu.edu
Linn State Technical College	http://www.linnstate.edu
Livingstone College	http://www.livingstone.edu
Louisiana State University	http://www.lsu.edu
Massachusetts Institute of Technology	http://www.mit.edu
Morgan State University	http://www.morgan.edu
New Mexico State University	http://www.nmsu.edu
North Carolina State University	http://www.ncsu.edu
Ohio State University	http://www.osu.edu/index.php
Oregon State University	http://oregonstate.edu
Pennsylvania State University	http://www.psu.edu
Polytechnic University of Puerto Rico	http://www.pupr.edu
Prairie View A&M University	http://www.pvamu.edu
Purdue University	http://www.purdue.edu
Reed College	http://web.reed.edu
Rensselaer Polytechnic Institute	http://www.rpi.edu
South Carolina State University	http://www.scsu.edu

Stanford University	http://www.stanford.edu
Texas A&M University	http://www.tamu.edu
Texas A&M Kingsville	http://www.tamuk.edu
Three Rivers Community College	http://www.trcc.cc.mo.edu
Tuskegee Institute	http://www.tuskegee.edu
University of Arizona	http://www.arizona.edu
University of California - Berkeley	http://www.nuc.berkeley.edu
University of California - Davis	http://www.ucdavis.edu
University of California - San Diego	http://www.ucsd.edu
University of Cincinnati	http://www.uc.edu
University of Florida	http://www.ufl.edu
University of Illinois	http://www.uillinois.edu
University of Maryland	http://www..umd.edu
University of Massachusetts - Lowell	http://www.uml.edu
University of Michigan	http://www.umich.edu
University of Missouri - Columbia	http://www.missouri.edu
University of Missouri - Rolla	http://www.umr.edu
University of New Mexico	http://www.unm.edu
University of South Carolina	http://www.sc.edu
University of Tennessee	http://www.utk.edu
University of Texas	http://www.utexas.edu
University of Utah	http://www.utah.edu
University of Virginia	http://www.virginia.edu
University of Wisconsin	http://wisc.edu
Washington State University	http://www.wsu.edu
Wilberforce University	http://www.wilberforce.edu/opencms/opencms/bulld

	og/home/home.html
Worcester Polytechnic Institute	http://www.wpi.edu

University Reactor Facilities

The Radiation Information Newtwork (USA)	http://www.physics.isu.edu/radinf
Indiana University Cyclotron Facility	http://www.iucf.indiana.edu
University of Washington/Nuclear Physics Laboratory	http://www.npl.washington.edu
University of Wisconsin Reactor Laboratory	http://reactor.engr.wisc.edu

[1] The links above are provided by the Secretariat to facilitate searches by the reader. They consist of an arbitrary selection of links available at the IAEA library and are neither complete nor express any preference.