NUCLEAR POWER: TIME TO START AGAIN

William D. Rezak

President Emeritus
State University of New York
College of Technology at Alfred
Alfred, NY 14802
Phone: (770) 287-0505
rezakwd@alfredstate.edu

ABSTRACT

One of America's best kept secrets is the success of its nuclear electric power industry. This paper presents data which support the construction and operating successes enjoyed by energy companies that operate nuclear power plants in the US. The result--the US nuclear industry is alive and well. Perhaps it's time to start anew the building of nuclear power plants.

Let's take the wraps off the major successes achieved in the nuclear power industry. Over 20% of the electricity generated in the United States comes from nuclear power plants. An adequate, reliable supply of reasonably priced electric energy is not a consequence of an expanding economy and gross national product; it is an absolute necessity before such expansion can occur. It is hard to imagine any aspect of our business or personal lives not, in some way, dependent upon electricity.

All over the world (in over 30 countries) nuclear power is a low-cost, secure, safe, dependable, and environmentally friendly form of electric power generation. Nuclear plants in these countries are built in six to eight years using technology developed in the US, with good performance and safety records.

This treatise addresses the success experienced by the US nuclear industry over the last 40 years, and makes the case that this reliable, cost-competitive source of electric power can help support the economic engine of the country and help prevent experiences like the recent crises in California and the Northeast.

Traditionally, the evaluation of electric power generation facility performance has focused on the ability of plants to produce at design capacity for high percentages of the time. Successful operation of nuclear facilities is determined by examining capacity or load factors. Load factor is the percentage of design generating capacity that a power plant actually produces over the course of a year's operation. This paper makes the case that these operating performance indicators warrant renewed consideration of the nuclear option.

Usage of electricity in the US now approaches total generating capacity. The Nuclear Regulatory Commission has pre-approved construction and operating licenses for several nuclear plant designs. State public service commissions are beginning to understand that dramatic reform is required. The economy is recovering and inflation is minimal. It's time, once more, to turn to the safe, reliable, environmentally friendly nuclear power alternative.

INTRODUCTION

It's time we take the wraps off the major successes achieved in the nuclear power industry. Over 20% of the electricity generated in the United States comes from nuclear power plants. An adequate, reliable supply of reasonably priced electric energy is not a consequence of an expanding economy and gross national product; it is an absolute necessity before such expansion can occur. It is hard to imagine any aspect of our business or personal lives not, in some way, dependent upon electricity.

All over the world (in over 30 countries) nuclear power is a low-cost, secure, safe, dependable, and environmentally friendly form of electric power generation. Nuclear plants in these countries are built in six to eight years using technology developed in the US, with good performance and safety records.

Nuclear fuel is uranium, which is readily available in America. This treatise addresses the successes experienced by the nuclear industry over the last 40 years, and makes the case that this reliable, cost-competitive source of electric power can help support the economic engine of the country and prevent further experiences like the recent crises in California and the Northeast.

HISTORICAL PERSPECTIVE

The alternatives for the generation of large quantities of electricity are narrowing. Nuclear power has proven its cost effectiveness and safe operation through its success over four decades. Herein are the data that support this contention.

There are over 440 nuclear power plants operating around the world, and another 33 under construction. Over 100 of these are in the United States. Only two other nations in the world have half that many!

The demand for electric power in America during the 28 years between World War II and 1973 grew at a rate of about 7% per year. The unit price of electricity declined during this period due to increased power usage; larger and more efficient generating plants; better transmission and distribution systems; and improved power plant and fuel technology. As it became economically effective to build and operate large electric generating power plants and improved technology made nuclear plants competitive with fossil fueled plants, electric utility companies, in the late 1960s and early 1970s, planned to divide future additions to generation capacity primarily between coal-fired and nuclear power.

Because the electric utility industry in the early 1970s had no reason to anticipate a change in the 7% annual growth rate for electricity demand, it was ordering new capacity to meet the expected demand. Utilities were projecting that the lead time between ordering and commercial operation of a nuclear power plant was eight years. These two parameters led utilities to order and plan for construction of approximately 200 new nuclear power plants by the year 2000.

Circumstances changed radically in 1973. The decision by the Organization of Petroleum Exporting Countries (OPEC) to decrease oil production and raise prices, coupled with the Arab oil embargo on the United States, drastically affected the price and utilization rate of energy worldwide, and, hence, impacted the world economy. Specifically, the general population in America began to conserve personal and business/industrial consumption of energy. On a grander scale, the increased price paid by industry for energy resulted in an economic slowdown.

Because these circumstances were not well understood in 1973, the utility companies carried forward their planned power plant projects with considerable momentum. Large increases in the price of crude oil established by the OPEC cartel led to substantial increases in the price of fuel oil (domestic and imported) in the US. There were parallel increases in the price of natural gas. Coal prices were already increasing as a result of mine safety legislation. The fact that the price of coal was pegged to the price of oil led to much higher energy prices, as well as to profound changes in the economic climate in the US and the rest of the world.

These economic changes resulted in a sharp decrease in the rate of growth of the demand for electric power. The industry did not immediately understand that this decreased rate would persist. It would have been imprudent for electric utility companies to have reacted too quickly to this decrease in the rate of demand for electricity in 1973 and '74. Trends had been steady for 28 years at the 7% growth rate.

It took several years for the industry to realize that growth would be significantly less for the long term. Electric utilities eventually cancelled some power plant orders, deferred others, stretched out the construction of others, and eventually shut down construction and "mothballed" still other plants already well along in construction.

The increase in demand for electric power over the period 1973-2002 (over 28 years) averaged about 2.5% per year, about one-third of the steady growth rate between World War II and 1973. Cancellation of nuclear power plant construction projects was a necessary and logical conclusion in light of this new lower growth rate. Yet, it has had enormous consequences for the electric power industry and for public perception of nuclear power. Even so, electric generating capacity grew by almost 4% per year from 1973 to 1990, leading to substantial excess generating capacity during the last decade of the last century.

There is no mystery concerning the cancellation of a large number of nuclear plants and the lack of new orders in the United States - there was an excess of capacity on order and no need for more generating capability. The same situation applied to coal-fired plants. It was excess generating capacity that resulted in the lack of orders. Public perception, however, remains that it was cost, environmental opposition, safety concerns, backlash from the 1979 Three-Mile-Island incident, and increased regulatory burden that led to these cancellations. While these were all factors in completing nuclear plants then under construction, they were not the reason for the absence of orders. This perception will, nonetheless, preclude future nuclear power plant construction if it is not reconciled with fact.

Forecasting the growth of the demand for electric power is a risky exercise at best. It involves estimating the rate of economic growth, the type of growth, and the energy and electricity demands associated with that growth. Many observers agree that the US economy is likely to sustain an average growth rate, as measured by growth in the gross national product (GNP), of 2.5% per year well into the 21st century. The increase in the demand for electric power has been demonstrated to track the growth rate of the GNP. Thus, for planning purposes, a growth rate for electric power demand of about 2.5% per year seems a realistic projection.

A deficiency in electric power supply has a greater negative impact on the economy than an excess of capacity of the same magnitude. It is easy to slow down construction of power generation projects if the need is less than expected. It is much more difficult to speed them up to meet unanticipated demand--witness California and the Northeast. Imagine the consequences if the economy were stifled by the lack of electricity to support growth in the business sector!

The fact that utility firms pressed forward in the 1980s with plans for increased generating capacity assured the country of a solid foundation upon which to build the economic expansion of the ‘90s. Unless substantial new capacity, beyond that in place and that now planned, is ordered, and put into operation in the next few years, significant shortfalls in the supply of electricity are likely in the US--not just in California and the Northeast.

NUCLEAR RISK

Nuclear power generation technology utilized throughout the world is based primarily on that developed in the US. The nuclear industry has accumulated over 2600 reactor-years of operating experience in the US, and about 9500 worldwide. In all of those reactor-years of experience, the most serious operating problem in the United States was the 1979 Three Mile Island (TMI) failure. That failure resulted in damage to the power plant; but, no injuries to plant operators or the public.

When it was finally necessary to vent the TMI containment vessel in order to allow work crews inside, there was a great hue and cry from the press. Unfortunately, the industry and the media failed to convey to the public that it was more dangerous to drive to the TMI site to protest this release, than to be exposed to the release itself!

The risks associated with any potential accident may be calculated. The loss of life expectancy associated with exposure to TMI radiation for residents of the area was approximately two minutes. The loss of life expectancy from being struck by lightning for these same people was 20 hours (Cohen, 1990).

The most serious nuclear power generation incident worldwide was the 1986 Chernobyl disaster in the Ukraine. There was extensive physical damage and loss of life associated with the Chernobyl accident. Its reactor safety systems were, however, completely different from those used in the western world. The Chernobyl plant had no containment vessel to trap toxic gasses and dust particles escaping from the reactor to the atmosphere. The reactor designs in the west have a containment vessel to preclude the type of accident which occurred at Chernobyl.

A Chernobyl-type reactor can begin to run out of control (become unstable) when experiencing significant temperature increase or loss of cooling water. Reactors that are unstable under these conditions are not licensable in the US. The Ukraine and Russia are currently removing from service their Chernobyl-type nuclear plants.

We all receive daily background amounts of radiation from the natural environment. To this is added the technology dosage from x-rays and cathode ray tubes (TV and computer monitors) to which we regularly subject ourselves. The likelihood of experiencing a health problem as a result of radiation is far greater from this natural and self-inflicted exposure than from that which might escape from a nuclear power plant.

The risks of driving an automobile, working in an industrial plant, or choking to death on food far exceed those associated with the operation of nuclear power plants. These risks must be weighed against the benefits--the maintenance of the standard of living to which we have become accustomed and the economic, environmental, and political security of the nation. As a result of the media’s poor job of accurately reporting the risks associated with nuclear power plant radiation emission, the public believes them to be much greater than those we experience every day of our active lives.

Risks associated with living in poverty, smoking, working as a coal miner, being overweight, drinking alcohol, driving automobiles, contracting pneumonia or influenza, abusing drugs, contracting AIDS, drinking coffee, utilizing birth control pills, and flying on airplanes each are more apt to shorten our lives than living near a nuclear power plant (Cohen, 1990).

OPERATING SUCCESS

Traditionally, the evaluation of electric power generation facility performance has focused on the ability of plants to produce at design capacity for high percentages of the time. Successful operation of nuclear facilities is determined by examining capacity or load factors. Load factor is the percentage of design generating capacity that a power plant actually produces over the course of a year's operation.

Table 1 indicates load factors for the best performing nuclear power producing nations through 2002, the last year for which data is available (International Atomic Energy Agency Power Reactor Information System database). The numbers in parenthesis indicate the number of nuclear power plants operating in the country.

When comparing US data with that of other nations, it is important to note that many of the other nations have only one operating utility organization. The US has more than 30 independent companies operating nuclear power facilities. Each of these companies is subject to its own management and operating vagaries.

A review of Table 1 indicates that the four nuclear power plants operating in Finland were able to generate at 93.2% of load capacity in 2002, and at a cumulative average of 90.6% of load capability during their years of operation through 2002. The nine Spanish plants had a 2002 load factor of 92.6%, and a cumulative load factor of 85.1%.

The 103 units operating in the US during the same time frame achieved a 2002 load factor of 90.5%, and a cumulative load factor of 75.1%. This is a significant improvement over the cumulative load factor through 1994, which was 64.2%. The US, with almost twice as many plants as any other nation and over 30 independent operating entities, is achieving very well.

Annual load factor for American plants has increased by 25 percentage points in the last 20 years. It was 65.2% in 1989, 77.2% in 1994, 88.5% in 1999, and 90.5% in 2002. This is also a most impressive performance indicator!

Table 1 also indicates the percent of electric generation that is nuclear in the 22 countries listed. Seventeen countries are more dependent on nuclear power than the US, some relying almost entirely on nuclear power.

The cumulative load factor for all 441 nuclear plants on-line worldwide at the end of 2002, for their then approximately 9500 reactor-years of operation, was about 77%. Several generating firms in the US that operate three or more nuclear plants exceed or were close to this cumulative average. They are:

Table 2

Operator	No. of Nuclear Plants	Cumulative Load Factor thru 2002 (%)
Southern Nuclear	6	81.2
Arizona Public Service	3	78.2
Nuclear Management	8	77.4
Florida Power & Light	4	77.5
Duke Power	7	77.2
Constellation Nuclear	4	73.0

The bottom line is that the 100+ nuclear plants currently operating in the US are a source of safe, affordable, reliable electric energy for their customers and the 20% of the economy that they support.

CONSTRUCTION SUCCESS

During the decade of the 1980s, 45 new nuclear power plants went into operation in the United States. Construction cost per kilowatt of generating capacity for these facilities varied from under $1,000 to almost $6,000. Schedules for completion ranged between 85 and 188 months. Many well-managed nuclear power plant projects were placed into service on schedule and within budget. A listing of construction cost and duration of some successful, and some not so successful, nuclear plants is provided in Tables 3 and 4.

Some of the successful utilities did the right things right the first time--Arizona Public Service, Duke Power, Florida Power and Light, Pennsylvania Power and Light, and South Carolina Electric and Gas; and some learned to adapt--Commonwealth Edison, Houston Lighting and Power, and the combine of Southern California Edison/San Diego Gas and Electric. The performance of these utilities in construction of their nuclear plants is indicated in Table 3. Those listed in Table 4 were not as effective in bringing their nuclear projects to fruition on schedule and within budget.

The three Palo Verde units of Arizona Public Service came on line in the second half of the decade of the ‘80s. The cost per kilowatt for construction of these units was $1,641 for Unit No. 1 (which included site preparation) and then $1,283 and $1,253 for Units No. 2 and 3, respectively. These nuclear units started operation during the same time frame as Perry Unit #1 constructed by Cleveland Electric Illuminating which cost $4,319 per kilowatt; Braidwood Unit #1 and Byron Unit #1 constructed by Commonwealth Edison, which cost $2,803 per kilowatt and $2,198 per kilowatt, respectively; Fermi Unit #2 constructed by Detroit Edison which cost $3,795 per kilowatt; and Beaver Valley Unit #2 of Duquesne Light which cost $5,354 per kilowatt (Utility Data Institute database, 1990).

Because these units came on line during the same five-year period, they experienced the same economic inflation factors and regulatory environment during construction. Some construction projects were simply managed better than others.

Now, 140 new coal-fired power plants also commenced operation in the '80s. The cost per kilowatt of generating capacity for these facilities ranged from $237 to $1,933 (Utility Data Institute database, 1990). While these capital investment costs are considerably lower than those for nuclear power plants, the cost of fuel for these facilities is much higher over the life of the plants. The low lifetime fuel cost of nuclear power plants balances the high initial investment. The reverse is true of coal-fired plants--relatively low initial investment, high fuel cost over the life of the facility.

Design and construction of conventional fossil fuel electric generating plants is well understood, having evolved over the 20th century. Supervision of fossil fuel construction projects is typically left to utility middle managers, since the technology is well developed, regulations minimal, and there is a high degree of confidence that projects can be constructed on schedule and within budget.

Utilities that took the same approach (middle management oversight) to design and construction of nuclear power plant facilities were in for a rude awakening. The complexity of the designs coupled with the regulatory environment and inflationary economy spelled disaster for projects not carefully attended by top management. The fact that the projects and utilities mentioned in Table 3 were able to achieve relative success regarding schedule and budget indicates that, as in all endeavors, effective leadership yielded positive results.

Utility executives who managed these successful projects made sure that they and their engineers clearly understood the technology, borrowed funds for construction at competitive interest rates when the market permitted, and aggressively managed the licensing process with the Nuclear Regulatory Commission (NRC). In the same environment (high inflation rates, changing regulatory environment), some utilities were successful, others were not.

CAN FUTURE NUCLEAR POWER PLANTS BE CONSTRUCTED AT REASONABLE COST?

Accurate cost and schedule projections will be necessary in order for utilities to undertake nuclear power plant construction projects in the future. This should be a realistic expectancy, since the licensing process has been reformed.

These reforms will allow the NRC licensing process to continue to provide effective regulation of construction and operation of plants; and will preclude the uncertainties utilities faced on construction projects in the 70s and 80s. Congress has also enacted legislation that calls for NRC issuance of a single license prior to construction, to provide for both construction and operation of plants. Previously, two separate licenses were required. Single licensing will help assure a stable environment for construction of nuclear plants.

One of the reasons that so many other nations have enjoyed successful nuclear power generation programs is that most utilize a replicated single plant design which is operated by a single utility. In the US during the 70s and 80s, there were four major nuclear plant equipment suppliers, 8 or 10 engineering firms (each with their own plant designs), and over 50 separate utilities ordering plants. This resulted in many combinations of different equipment designs, plant designs, and owner preferences, leaving a wide range of differences between individual plant designs and operating characteristics. Wise utilities duplicated units within their own systems. The NRC, however, required many of the duplicate units to incorporate the latest operating experiences of the industry.

The NRC has worked with the equipment suppliers and engineering firms to develop several standardized plant designs. These standardized designs have been certified.

It then becomes the responsibility of the utilities to assure that they do not request customized changes to these pre-approved equipment and plant designs. Such changes would place at risk the licensing process for the particular installation. Adoption of standard equipment and plant designs will expedite the safety and environmental licensing processes and render predictable the construction schedule and cost of nuclear power plants. This approach has proven successful in Belgium, France, Japan, Sweden, Switzerland, and the United Kingdom. It has compromised neither safety nor the environment.

The principal regulation of the operation of electric utility companies in the US is carried out by the public service commissions (PSCs) in each of the 50 states. This is not to be confused with nuclear safety regulation which is managed by the Nuclear Regulatory Commission (NRC) of the federal government. The PSCs generally establish allowable rates of return on undepreciated investment and approve specific rate schedules for the operating electric utility companies. These commissions have historically waited until the construction of plants is completed before deciding how much of the total plant cost could be charged to customers in the "rate base" and what the rate schedules will be after the new plant is in operation.

There has been continuing controversy over these matters particularly over the question of how much of the cost of new, expensive nuclear power plants can be put into the rate base. These controversies led to "prudency" hearings where the question of "prudent judgment" by the utilities was scrutinized with perfect hindsight 10-15 years after the decisions to build facilities were made. Some experts allege that the recent debacle in California resulted from poor PSC caretaking. These decisions should be made before the plant is built and not left to hearings and discussions after it is completed.

WHAT ABOUT TOXIC WASTES?

The fossil fuels (coal, oil, and natural gas) all have toxic wastes. Oil supply is subject to the whims of OPEC, and should be reserved for transportation. Natural gas should be reserved for residential and institutional heating. Combustion of coal in power plants results in a number of noxious emissions. These include particulate matter and toxic gasses. In addition, hot carbon dioxide emissions contribute to the "greenhouse effect" which warms the atmosphere. Continued warming could result in such disastrous consequences as the raising of ocean levels (due to melting of the polar ice caps) by as much as two meters during the next 50 to 60 years. This could displace as many as 50 million people! This kind of global warming could also produce deserts in sub-Saharan Africa, in Asia, and in South America.

Coal-fired power plants are also a culprit in the production of acid rain. This, too, may be an issue in the 21st Century, as it leads to crop contamination and structural erosion.

Over 30 million tons of toxic chemical waste are produced in the US every year by various industries (US Council for Energy Awareness, 1989). This compares with a total of approximately 40,000 metric tons of highly irradiated nuclear fuel utilized by all the commercial nuclear power plants in the US during the last 40 years. This amount is so small that it could be stacked less than 30 ft. high on top of a football field! Additional low level radioactive waste is processed at several sites in the nation.

The US Department of Energy opened the Yucca Mountain storage site for spent nuclear fuel in corrosion resistant canisters to be buried in a natural salt formation for permanent storage. Since this waste is in such small quantity, it could be rendered harmless in this fashion.

Spent fuel transport and storage have achieved an exemplary safety record for over four decades. Studies have been conducted of worst-case population exposures as part of the Final Environmental Impact Statement. These analyses defend acceptance criterion for the bounding outcomes of these events, based on current accepted activities within society that produce high dose exposures to the general public.

Nuclear plants produce far fewer toxic substances than their coal-fired counterparts. And, this waste may be disposed of safely.

WHAT ARE THE ALTERNATIVES TO NUCLEAR POWER?

Manufacturers of electrically operated appliances have done a marvelous job of making them evermore efficient. This coupled with the fact that the electric demand growth rate decreased significantly in the US while utilities continued to build large electric generating capacity reserves in the 1970s and ‘80s, led to a stagnant maximum generating capacity for the nation through the decade of the ‘90s, when few new power plants were built. The economic expansion of the ‘90s, coupled with little expansion of electric power generating capacity, led to the recent situation in California and the Northeast. This will be experienced across the country unless new generating and transmission capacity is added.

During the period between 1973 and 1983 when electric demand growth rate in the US decreased from about 7% per year to approximately 2.5% per year, 105 nuclear plants were cancelled or deferred. During the same time period, 75 fossil fueled plants (plants burning coal, oil, or natural gas) were cancelled or deferred. More nuclear plants were cancelled simply because more nuclear plants were on order.

Global warming has raised serious concerns about adding coal-fired electric generating capacity. Oil is potentially unavailable and subject to the pricing whims of the OPEC, and it should be reserved for transportation.

Natural gas is clean and safe, and should be reserved for residential and commercial/institutional heating. It is also subject to dramatic price fluctuations.

Hydroelectric power is clean and renewable, but dam sites are environmentally sensitive. Solar, geothermal, and fuel cells are either insufficient to support the expanding US economy, or their technology is not adequately developed for use at this time. Wind power is emerging, but, again, not in the scale that will support significant economic growth.

The NRC, in the last decade, has approved designs for US nuclear plant manufacturers. This will lower construction cost.

Americans should consider themselves lucky that the electric generating industry in the 1980s had the foresight to press forward with completion of its nuclear construction program. The health of this industry is essential to the health of the economy and the standard of living for all of us.

The only substantial, readily available, and reliably priced natural resources for new base-load electric generation in the US are coal and uranium. The reserves of both are large in America. The position of many electric utility companies has been that if potential shortages of electricity occur (as they surely will--witness California and the Northeast), they will attempt to deal with these by:

1. Encouraging conservation of energy use by both residential and industrial consumers;
2. Implementing load management programs which provide incentives for consumption of electricity in off-peak hours (generally between midnight and 6:00 a.m.);
3. Purchasing power from pools with excess capacity or from industrial producers (this didn't work in California!);
4. Use of "peaking" combustion turbines which are relatively inexpensive and may be installed on short-time schedules; but, which don't provide base-load support for an expanding economy; and
5. Installation of traditional coal-fired or nuclear power plants.

CONCLUSION

Usage of electricity in the US now approaches generating capacity. The NRC has pre-approved construction and operating licenses for several nuclear plant designs. The PSCs are beginning to understand that dramatic reform is required--none of the other 49 states want to replicate the situation in California. The economy is recovering and inflation is minimal. It's time, once more, to turn to the safe, reliable, environmentally friendly nuclear power alternative.

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WILLIAM D. REZAK

Bill Rezak was President of the State University of New York College of Technology at Alfred from 1993 to 2003. He has been instrumental in transforming Alfred State from a two-year technical college into a baccalaureate polytechnic. Prior to coming to Alfred State, he was Dean of the School of Technology at Southern Polytechnic State University in Marietta, Georgia.

Earlier, Rezak spent 18 years in engineering, design and construction of power generation facilities, both nuclear and fossil fueled. He earned a Bachelor of Science in Mechanical Engineering from Lehigh University, a Masters in Mechanical Engineering from Stevens Institute of Technology, and a Ph.D. in Human Resource Development from Georgia State University. He is a registered professional engineer in several states.

Table 1
Load Factors Among Nations with
Significant Nuclear Power Programs

Rank[1]	Nation (#)[2]	% of Electric Generation that is Nuclear	2002 Load Factor (%)	1999 Load Factor (%)	1994 Load Factor (%)	1989 Load Factor (%)	Cumulative Load Factor thru 2002 (%)
1	Finland (4)	30	93.2	92.6	87.7	89.5	90.6
2	Spain (9)	26	92.6	87.0	76.7	83.1	85.1
3	Switzerland[4] (5)	40	92.6	84.7	88.9	83.2	87.1
4	United States (103) [3]	20	90.5	88.5	77.2	65.2	75.1
5	South Korea (16)	39	90.4	89.2	86.7	78.1	85.0
6	Belgium (7)	57	90.0	91.3	81.1	79.5	87.8
7	Hungary (4)	36	87.7	87.6	87.4	89.7	86.2
8	Czech Republic (6)	25	86.3	86.3	83.2	81.3	82.5
9	Germany (19)	30	86.0	86.8	79.9	75.4	85.2
10	China (7)	1	85.3	63.8	---	---	81.1
11	Slovak Republic (6)	55	85.3	67.5	79.0	79.1	78.4
12	Canada[4] (14)	12	85.2	79.4	85.1	86.8	78.8
13	Sweden[4] (11)	46	85.0	82.0	75.3	73.0	80.6
14	India (14)	4	84.4	76.2	44.9	35.7	64.6
15	Mexico (2)	4	84.0	86.1	73.8	----	80.2
16	France[4] (59)	78	82.4	70.3	67.4	65.5	78.6
17	Japan (54)	35	78.1	79.0	70.9	72.1	75.4
18	Ukraine (13)	46	77.1	63.9	62.4	67.8	68.6
19	Bulgaria (4)	47	74.8	46.7	45.2	64.7	70.5
20	Russia (30)	16	74.7	62.4	57.8	74.6	70.6
21	Lithuania (2)	80	70.3	42.0	31.9	63.6	70.3
22	United Kingdom[4] (31)	22	42.6	---	82.2	65.5	79.8

[1] In order of highest 2002 Load Factor.
[2] No. of nuclear plants.
[3] Not counting Browns Ferry #1, which hasn't operated in several years.
[4] Some plant performance data not available through 2002.

Table 3
Selected Nuclear Power Plant Projects of the 1980s
with Construction Cost < $1900/Kwe

Owner	Plant Name & Unit No.	Net Mwe	Reactor Type	Const. Permit Date	Comm. Oper. Date	Const. Dura. (Mos.)	Cost ($/Kwe) (2)
Arizona Public Service	Palo Verde 1	1221	PWR	5/76	1/86	116	1641
	Palo Verde 2	1221	PWR	5/76	9/86	(1)	1283
	Palo Verde 3	1221	PWR	5/76	1/88	(1)	1253
Commonwealth Edison	Braidwood 2	1120	PWR	12/75	10/88	(1)	1615
	Byron 2	1105	PWR	12/75	8/87	(1)	1666
	LaSalle 1	1036	BWR	9/73	1/84	124	1180
	LaSalle 2	1036	BWR	9/73	10/84	(1)	949
							1605
Duke Power	Catawba 1	1129	PWR	8/75	6/85	118	1605
	Catawba 2	1129	PWR	8/75	6/86	(1)	1359
	McGuire 1	1129	PWR	2/73	12/81	106	753
	McGuire 2	1129	PWR	2/73	3/84	(1)	849
							1671
Florida Power & Light	St. Lucie 2	839	PWR	5/77	8/83	75	1671
Houston Lighting & Power	So. Texas 2	1250	PWR	12/75	6/89	(1)	1143
Pennsylvania Power & Light	Susquehanna 1	1032	BWR	12/73	6/83	114	1690
	Susquehanna 2	1038	BWR	12/73	2/85	(1)	1874
Southern Carolina Electric & Gas	Summer	885	PWR	3/73	1/84	130	1367
Southern California	San Onofre 3	1080	PWR	10/73	4/84	(1)	1482
Edison/San Diego Gas & Electric							

(1) Duplicate unit on same site with same construction permit, but later scheduled commerical operating date.
(2) Includes interest on funds used during construction (IFUDC).
Source: Utility Data Institute.

Table 4
Selected Nuclear Power Plant Projects of the 1980s
with Construction Cost > $2199/Kwe

Owner	Plant Name & Unit No.	Net MWe	Reactor Type	Const. Permit Date	Comm. Oper. Date	Const. Dura. (Mos.)	Cost ($/Kwe) (2)
Cleveland Electric Illuminating	Perry 1	1205	BWR	5/77	11/87	125	4319
Commonwealth Edison	Braidwood 1	1120	PWR	12/75	7/88	150	2803
	Byron 1	1105	PWR	12/75	9/85	117	2198
Detroit Edison	Fermi 2	1075	BWR	9/72	1/88	183	3795
Duquesne Light	Beaver Valley 2	833	PWR	5/74	11/87	162	5354
Entergy Operations	Gulf Port	1142	BWR	9/74	7/85	130	2789
	Waterford 3	1075	PWR	11/74	9/85	130	2370
Georgia Power	Vogtle 1	1079	PWR	6/74	6/87	156	5419
(Southern Nuclear)	Vogtle 2	1100	PWR	6/74	5/89	(1)	2226
Gulf States Utilities	River Bend	936	BWR	3/77	6/86	111	4553
Houston Lighting & Power	So. Texas 1	1250	PWR	12/75	8/88	152	2896
Illinois Power	Clinton	930	BWR	2/76	4/87	134	4293
New Hampshire Yankee	Seabrook	1150	PWR	7/76	7/90	168	5739
Niagara Mohawk Power	NineMile Point 2	1072	BWR	6/74	4/88	166	5939
Northeast Utilities	Millstone 3	1142	PWR	8/74	4/86	140	3760
Pacific Gas & Electric	Diablo Canyon 1	1073	PWR	4/68	5/85	205	2774
	Diablo Canyon 2	1087	PWR	12/70	3/86	183	2327
Philadelphia Electric	Limerick 1	1055	BWR	6/74	2/86	140	3773
	Limerick 2	1055	BWR	6/74	1/90	(1)	2626
Southern California Edison/San Diego Gas & Electric	San Onofre 2	1070	PWR	10/73	8/83	118	2184
Texas Utilties Electric	Commanche Peak 1	1150	PWR	12/74	8/90	188	5130
Union Electric	Callaway	1125	PWR	4/76	4/85	108	2597
Washington Public Power Supply System	WNP-2	1095	BWR	3/73	12/84	141	2802
Wolf Creek Nuclear Operating Corp.	Wolf Creek	1135	PWR	5/77	9/85	100	2487

(1) Duplicate unit on same site with same construction permit, but later scheduled commerical operating date.
(2) Includes interest on funds used during construction (IFUDC).
Source: Utility Data Institute