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Recent Developments Affecting State Regulation of Nuclear Power

by Peter A. Bradford

In recent months, state legislators and regulators have begun to consider applications to build new nuclear power plants, a possibility unseen since the 1970s. No orders for a new unit in the U.S. have been finalized, but the Nuclear Regulatory Commission (NRC) has received four site-specific applications and anticipates another sixteen for new units (encompassing altogether some 31 power plants with a total capacity of 40 GW) by the end of 2009.[1] Three early site approvals have been granted. These do not permit construction, but they remain valid for twenty years while the permit holder decides whether to go forward with a specific design. In addition, the NRC has approved four reactor designs for future construction and has others under advanced review.

The Energy Policy Act of 2005 contained substantial incentives for new reactor construction. These have been augmented by a 2007 provision extending $18.5 billion in federal loan guarantees for new nuclear power plants in 2008-09. Because new nuclear units remain uneconomic without these incentives and because the incentives are enough for just a few plants, many of the pending NRC applications will not result in new plants unless further incentives are enacted. Consequently, some states now face requests for rapid regulatory and/or legislative action driven by desire to secure a place in the queue for the limited federal incentives.

The potential rate impacts of the new plants are substantial. A 2007 Keystone fact-finding report estimated the cost of a new nuclear unit at $3600-$4000 per kW ($3.5- $4 billion per 1000 MW, or 8.3-11.1¢/kWh). In October, 2007, a Moody's analysis upped this estimate to $5000-$6000 per kW. In early 2008, Florida utilities submitted testimony containing nonbinding estimates that are potentially higher still. These estimates of capital costs remain well above the projected total costs of new coal plants and toward the upper end of projected price ranges for the output of gas-fired plants. Most of the interest in building nuclear plants to meet projections of load growth and retirement of older units makes economic sense only in a world likely to be committed to very large reductions of greenhouse gas emissions, and then only if other low-carbon energy sources cannot do the job at lower cost and with less risk.

This *Issuesletter* sets forth some of the challenges that new nuclear units will pose for state regulators, as well as some possible solutions.

Background

The U.S. nuclear power industry has been through a unique 50-year economic trajectory in which hundreds of billions of dollars were paid by customers (and sometimes investors) to cover construction cost overruns, plant cancellations, and expensive operating experi-

ence. According to *Forbes Magazine* in 1985, "The failure of the U.S. nuclear power program ranks as the largest managerial disaster in business history, a disaster on a monumental scale." No single issue – not even electric industry restructuring – has caused so much turmoil for state utility regulators.

The immense economic losses have often been attributed to an ill-conceived nuclear licensing process, to erratic state and federal regulation, to overindulgence of intervenors, and to public fears fanned by the 1979 accident at Three Mile Island. Remedies for these problems having now been put in place, regulators are being assured that future nuclear construction should go more smoothly and predictably.

But if the real causes of nuclear power's past cost overruns differ from those that have been addressed, then neither investors nor regulators can be sure that the cost of new nuclear units can be forecast with confidence. Since those costs seem already to be above the cost of conventional alternatives (see Figure 1), methods will have to be found to protect customers and taxpayers from this uncertainty.

Figure 1:
Relative per kWh costs of new nuclear, coal, and gas, from 2003 MIT study "The Future of Nuclear Power." More recent estimates for these technologies are considerably higher, as a consequence of rising fuel, construction, and environmental compliance costs.

Base Case	25 Year	40 Year
Nuclear	7.0¢	6.7¢
Coal	4.4¢	4.2¢
Gas (low, $3.77MMBtu, levelized over 40 years)	3.8¢	3.8¢
Gas (moderate, $4.42 MMBtu)	4.1¢	4.1¢
Gas (high, $6.72 MMBtu)	5.3¢	5.6¢
Gas (high w/ 10% heat rate improvement)	4.9¢	5.1¢

The Role of Nuclear Licensing and Regulation in Causing Delays and Cost Overruns

The nuclear licensing process of the 1960s and '70s issued some 230 construction permits – more than the rest of the world combined during those years – though only half of the plants were actually built. No application was ever rejected. Because plant construction continued while the hearings went on, only two plants were actually delayed by hearings, and those two (Shoreham and Seabrook) came long after applications to build new plants had ceased to be filed.

Nor were many nuclear plant cost overruns the result of unnecessary rule changes and back-fitting requirements by the NRC.

Rather, the U.S. nuclear industry grew too fast for its own good. In 1968, the average plant under construction was four times larger than the largest plant in operation, and ten times more nuclear capacity was being built than was in operation. Immense financial commitments were made to reactor designs for which little or no operating experience existed. When – as happened with some frequency – events showed that safety margins were smaller than regulators had believed, modifications were needed to assure that the required levels of safety were being met. The safety goals were consistent, but the regulations necessary to attain them changed in response to the performance of the technology. The 1971 discovery of shortcomings in emergency core cooling system designs and the 1975 fire that destroyed the safety cables at Brown's Ferry were two examples. Others included fuel cladding failures and pipe cracking. The 1979 accident at Three Mile Island was the most dramatic example, but many plant cancellations and cost overruns predated that accident.

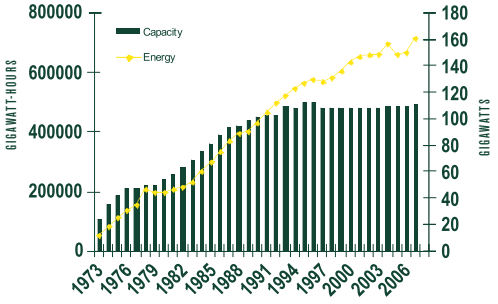
Nuclear Power in Current Power Markets

In the mid-1990s, restructuring seemed likely to accelerate the decline of nuclear power in the U.S. As competition and low natural gas prices lowered wholesale power prices, several nuclear units across the country closed. Others were expected to follow.

Instead, the 21st century – with the turnaround in power market prices – has been favorable for existing U.S. nuclear power plants. No more nuclear plants have closed.

The NRC has extended the licensed lives of nearly half of the nation's 104 units by 20 years and seems likely to do so for almost all of the rest. In addition, the NRC has approved capacity increases totaling of more than 5,200 MW (about the equivalent of five more plants) at the existing nuclear units and expects to decide on another 2,830 MW by the end of 2013. Despite the absence of new plants, nuclear power's share of U.S. electric generation has held steady at about 20% for more than a decade, thanks to the increases in plant output depicted in Figure 2. This is largely because the industry has succeeded in increasing power output from about 65% of power plant capacity to 90% over the last 20 years.

Figure 2:
U.S. Nuclear Power Plant Capacity and Output 1973-2007



Many existing units have been immensely profitable. The forthcoming end of many relatively inexpensive long-term contracts (which expire on the end date to the original licenses) will free up thousands of additional megawatts to charge market prices.

With natural gas prices remaining high, with power markets developing new ways to reward available generating capacity, and with a likelihood of further price increases due to the implementation of greenhouse gas emissions reduction rules, the business picture for the *existing* nuclear units now seems very bright, although the likely price increases will have a depressing effect on demand,

The favorable economics of the existing units have not translated into investor enthusiasm for building new plants and for good reason. In restructured markets, nuclear plants needed only recover 2-3¢/kWh because restructuring decisions in the 1990s treated the rest of their costs as "strandable" and passed them through to customers as "non-bypassable" surcharges.

In all markets – restructured or not - new nuclear plants will have to recover at least 8¢/kWh (and perhaps twice as much) to cover total construction and operating costs. Too much uncertainty surrounds the building and operating of new units (to say nothing of the cost of alternatives and the realistic potential of energy efficiency) for investors to be confident that this will occur.

This uncertainty as to recovery of very large costs explains the industry's insistence on federal measures that shift risk from investors to taxpayers and on state provisions that shift risks from investors to customers. Many of the industry's legislative initiatives seek to undo the lessons learned from the nation's last experience with nuclear plant construction, when regulators increasingly resisted efforts to shift construction management risk away from investors, who showed and continue to

show themselves unwilling to shoulder it.

Thus, the recent federal legislation offering some $18.5 billion in loan guarantees for new nuclear units shifts risks from lenders to taxpayers. The federal production tax credit of 1.8¢/kWh for the first 6,000 MW of new nuclear power shifts costs to taxpayers outright by reducing tax payments from plant owners. State laws eliminating any requirement that investment in canceled plants meet a "used and useful" standard and putting nuclear costs into rate base before plant completion and offering less effective prudence reviews shift risks from investors directly to customers.

Some Regulatory Challenges and Options

1. Should new nuclear plants have to go through competitive bidding and/or integrated resource planning (IRP)?

The short answer is "yes."

U.S. experience with competitive power supply procurement over the last 25 years has been almost entirely successful. We have maintained superior economic growth without facing shortages of generation. At the same time, we have significantly diversified our energy generating technologies and improved the efficiency of existing plants. Indeed, nuclear power plants have led the way in efficiency improvement since the early 1990s, when they were first confronted by the incentives and the challenges presented by potential competition.

Reversing this history to would be shortsighted indeed. If nuclear construction is to make a comeback, it should do so in the context of the improved regulatory practices of the 21st century rather than by shifting the financial risks back to those least able to evaluate and to manage them.

2. What are the pros and cons of allowing construction work in progress (CWIP) to be charged to customers before a new plant comes into service?

The historic method of financing utility plant construction in the U.S. has been for the utility to raise the necessary funds to build the plant and then to recover those funds, including a return on them, once the plant goes into operation. At that time, the utility also recovers the borrowing costs associated with those funds. This is the approach embodied in the legal requirements in many states that customers only pay for property that is "used and useful" in serving them.

Because nuclear plants are uniquely expensive to build and because of the uncertainties that accompany the long construction times, companies building such plants often seek to charge some form of CWIP to customers before the plant goes into operation. They argue that this practice – by reducing the amount that they will need to raise from the capital markets – will reduce both the amount of money and the cost of money that will ultimately need to be repaid, thereby lowering the cost of the plant itself. In some cases, where the builder has come under extreme financial stress, it has also been argued that CWIP was needed to avert bankruptcy.

CWIP (which is not a possibility in competitive power markets because recovery is based entirely on output) does offer the prospect of decreased "rate shock" in jurisdictions that follow traditional rate base regulation. By having customers bear some of the costs before the plant comes online, the amount of new rate base added in a single year is reduced.

However, CWIP should not be seen as providing real savings in the sense that reduced concrete or labor costs do. Instead, risks and burdens are shifted from investors to customers as the customers replace investors and

bankers as the suppliers of the capital needed to build the plant. If, for example, a plant on which CWIP has been collected is cancelled after billions have been spent on construction (as happened in the 1980s), the customers are unlikely to get their money back.

The cost to society as a whole of the new units is not reduced. Indeed, given that investors and owners are far better able to monitor and manage risk than customers or taxpayers (and given the Department of Energy's woeful experience in managing loan guarantees), the societal costs may well increase when risk is transferred to entities less able to manage and reduce it.

Regulators allowing CWIP to be charged to customers are taking on a responsibility to be no less vigilant about the security of these sums than would investment bankers be if the money were coming from conventional sources. Consequently, they may want to consider applying private sector techniques of due diligence oversight as well as a cap on the total recoverable cost of plant, as discussed further below. In addition, all of the measures that transfer risk from investors to customers should be reflected in a lower cost of capital. Otherwise, investors and lenders will be compensated for the risks that customers are bearing.

3. What are the pros and cons of "rolling prudence reviews" by regulators to determine the recoverability of investment in nuclear power plants under construction?

Potential builders of new nuclear units have proposed a concept that they term "rolling" or "contemporaneous" prudence reviews to reassure investors in new units that the costs will ultimately be recovered from customers. In essence, rolling prudence reviews require regulators to assess the prudence of expenditures at periodic intervals during construction. If no imprudence is discovered, then those amounts are assured of recovery when the plant comes on line. Some states provide for a limited further review in the event of a showing along the lines of fraud, deceit, or the emergence of information that could not have been discovered at an earlier date. Others prohibit later review under any circumstances.

This concept is designed to avoid a repeat of the dozen or so cases in the 1970s and 1980s in which regulators disallowed hundreds of millions of dollars for imprudence when plants vastly exceeded their cost estimates. But – far from uncovering and deterring all imprudence – this new approach is more likely to tie the hands of regulators by the time certain kinds of imprudence become obvious. This is because rolling prudence reviews are not really prudence reviews; they are expenditure reviews.

The prudence reviews of the 1970s and 1980s occurred when significant cost overruns and price impacts were already obvious. The cost overruns guided the prudence reviews to clearly defined problem areas giving rise to the cost overruns, thereby enabling the limited resources of the state regulators to be spent where they would do the most good. When plants came on line close to schedule and budget, major prudence reviews were rarely undertaken. The reviews themselves were not based on hindsight, but hindsight did usefully illuminate places to look for imprudence.

In nuclear construction, significant flaws can lie undiscovered for years, only to emerge in ways that require the expenditure of hundreds of millions of dollars well in the future. The quality assurance problems that cancelled Zimmer (Ohio), the reversed blueprints that necessitated the relocation of a great deal of seismic equipment at Diablo Canyon (California), and the sinking building that led to cancellation of Midland (Michigan) were each

the result of miscalculations that went undiscovered for many years. These are not isolated examples.

Regulators engaging in rolling prudence reviews at any of these sites would have had no basis to disallow the expenditures as they were made. Years later, in order to reopen these decisions under the standards of the current rolling prudence laws (if indeed they could do so at all), regulators would have to prove fraud or that they could not have discovered the imprudence sooner. Both are difficult standards and would transform the fundamental regulatory principle that the customers should never pay for imprudently incurred costs into something more like "customers should pay for imprudently incurred costs if the regulator fails to detect them within a few months of their being incurred." Thus these necessarily limited reviews shift substantial risk to customers.

4. Should regulators limit the amount chargeable to customers for a new nuclear power plant at the time that they approve construction – or in reviewing requests for CWIP or rolling prudence approvals?

Perhaps the most important overall lesson from past U.S. experience with nuclear construction is the need to avoid commitments to costs that are open-ended and unlimited. Investors have proven unwilling to shoulder such exposure. Regulators should be clear as to the limits on the amounts that can be charged to the customers, and those limits should not exceed the costs of the next best alternatives.

For large industrial facilities such as paper mills or oil refineries (or for power plants built in regions where cost recovery comes through power markets), prices cannot be raised to cover cost overruns, so a de facto cap on the recoverable amount is established by the market price. Investment capital is forthcoming, but it depends on confidence that the output of the new plant can be sold profitably at prevailing market prices.

Both competitive bidding and IRP processes provide the information necessary to base a cap on the price of the next best alternative, information that was largely lacking in the 1970s. Such a cap can be flexible, to allow for one or more increases in the case of unforeseeable events that increase the costs of all alternatives. However, such a cap would have the effect of putting power plant builders in non-power market jurisdictions on notice that there is a presumptive limit that cannot be exceeded without investors bearing the costs. Such a measure would seem especially important in any jurisdiction that exposes its customers to the risks posed by CWIP or rolling prudence.

In the 1980s, a few states put a cap on the amount that could be recovered from customers for particular nuclear units. At Nine Mile II in New York and at Limerick II in Pennsylvania, utilities were given an amount above which costs would fall on the investors. California regulators applied a performance-based plan to Diablo Ccanyon instead of putting the units in rate base. Each of these approaches limited customer exposure while providing enhanced incentive to control costs.

More recently, Areva accepted a cap on the amount that could be charged to customers in Finland where it has been building the first of its European Pressurized Water Reactors since 2005. That plant is well behind schedule and over budget, but Finnish customers are protected from the rate impacts, a result that U.S. regulators may also want to achieve.

Other safeguards might include constraining preapprovals of new nuclear preconstruction costs narrowly, to avoid open-ended commitments to large payments for long lead time

items that must be manufactured abroad, with substantial exposure to declines in the value of the dollar. Another area worthy of particular scrutiny is proposals to commit to building two units within a short time of each other. Economies of scale are, of course, possible, but some of the worst cost overruns in the 1970s and 1980s occurred at sites – Seabrook, Millstone, Indian Point, Marble Hill, Grand Gulf, South Texas, Vogtle to name just a few - where the challenges of managing additional construction far outweighed the apparent savings from building both units in the same time frame.

5. Are new nuclear units essential to maintaining an adequate electric power supply as concerns about climate change require reductions in carbon emissions?

There is no way to know the answer at this time, which – in light of nuclear power's very high costs and other difficulties – is reason enough to proceed with caution, allowing a few plants to prove themselves in licensing, construction, and some operation before seeking a larger expansion, especially one based on extensive subsidy of one favored technology.

The economics of new nuclear units certainly improve relative to coal and natural gas if a price of some kind is put on the emission of greenhouse gases. But this is also true of all other low- or zero-carbon sources, including energy efficiency and many forms of renewable energy, as well as potential carbon capture and storage.

Because nuclear power is not only expensive but is increasing in cost at a dramatic rate, techniques such as competitive procurement, creative use of cost caps, and integrated resource planning for protecting customers should take precedence over regulatory or legislative efforts to pick a particular technology.

In the 1970s arguments similar to those arising today from climate change were made to the effect that only nuclear power could reduce U.S. electric sector oil demand, then above 20%. But even though nuclear construction came to an end, oil now accounts for less than 3% of U.S. power generation.

Combinations of natural gas and energy efficiency did the work that policy makers had thought could only be done by nuclear power, and they did it at much lower cost. Indeed, electric restructuring was stimulated in considerable part by the fact that the new gas technologies and supplies promised to deliver electricity at less cost than the existing nuclear units, creating apparent opportunities for customers to save money by switching to new generating companies that did not have nuclear plants in their portfolio.

In summary, nuclear power's low carbon content is (or might be) an attractive feature in a world increasingly concerned about climate change. But the cost of new nuclear units is only beginning to become clear, and they are much higher than the industry estimates of a few years ago. Regulators will need to be sure that nuclear proposals are thoroughly and evenhandedly compared to all alternatives and that mechanisms are adopted to protect customers from the types of unpleasant surprises that history has shown to accompany this problematic technology.

Peter Bradford has written and consulted extensively on energy and regulatory issues. He was a member of the Nuclear Regulatory Commission and was also chair of both the Maine Public Utilities Commission and the New York Public Service Commission.

1 http://www.nrc.gov/reactors/new-reactor-licensing.html

The Regulatory Assistance Project
50 State Street, Suite 3
Montpelier, VT 05602

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VERMONT
50 State Street, Suite 3
Montpelier, Vermont 05602
Tel (802)233-8199 Fax (802)223-8172

MAINE
PO Box 507, 110B Water Street
Hallowell, Maine 04347
Tel (207)623-8393 Fax (207)623-8369

NEW MEXICO
27 Penny Lane
Cedar Crest, New Mexico 87008
Tel (505)286-4486 Fax: (773)347-1512

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