# Can Nuclear Power Compete?

**Geoffrey Rothwell**

Commercial nuclear power is the world's most regulated industry. The early reason for heavy central government control was to prevent the spread of nuclear weapons technology. In the United States the federal monopoly of nuclear materials ended with the Atomic Energy Act of 1954. With this legislation the government's role shifted from owner to promoter: the Atomic Energy Commission (AEC) was established to encourage the private "development and use of atomic energy." The AEC funded the design of reactors to generate electricity through the Power Demonstration Reactor Program beginning in 1955. On the basis of this experience, manufacturers began offering large-scale reactors to the nation's electric utilities in 1963. Haddam Neck, operated by Connecticut Yankee, a 582-megawatt plant, entered commercial operation on January 1, 1968, at a cost of $92 million. Utilities ordered hundreds of reactors on a cost-plus basis during the next ten years.

While the utilities were building those plants, significant regulatory changes took place. In 1969 Congress passed the National Environmental Policy Act requiring environmental impact statements for federally funded projects. In 1971 the *Calvert Cliffs Coordinating Committee* v. *Atomic Energy Commission* decision extended the requirement for an environmental impact statement to nuclear reactors. The Energy Reorganization Act of 1974 moved the functions of the AEC to two agencies. The Energy Research and Development Agency (later, the Department of Energy (DOE)) assumed the task of developing nuclear power. The Nuclear Regulatory Commission (NRC) became the public health and safety regulator. A rapidly changing industry and a series of industry accidents overwhelmed the NRC's staff. Because of the fire at Browns Ferry in March 1975 and the partial meltdown of the Three Mile Island reactor in March 1979, the licensing of new plants slowed in the late 1970s. The retrofitting of existing plants with new safety equipment, structures, and systems grew. Utilities cancelled 100 reactor orders between 1972 and 1982. They have not placed new orders since 1978.

The nuclear industry has been floundering for fifteen years. The industry has thrived with federal research and development subsidies, accident liability limits, and guarantees to dispose of radioactive waste. But the industry has suffered from conflicting regulatory requirements and the problems of managing a complex technology.

This article outlines the costs and risks associated with the light water reactor. When the government or society bears these costs or risks, there are explicit and implicit subsidies to the nuclear industry. These subsidies have been defended as responses to market failures, where characteristics of the technology prevent the efficient allocation of resources by using market mechanisms. But these subsidies also distort behavior. If we can properly assign costs and risks, for example, by mimicking market results, reliance on regulation may be unnecessary.

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## Regulating Nuclear Market Failures

The life of a nuclear power plant has four stages: design and fabrication of the reactor (also known as the nuclear steam supply system), design and construction of the power plant, operation, and decommissioning and waste disposal. The operation stage has two phases: generation and safety. Each stage exhibits problems that can lead to market failure.

First, the market might not offer adequate incentives for a manufacturer to make the huge research and development investments associated with designing and fabricating a reactor. It is well known in economics that firms find it difficult to appropriate the benefits from basic research. Knowledge that cannot be withheld from others becomes a public good. Under such circumstances the firm cannot charge those who use the information. That is likely to occur when the results of basic research are not patentable or marketable. Without property-rights protection there is insufficient investment in basic research, and there is an economic rationale for government involvement. But because the fifty nuclear utilities represent a limited market for reactor development and demonstration, property rights can be more easily enforced for nuclear power than for other forms of energy research. Development costs should be recovered through reactor sales or through cooperative ventures with the electric utilities.

Second, consider the design and construction of the power plant. During the mid-1960s, the reactor manufacturers, the architect-engineers, and the contractors worked together to provide an operating reactor at minimum cost under "turnkey" contracts. Later, reactors were built under cost-plus contracts. The utilities absorbed the cost overruns and tried to pass them on to their customers. That system encouraged increased state-level regulatory intervention. Because of the escalating capital charges, the state public utilities commissions became more aggressive during public convenience and necessity hearings (often by denying permits) and during rate hearings with prudence reviews of management decisions (often by disallowing expenditures).

Of course, much of the real increase in cost was associated with changes in the NRC's safety regulations. Delays in construction increased the financial cost. The cost-plus contract was used to address problems of incomplete information in the design of nonstandardized and ever-larger reactors. Further, no fixed-price contract could anticipate the contingencies associated with changes in NRC regulations.

To encourage cost minimization, as found in competitive markets, the cost-plus relationships between the constructors and the utilities should be replaced with fixed-price contracts. To eliminate problems of incomplete information and regulatory risk, however, fixed-price contracts will require NRC-preapproved standardized designs. Such designs would specify standard structures and equipment and the sequence of building and installation. Without competitive bidding on standard designs, it is unlikely that public utilities commissions will approve the next generation of reactors.

Third, the electric utility generates electricity and sells it at a regulated price that reflects operating expenses, depreciation, and a reasonable rate of return on funds invested in the reactor. That formula has been defended with the assumption that electricity-generating technologies exhibit increasing returns to scale, where larger plants yield lower costs. This characteristic implies that in the long run only one firm will survive in a local market. In return for a monopoly franchise to provide electricity in a local market, the firm submits to local regulation. Unfortunately, regulation has led to distortions in electric utility behavior favoring capital-intensive technologies, such as nuclear power.

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In the late 1960s, however, generating costs began to rise with plant size. Further, after reactors achieved commercial operation and after investments entered the rate base as "used and useful," reactor productivity was less than expected. Prices rose as customers paid the capital charges on fewer kilowatt-hours. Unlike in firms in the competitive sector, profits did not immediately fall with lower productivity because rates were increased to cover losses. By the end of the 1970s, however, the state commissions began to deny rate increases. Instead of stimulating productivity, rate increase denials resulted in cutbacks in reactor maintenance and thereby lowered expected long-run performance.

In response to the end of increasing returns, the Public Utility Regulatory Policies Act of 1978 requires utilities to purchase power from nonutility generators. This stimulates competition and provides benchmarks to evaluate utility performance. To encourage nonutility generators, however, there must be guarantees of access to transmission facilities. In return for those guarantees, the utility must have assurances of nonutility generator reliability.

Another problem with rate regulation is that it suffers from asymmetric information because the firm is more familiar with the business of generating electricity than the regulator. Regulatory resources are used to discover what the utility already knows. A simpler alternative is to use economic incentives to elicit efficient behavior. For example, an incentive to encourage productivity improvements would allow the utility to charge a higher price when the reactor performs above a target level. Consider the incentive-based agreement between Pacific Gas and Electric (PG&E) and the California Public Utilities Commission on Diablo Canyon. Diablo Canyon's construction costs have been removed from PG&E's rate base and are being recovered over a twenty-eight-year period, starting in 1988, under a performance-based pricing program. PG&E pays all expenditures, including capital additions. Under that incentive system, Diablo Canyon broke the world's record in 1991 for the longest period of continuous operation at a nuclear reactor. In so doing, it achieved a capacity factor higher than its target level and was rewarded. Incentive schemes provide an evolutionary move away from the problems created by rate-base regulation. They help distribute the risk of poor management, insulated by regulation, away from ratepayers toward the utility and its investors.

Fourth, the second phase of the operating stage is the safety behavior while generating electricity. Although there has always been the chance of radioactive contamination of both reactor workers and the public, the industry has historically done a good job at containing exposure. More troublesome is the low probability of a high-cost catastrophic accident, for example, one similar to Chernobyl. Early worries over liability for such an accident prompted passage of the Price-Anderson Act in 1957 to "protect the public" and "encourage the development of the atomic energy industry." That act limited compensation to less than a billion dollars and indemnified the reactor manufacturer, the architect-engineer, the general contractor, and the utility.

**The Price-Anderson Act of 1957 provided indemnity coverage to protect the public from the low probability of a high-cost catastrophic nuclear accident and to encourage the development of the atomic energy industry.**

In 1966 indemnity coverage was reduced through increases in private insurance. In 1975 industry self-insurance was introduced with "retrospective premiums"—after an accident each reactor would be assessed a maximum of $5 million. By 1982 there were enough reactors that could contribute retrospective premiums to end government indemnification. In 1988 the liability limit was increased to $7 billion with $160 million from private insurers and payments of up to $63 million from the owner of each reactor (there are 110 reactors). Unfortunately, each reactor would pay the same retrospective premium regardless of safety behavior.

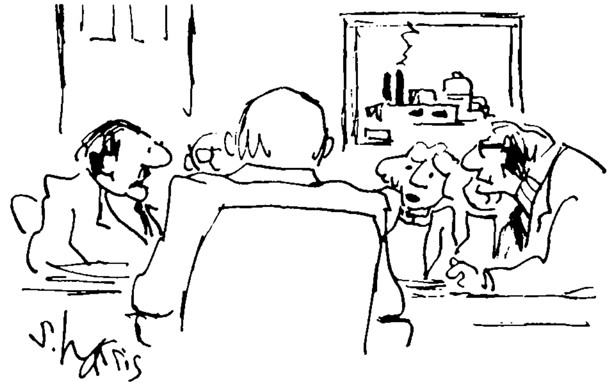
A more efficient solution would have been to assign full liability to those parties and let the insurance market determine the probability of an accident, its consequences, and the proper premiums for coverage. But two problems plague this market: moral hazard and small numbers. Here, moral hazard refers to changes in the insured's behavior that affect the chance of an accident once insurance has been established. If the insurer cannot accurately monitor the insured, there is no guarantee that the insured will take the same level of care expected by the insurer when determining the premium. This problem is partially solved with a deductible so that the insured is not fully insured. With a nuclear accident, the firm's financial losses and loss of reputation play the role of a deductible. For example, although there was little off-site damage, Three Mile Island's owner sustained a substantial loss.

The small-numbers problem remains because there has been little experience with these types of accidents. An insurer will never know the underlying probability of a catastrophic accident. Nor can the insurer anticipate the loss. Therefore, reasonable premiums are difficult to determine. Nevertheless, with information from the private insurance market (the first $160 million) and with an estimate of the probability and cost of a nuclear accident, Jeffrey Dubin and I calculated that the annual premium for the average reactor for losses above $7 billion (the current liability limit) should be $22 million. Under current law the $22 million per reactor year is an implicit subsidy to the nuclear industry that will not be realized until a catastrophic nuclear accident occurs. This subsidy should end with the repeal of the liability limit. With repeal, given the nuclear industry's maturity, the industry is likely to organize some form of self-insurance with risk-based premiums.

In exchange for Price-Anderson protection, the industry has been subjected to the AEC's and NRC's safety regulation. The NRC's prescription-based regulations that govern reactor construction, maintenance, and operation do not appear to work. NRC regulations can conflict with one another, and the cost of their implementation can be greater than their benefit. Until market mechanisms can assure reactor safety, the NRC should define safety standards and allow utilities to meet them in a cost-effective manner.

The last stage in the reactor's life cycle is decommissioning and waste disposal. The primary market failure here arises from the negative externality from radioactive waste. There is an externality because this waste affects both its producer and persons who may be exposed to its radioactivity. Without well-defined property rights, negative externalities can lead to overproduction. To address this problem there can be an assignment of property rights to either the firm or the public. If the costs of negotiating an agreement between the firm and the public (transaction costs) are negligible, according to Coase's theorem, the parties will bargain to an efficient outcome, whatever the initial assignment of property rights. Of course, negotiations can be costly. Further, the equity implications in all property-rights assignments involve political and strategic activities.

Negative externalities are particularly acute for radioactive waste. There are two types of radioactive waste: low-level waste, including contaminated clothing, and high-level waste, including spent nuclear fuel and the reactor core. The differences between these are the toxicity of the waste and the period during which it is toxic. The radioactivity in most (more than 90 percent of) low-level waste will decay to acceptable levels within 100 years. The radioactivity of spent fuel will not decay to acceptable levels for 100,000 years. Although 100 years is a long time, contracts between producers and disposers are possible. The disposal of low-level waste has been assigned to regional compacts. For example, the southwestern compact includes Arizona, California, North Dakota, and South Dakota, with California as the host state. (A site outside Needles, California, is being considered.) Property rights to an environment free of low-level radiation have been assigned to the public. Producers must pay for disposal. They, therefore, include this cost in their business decisions.



"BUT WHAT IF WE PASS THE 30% SAVING ON ELECTRICITY ON TO THE CONSUMER, AND THEN THE NUCLEAR POWER PLANT BLOWS UP?"

Because high-level waste creates a negative externality for future generations, markets are an imperfect guide to the efficient allocation of resources. Throughout the history of the nuclear industry, the federal government has accepted the responsibility for long-term disposal. In 1982 Congress passed the Nuclear Waste Policy Act. That act mandated the opening of a long-term disposal site by 1998, at which time the federal government would assume ownership of the spent nuclear fuel. To finance construction of the site, the act established a Nuclear Waste Fund with a one mill ($.001) charge to customers for each net kilowatt-hour of electricity.

**In exchange for Price-Anderson protection, the industry has been subjected to safety regulation by the Atomic Energy Commission and the Nuclear Regulatory Commission. The NRC's prescription-based regulations that govern reactor construction, maintenance, and operation do not appear to work.**

In effect, the property rights to generate high-level waste have been assigned to the nuclear utilities. The public, through the federal government and through their electric bills, is paying for long-term disposal. Although utilities hold those rights, they are politically vulnerable. For example, California has adopted legislation limiting new reactors there until "there exists a demonstrated technology or means for the disposal of high-level nuclear waste." To decrease their vulnerability, utilities should take a more active role in short- and medium-term storage technology development and facilities construction.

## Comparative Nuclear Costs

With those market failures and regulatory responses, can nuclear power compete with other forms of central-station electricity generation? Many authors have estimated future nuclear plant costs. Almost everyone agrees on the forecasting methodology: project spending on structures and equipment during the construction period; project operation and maintenance costs during the plant's lifetime; project fuel costs during each period of operation and waste storage after operation; project kilowatt-hours (kWh) of generation in each period; discount all costs and kWh to the present and divide discounted costs by discounted kWh. This gives a levelized value in constant, real mills per kWh. If each kWh were sold for that price during the plant's lifetime, discounted costs would equal discounted benefits. Unfortunately, following this forecasting method leads to disagreement.

**Given the market failures in the nuclear power industry and the regulatory responses to them, forecasters have found that nuclear power will be economically viable only if the nuclear industry and its regulations change.**

For example, to project construction spending, forecasters must determine the length of the construction period, the total real cost of structures and equipment, the escalation rate of each type of real cost, the spending during each period, and the utility's cost of capital. With these assumptions, the construction cost and the opportunity cost of capital during construction (interest during construction) can be calculated. There are several ways to estimate each of these parameters: through engineering models of the construction process; through statistical studies; or through case studies of completed plants or of orders for plants. Similarly, estimates must be made for the discount rate, the real operation and maintenance and fuel costs, the rates of inflation, and the lifetime generation. Therefore, many results are possible.

Representative forecasts are available from the Organization for Economic Cooperation and Development. Assumptions for the United States have been supplied by the Energy Information Administration (EIA). The EIA has assumed: a construction time of ten years for a 1,200-megawatt (MW) pressurized water reactor and four-and-a-half years for two 600-MW coal-fired power plants with flue-gas desulphurization (scrubbers); 65 percent load factors (the ratio of realized to potential output) for both technologies; thirty-year lifetimes; and a 5 percent real discount rate. Nuclear capital costs include the discounted cost of decommissioning. Nuclear fuel costs include the one mill charge for waste disposal. Also, because of differences in weather and delivered coal prices, forecasts were made for three regions: eastern, central, and mountain. Also, for the central region, a "best" case was developed by assuming a construction time of 7.8 years for the pressurized water reactor. The results appear in Table 1.

Nuclear power is competitive with coal only under the "best" case, where the ratio of coal and nuclear costs is almost one. More recent cost estimates based on reactor manufacturer assumptions favorably compare nuclear reactors with combined-cycle turbines burning natural gas. The manufacturers assume: the cost of structures and equipment (direct costs) for new reactors will be equal to the direct costs of the cheapest of the large reactors finished in the late 1970s and 1980s; standardization and modular construction will reduce the cost of engineering and construction services; construction times will be as short as the shortest times in the 1970s, six to seven years; reactors will be operated

**Table 1: Nuclear and Coal-Fired Costs of Producing Electricity**

| | Nuclear Cost per kWh | | | | Coal-Fired Cost per kWh | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Region | Capital | Operation & Maintenance | Fuel | Total | Capital | Operation & Maintenance | Fuel | Total | Ratio |
| Eastern | 47.9 | 6.1 | 7.1 | 61.1 | 21.7 | 4.4 | 28.8 | 54.9 | .89 |
| Central | 47.6 | 6.6 | 7.1 | 61.3 | 21.4 | 5.2 | 17.8 | 44.4 | .72 |
| "Best" | 31.3 | 6.6 | 7.1 | 45.0 | 21.4 | 5.2 | 17.8 | 44.4 | .99 |
| Mountain | 46.4 | 6.3 | 7.1 | 59.8 | 21.1 | 4.2 | 15.3 | 40.6 | .68 |

on two-year fuel cycles with 80 percent capacity factors; and operation and maintenance costs will be slightly lower than those average costs in the mid-1980s. Under these assumptions, nuclear power costs 45 mills in 1991 dollars. That is the same cost as natural gas and is lower than the cost of clean coal. (But these comparisons do not include the implicit subsidies to the energy industries.) The implication of these forecasts is that nuclear power will be economically viable only if the nuclear industry and its regulations change.

### Reforming Nuclear Regulation

The Bush administration hopes to revive the nuclear industry through its 1991 *National Energy Strategy,* which proposes three measures to address the high cost of nuclear electricity. First, develop new, passively safe reactor designs. Second, reform the nuclear power licensing process. Third, properly manage and dispose of high-level nuclear waste. I quote from the strategy's executive summary and discuss each measure in turn.

**Develop New, Passively Safe Designs.** The Department of Energy is working toward Nuclear Regulatory Commission certification for two "next generation" light water reactors (with simplified designs and better engineered safety systems) and two more advanced light water reactors (incorporating the concept of "passive safety") by 1995.

Two firms are developing advanced light water reactors: General Electric (advanced boiling water reactor) and Combustion Engineering (System 80 Plus). Each of these designs is based on experience with the current generation of reactors. GE developed its advanced boiling water reactor with the Japanese (Hitachi and Toshiba) and is now building two of these reactors for Tokyo Electric Company. They should be operating by the late 1990s. Combustion Engineering is basing the System 80 Plus on its three pressurized water reactors at Palo Verde, Arizona. The NRC hopes to certify these as standard designs in the early 1990s.

To address safety concerns, passively safe reactors are being developed. Passively safe reactors rely on passive means, such as gravity, to control the reactor. For example, Westinghouse's AP600 (advanced passive-600 MWe) reactor stores hundreds of thousands of gallons of water above the reactor that can be injected without pumps in an emergency. GE is designing its simplified boiling water reactor so that no operator intervention is required for three days after a loss-of-cooling-water accident. The NRC hopes to certify these as standard designs by the 1995.

Funding for reactor development has been available from DOE's light water reactor and advanced reactor R&D programs through DOE laboratory facilities and from the Electric Power Research Institute (EPRI), acting on behalf of the utilities. In the 1980s DOE appropriations for nuclear power were approximately $100 million per year. Advanced reactor development and demonstration will require an additional $3 to $4 billion during the 1990s. There is no market-failure reason for the federal government to fund or direct this research. EPRI, as the electric utilities' research institute, is in a much better position to coordinate those efforts. Therefore, the federal government should not fund further reactor development.

**Reform the Nuclear Power Licensing Process.** The licensing process for new nuclear power plants must be reformed by legislation to provide for early resolution of technical and institutional issues such as emergency planning prior to construction. The duration of and uncertainty associated with the postconstruction hearing must be reduced while improving the public's opportunity to address valid safety questions during the licensing process.

This measure is based on attempts throughout the 1980s to reform reactor licensing. Those reforms have included preapproval of standardized reactor designs, preapproval of reactor sites, and combination construction permits and operating licenses. "Essentially complete" standardized designs (plans detailing the entire construction process) and reactor

**To address the high cost of nuclear electricity the Bush administration proposes developing new, passively safe reactor designs, reforming the nuclear power licensing process, and properly managing and disposing of high-level radioactive waste.**

sites could be licensed without reference to a specific construction project. Those designs and sites could be incorporated by reference into an application for a construction permit for up to ten years from the date of approval (with provisions for renewal for an additional ten years).

In contrast to the involved process of obtaining an operating permit under current regulations, that reform allows a combined construction permit and operating license "if the application contains sufficient information." The combination license would include procedures for determining whether the reactor was built to specification. To ensure stability severe limits would be placed on challenges to reactor operation once the NRC had approved the combined license. Hearings would be limited to only those issues that could not be resolved at the time of license approval and that could adversely affect the safe operation of the plant.

Throughout the 1980s the NRC contended that it had the authority to implement those proposals. The NRC issued its standardization and licensing reform rule in April 1989. Before approval was given, the U.S. Appeals Court for the District of Columbia in November 1990 struck down the provision for a combined construction permit and operating license. Therefore, the *National Energy Strategy* seeks legislation to affirm the NRC rule. But issuing a combination license creates a moral-hazard problem *until* the standardized designs have been built and tests can be developed to ensure that a plant meets the design criteria.

**Properly Manage and Dispose of High-Level Nuclear Waste.** All Federal agencies must fully support the DOE's efforts under current law to site and license a permanent waste repository and a monitored retrievable storage facility. Federal agencies also must assist the Nuclear Waste Negotiator's efforts to identify potential hosts for these facilities. In addition, Federal legislation should be enacted that, while preserving existing due-process and regulatory requirements, will ensure that the Nation's need for facilities to isolate high-level waste is met in a timely manner.

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In 1987, to reduce federal spending on exploring the geology of long-term storage sites, Sen. J. Bennett Johnston introduced legislation to limit exploration to one site. The conference committee adopted provisions constraining the DOE from selecting a site that lay below an aquifer. The only site that qualified was Yucca Mountain, Nevada. Further, as a compromise to legislators from states that were candidates for monitored retrievable storage facilities (for example, Tennessee), the committee adopted an earlier amendment to revoke proposed sites for such facilities and to appoint a three-member commission to investigate the need for medium-term storage. When passed in December 1987, those changes to the Nuclear Waste Policy Act became the Nuclear Waste Policy Amendments Act of 1987. That act linked the construction and operation of monitored retrievable storage facilities to the licensing and construction schedule of the long-term repository and directed the review commission to compare spent nuclear fuel disposal systems with and without a monitored retrievable storage facility. The review commission found that a monitored retrievable storage facility "linked as provided in current law would not be justified, especially in light of uncertainties in the completion time for the repository."

Attempts to license the construction of a repository at Yucca Mountain have been blocked by the elected officials of Nevada. Nevada's governor has rejected DOE applications for permits to conduct tests at Yucca Mountain. Frustrated, the DOE has put off opening a repository until 2010 and has proposed to open a monitored retrievable storage facility by 1998.

In response to Nevada's delaying tactics, the DOE seeks legislation to force Nevada to issue permits. S. 1138 was introduced in the 102nd Congress to limit Nevada's right to issue permits, to unlink the construction of a monitored retrievable storage facility with the issuance of a construction permit for the repository, and to select Yucca Mountain as a site for a monitored retrievable storage facility. The Senate Energy and Natural Resources Committee approved S. 1138 in June 1991. The Energy and Power Subcommittee of the House Energy and Commerce Committee approved similar legislation in September 1991.

Because of the perceived negative externality associated with high-level radioactive waste storage, finding sites will continue to be difficult. The construction of a monitored retrievable storage facility should not depend on repository development. By delinking medium- and long-term storage, more solutions to the spent-fuel waste problem will become available. For example, some reactor sites could be economically viable locations of those storage facilities. Using those sites would reduce exposure to transportation personnel and the public and would use the infrastructure already available at operating reactors. The storage facility could be decommissioned with the reactors at those sites. At that time, a repository might be available.

### Legislative Priorities

The *National Energy Strategy* is bogged down in Congress. Soon after its introduction on February 20, 1991, implementations of the administration's proposals were introduced. In the Senate they became S. 1220, an omnibus bill by Sen. Johnston, chair of the Senate Energy and National Resources Committee. In the House Rep. Philip Sharp, chair of the Energy and Power Subcommittee of the House Energy and Commerce Committee, introduced H.R. 776, H.R. 777, H.R. 778, H.R. 779, and H.R. 780. Although Johnston and Sharp have tried to shepherd this legislation through Congress, it is unlikely that the omnibus approach will work because President Bush has refused to sign any omnibus bill that does not include Alaskan oil drilling liberalization, a provision that neither body of Congress is willing to approve. Therefore, if nuclear regulatory reform is to succeed in the 102nd Congress, politically viable nuclear reform legislation should be reintroduced.

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Congress should focus on the three issues identified in the *National Energy Strategy:* technology, licensing, and waste. Although a first-best world would involve a complete restructuring of the nuclear industry with much more reliance on market and marketlike mechanisms, it is unlikely that such restructuring will occur through congressional action. Given these limitations, some reforms should be enacted.

To provide for competitive bidding in reactor construction, standardized designs should be certified. Title VIII of S. 1220, "Advanced Nuclear Reactor Commercialization," directs the secretary of energy to carry out a program to encourage the deployment of advanced reactor technologies that are cost-effective, use modular construction, use a standardized design, exhibit enhanced safety features, and discourage the proliferation of radioactive materials for nuclear weapons. That program is to be carried out "to the maximum extent possible through cost-shared programs with the private sector." Its goals are to complete R&D and submit advanced light water reactor technologies for certification by 1995.

The title also calls for the selection of one or two advanced non-light water reactor technologies for demonstration by 1996. Section 8105 requires that private contributions "be not less than 50 per centum of the costs of such demonstration." The federal government should refrain from funding those demonstrations. Instead, to encourage marketable designs, the electric utility industry should fund demonstrations if designs look promising. Section 8105 should be reworded to eliminate federal financial support.

In S. 1220 Title IX, "Nuclear Reactor Licensing Act of 1991," calls for the NRC to "issue to the applicant a combined construction and operating license if the application contains sufficient information." This legislation is not immediately necessary. Until the standard designs have been built, the NRC cannot identify the tests and analyses to provide reasonable assurance that a reactor conforms to its license. Congress should reconsider combined construction permit and operating license legislation when standardized reactors are ready to be replicated.

The most important issue is that of high-level radioactive waste. The Nuclear Waste Policy Amendments Act provisions that linked medium-term storage construction to the long-term repository should be repealed. The nuclear waste negotiator should create a market in monitored retrievable storage sites. Through this market communities or corporations, working with state governments, could bid on the provision of such a site. That would

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allow the electric utilities to participate in interim waste management.

Future legislation should consider other issues. The Price-Anderson liability limit should be repealed before new reactors are constructed. The NRC should be directed to regulate by standards, not by directives. State regulatory commissions should encourage nonutility generation and implement performance-based pricing for rate-regulated utility generators.

Under the current regulatory structure, nuclear power cannot survive. Its viability should be determined by its economics, not by administrators and politicians. Regulation should be peeled away to allow assessment of its true costs. If nuclear power cannot compete, however, it should not be subsidized. Let the best energy win.

**Selected Readings**

Dubin, J. and Rothwell, G. "Subsidy to Nuclear Power through the Price-Anderson Liability Limit." *Contemporary Policy Issues*, Vol. 8 (1990).

Nichols, E. and Wildavsky, A. "Nuclear Power Regulation: Seeking Safety, Doing Harm?" *Regulation*, Vol. 11 (1987).

Organization for Economic Cooperation and Development. *Projected Costs of Generating Electricity from Nuclear and Coal-Fired Power Stations for Commissioning in 1995.* Paris: 1986.