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Competition: The Essential Element for Future Nuclear Success

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In the United States today, a common question is: "Will the nuclear generating business survive competition?" I propose that the question be turned around: "Will the nuclear generating business in the USA survive *without* competition?"

The future for nuclear electricity generation in the USA will fundamentally be a competition between technologies: nuclear versus fossil. Nuclear needs the opportunity for success provided by a competitive environment to ensure its place in the future. This conclusion is based on three points:

- Historically, the economic regulatory environment has negatively influenced the design and operating performance of nuclear plants, and the nuclear safety regulatory environment.
- Competition has time and again been shown to provide the best overall method for improvement.
- Competition is inevitable, and reliance on other mechanisms such as public policy will provide at best short lived support.

Each of these points will be discussed in turn. Before proceeding, I will first touch on three topics: what is meant by future nuclear success?; financial risk and financial reward; and rate regulation.

By "future nuclear success" I mean purely and simply investment in new nuclear generating capacity with the expectation of an appropriate return on that investment. This is most conspicuous as, but is not restricted to, orders for new nuclear power plants. Other examples would include the purchase of existing capacity by new investors.

Financial risk can be defined as the likelihood that investors lose some or all of their invested principal. Financial reward is considered to be the profits or return on investment that an investor may expect or receive. The relation between financial risk and financial reward is fundamental. Investors expect a greater opportunity for reward when they assume greater risk. There is nothing fundamentally right or wrong with high or low financial risk as long as there is the opportunity for matching financial reward. In a free market, businesses engage in a continuous effort to improve their reward and reduce their risk, with investors taking their money to the businesses that provide the best combination of risk and reward.

Rate regulation has been used as an alternative to market pricing for electricity utilities for nearly a century. In exchange for exclusive rights to a service franchise, utilities have agreed to have their rates (electricity prices) set by an economic regulator. In the USA this regulator is a state public utility commission (PUC). The PUCs set rates using a formula that includes the costs of providing the service and a rate of return on the investment in assets associated with providing the service.

Determining the reasonable costs, assets, and rate of return becomes a key part of the business. Rates are adjusted periodically through "rate cases", based on changes in any of the components in the rate formula. New assets are brought into the rate formula if they can be shown to be "used and useful". Continued recovery of costs and return on investment depends upon the continued prudent management of the business. Failure to be prudent may result in a penalty in a rate case.

For a business such as an electricity utility that

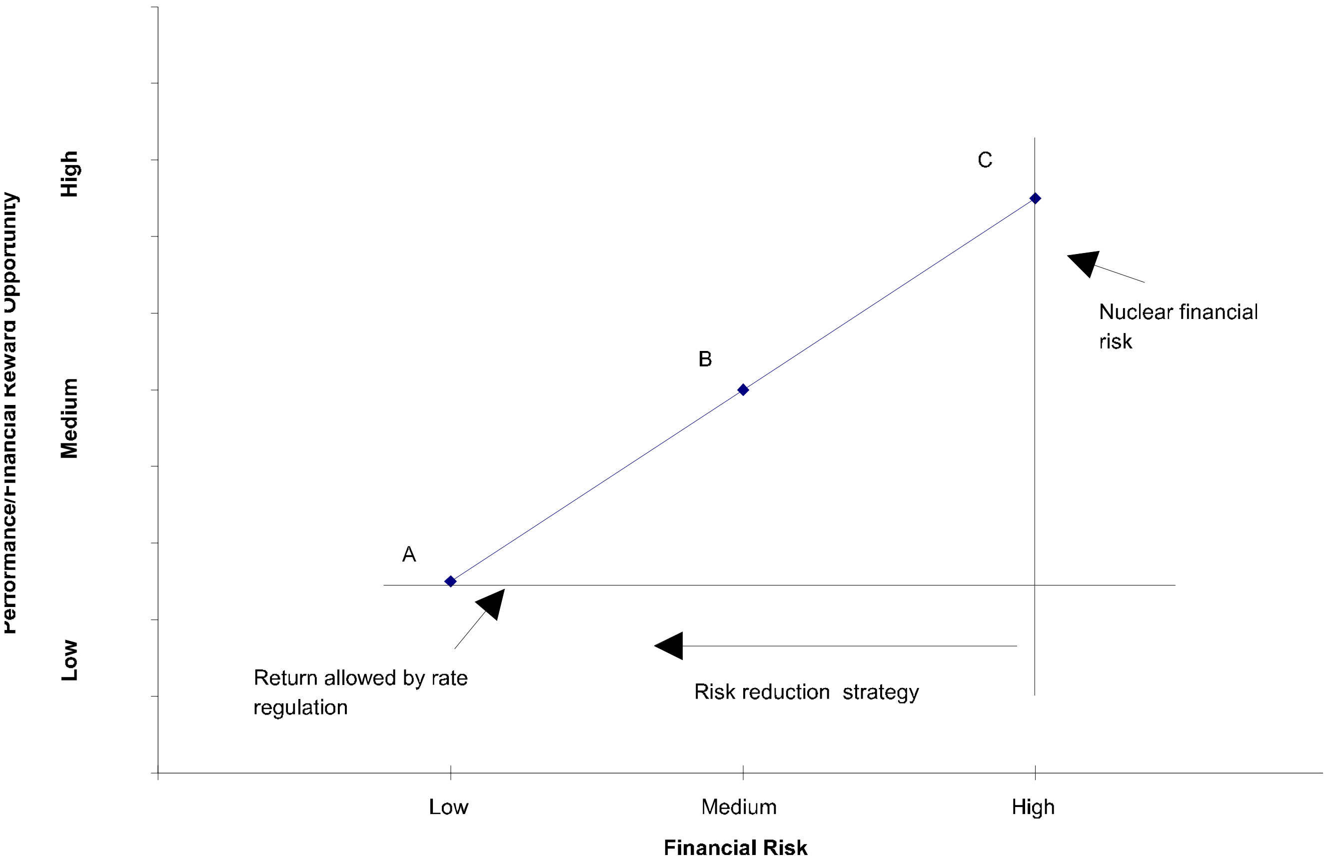

Figure 1. Rate regulation leads to a risk reduction nuclear business strategy.

is investment intensive, a key part of the rate process is determining the allowed rate of return to the business for its investments. This inevitably results in some average that takes into consideration many factors, including the average investment risk of the business.

Experience with Rate Regulation

It was suggested above that businesses attempt to improve their financial reward and reduce their financial risk. Utilities are no exception. The horizontal line represents the return allowed by rate regulators. The vertical line represents the real or perceived nuclear financial risk. The intersection of the horizontal and vertical lines is below the average line for typical businesses. This mismatch between allowed financial reward and nuclear financial risk is a fundamental disadvantage to nuclear in the eyes of the investor. As suggested earlier, investors take their money to the businesses that provide the best combination of financial risk and reward and move away from those that provide a less desirable combination. Utility management is faced with the task of resolving the mismatch between allowed financial reward and nuclear financial risk.

There are limited, if any, incentives for performance improvement. As an example: efforts to reduce costs are met with an overall reduction in rates in the next rate proceeding. This is in contrast to experience in a competitive market where investors would see an increase in their financial reward. In a rate regulated environment, return to investors stays relatively fixed, as long as performance is in a range considered prudent. Prudence, or the ability to defend company actions in a rate proceeding by the rate authority, is the performance standard.

The primary business options available to utility management are those associated with financial risk management. The overall result is a financial risk reduction strategy. Such a strategy is fundamentally defensive in nature, focused on avoiding initiatives unless they are defensible as prudent. This emphasis on prudence sets the stage for the relation with the safety regulator.

This inherent incentive, in a rate regulated environment, for nuclear financial risk reduction with prudence as the standard for performance has important negative consequences for nuclear

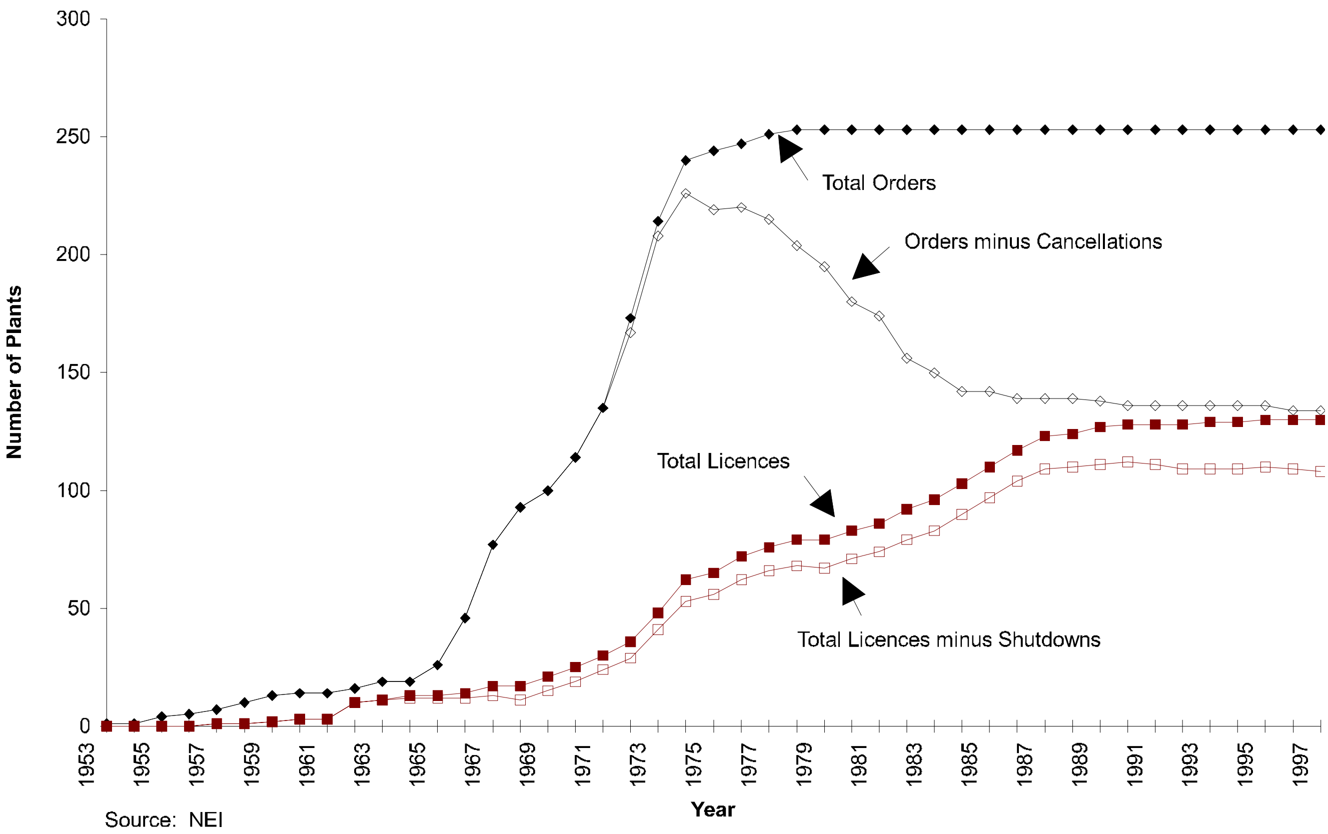

Figure 2. Orders, cancellations, licences and shutdowns in the US nuclear industry.

as a business.

It has resulted in stagnation of design and ownership, exceptionally wide variations in operational performance, negative signals to investors, and, most importantly, the shifting of leadership on plant improvements to the US Nuclear Regulatory Commission (NRC). Each of these points deserves further discussion.

Design and Ownership

The first aspect of nuclear operation in a rate regulated environment to be considered is design and ownership. We find that designs and ownership are basically frozen in place from the early 1970s.

The history of the orders, cancellations, operation and shutdown of power reactors in the USA is shown in Figure 2. We see the first US reactor order, part of a government demonstration project, in 1953, followed by a period of slow growth. Starting in 1965 the curve (“orders minus cancellations”) builds quickly, reaching a peak in 1974. The peak is followed by a steady decline that levels off in the mid 1980s.

Meanwhile the number of operating plants has increased steadily, with some reduction in the 1990s due to shutdowns of older units and a few newer units. The result is 108 operating reactors in the USA. They encompass a variety of designs by four vendors, that were set in the late 1960s and early 1970s and are relatively unchanged since. They are operated by 46 utilities, again relatively unchanged from the initial owners, in 32 states. In 1996, these plants generated more than 20% of the electricity used in the USA.

Figure 3 provides a more detailed look at orders and cancellations. The first decade was primarily a series of demonstration projects of small size. The second decade represented commercial projects with orders peaking in 1967 and again in 1972–1973. New orders dwindled to virtually zero by 1975 with the last order received in 1978. The first cancellation was received in 1972 and by 1974 the number of reactor orders had turned into a declining trend that accelerated and cancellations continued at an increasing rate until peaking in 1982. It is interesting to note that, of all the reactors that have operated in the USA, the last one ordered was in 1973. All reactors ordered after 1973 were subsequently cancelled. Also note that the drop off of orders was much steeper than the rate of

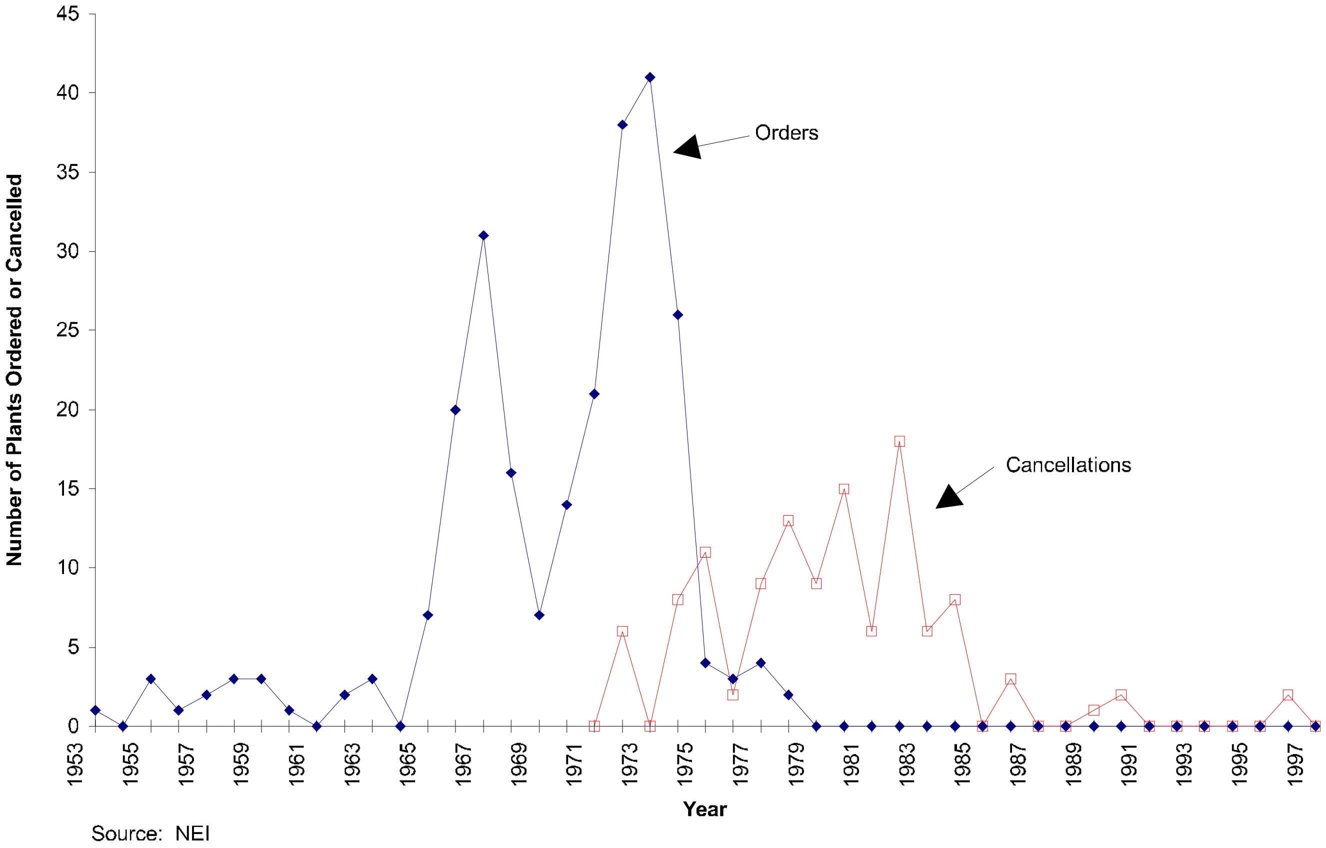

Figure 3. Orders and cancellations of nuclear plants in the USA, year by year.

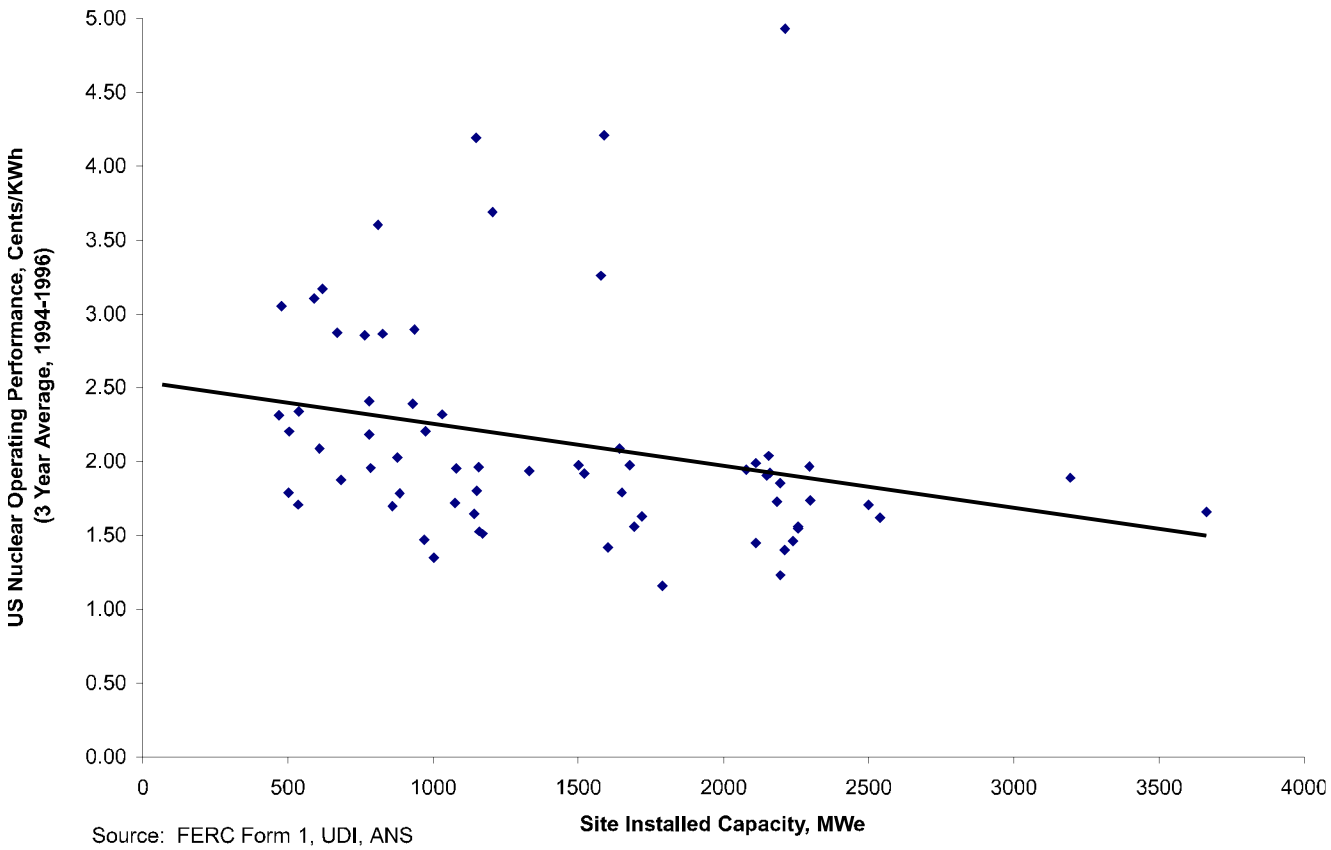

Figure 4. Unit cost of production of US nuclear plants against site installed capacity.

cancellations.

Figures 2 and 3 suggest that whatever effect the event at Three Mile Island had on the US nuclear industry, the industry was already in steep decline by 1979. The decline followed the oil supply disruptions that took place in the early 1970s. The roots of this decline appear to be in the early 1970s, as the US saw significant new environmental legislation on clear air and clean water. Presumably nuclear would have offered advantages, particularly in clear air. However, this legislation also significantly increased nuclear financial risk by new process requirements for issuing nuclear operating licences.

As the investment community realised that these new processes involved financial risk greater than that commensurate with the financial reward, motivation for new orders evaporated. Cancelling an existing order, however, was a more difficult task. In the rate regulated environment, cancelling an order raises questions about the prudence of the original decision. An imprudent decision could result in the state PUC finding that it was inappropriate to allow the utility management to collect from its ratepayers the money spent to date. Consequently the cancellations extended over a period of time, as opportunity provided.

The diverse designs and dispersed ownership of nuclear plants is a challenge for both management and regulator. It limits opportunity for improved management that multi-unit operation should provide. It also puts a heavy burden on the NRC to provide a regulatory regime that covers the variation in design while being sufficiently specific to ensure safety.

Reviewing design and ownership reveals:

- investor interest in nuclear power plants evaporated quickly, prior to the event at Three Mile Island;
- no new investment means no new designs;
- a nuclear plant has been virtually a non-transferable asset.

Operational Performance

The second aspect of nuclear operation in a rate regulated environment to be considered is operational performance. Overall operational performance from the perspective of an investor has not been good. Two perspectives on performance are offered, both involving the unit cost of production.

One of the best overall measures of successful plant operation is the unit cost of production. In the USA this is commonly expressed as cents/kWh. The value of this measure is in its combination of both the cost of a plant's operation and its electricity production. The impacts of personnel, material or regulatory problems are quickly apparent as cost and production are both impacted.

Figure 4 shows a scatter plot of production costs in cents/kWh versus site installed capacity in MWe for each operating reactor. A trend line plotted using a least squares fit to the data is included. Note that the trend line supports the conventional wisdom that a larger site appears to offer the expected benefits of economies of scale. However, two cautions. First, the benefit is smaller than might be expected. A doubling of site installed capacity from 1000 MWe to 2000 MWe reduces the cost by less than 15%. Second, note the scatter in the data. Overall, size does have some advantage, but there are clearly small plants that are performing just as well as plants two or even three times their size.

Figure 5 shows a scatter plot of production costs in cents/kWh versus total investment in US$/kWe for each operating reactor. A trend line plotted using a least squares fit to the data is included. The trend line speaks clearly that increasing nuclear investment supplies no benefit in lower costs or performance. Again, note the scatter in the data.

Reviewing the operating performance reveals:

- there is exceptionally wide variation in performance;
- the economies of larger plants have not been fully realised;
- the signals to investors are not positive.

Regulatory Environment

The third and final aspect of nuclear operation in a rate regulatory environment is the relation between the utilities and the primary safety regulator, the NRC.

As indicated earlier, the rate regulatory environment is one in which the financial risks associated with the nuclear investment are larger than the rewards allowed in the average return on investment. The result is that the utilities in general, in response to general investor attitudes, develop a nuclear financial reduction strategy, and resist taking the initiative to improve the power plants. The prudent strategy to reduce nuclear risk to investors is to only do what is required. In any developing technology, improvements would be expected based on operating experience. In the case of the nuclear industry, because of the risk/reward mismatch, this responsibility has been

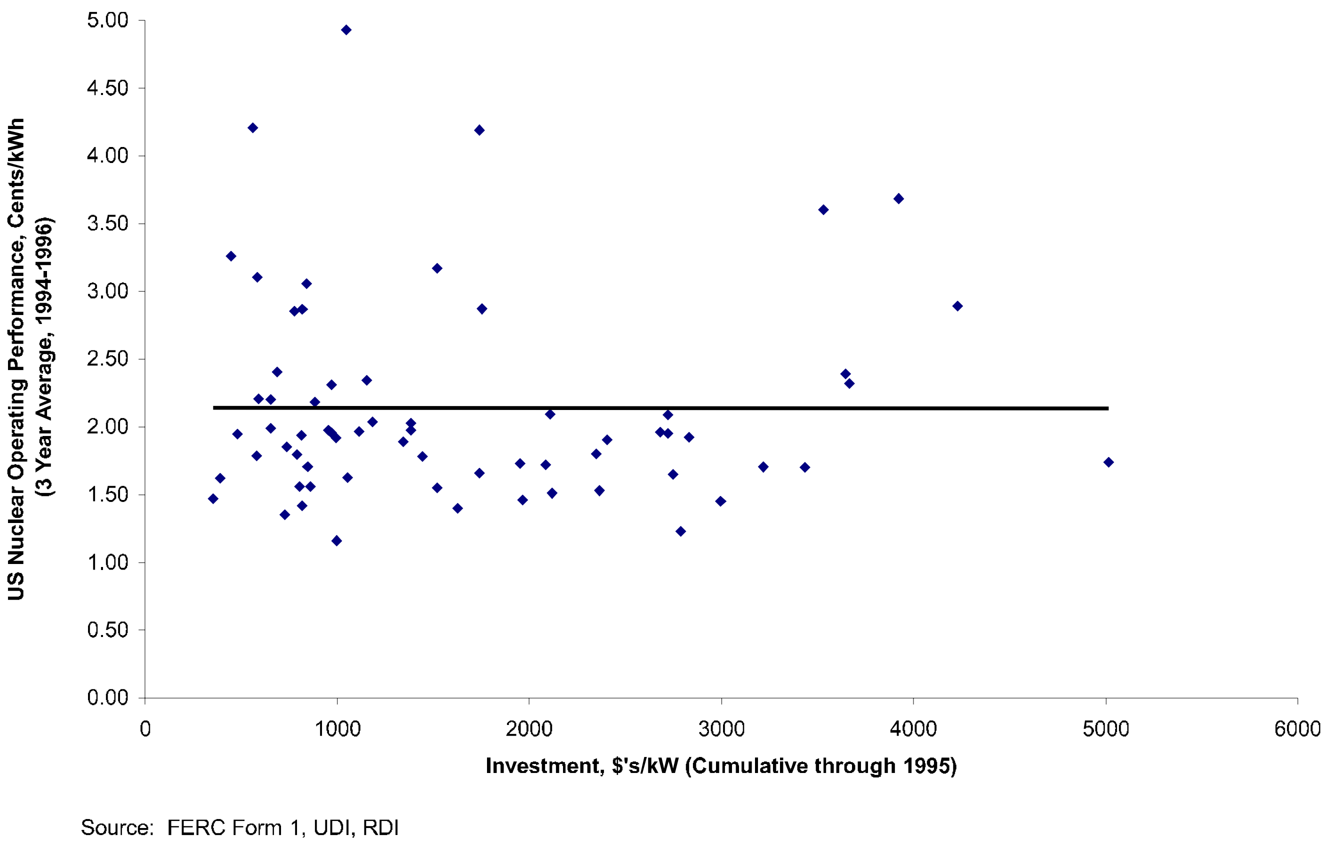

Figure 5. Unit cost of production of US nuclear plants against investment per installed kWe.

substantially ceded by default to the primary safety regulator.

This shift in responsibility from the utility to the NRC puts the regulator in a very difficult position. Regardless of the talents represented by the NRC staff, the fundamental success of performance improvements depends on the operating personnel having the desire to improve. The opportunities for reward in a competitive environment would provide incentives to utilities to seek operational improvements instead of resisting them.

Competition as a Method for Improvement

While utilities in general have operated in a rate regulated environment, the US nuclear industry has been exposed to some competition. The results are encouraging. We will look at the experience of US reactor vendors, competition with coal, and finally the relation between safety and economic performance.

The static design of nuclear power plants in the USA contrasts with the experience of several of the US reactor vendors, who have moved ahead to improved designs and commercial success in the competitive world market for new generation. As an example, the success of the Advanced Boiling Water Reactor (ABWR) is notable, and commendation is due to the team of Tokyo Electric Power, General Electric, Hitachi and Toshiba that made it possible.

The effects of competition with coal, while indirect, have also been favourable. In Figure 6, you see the change over time of average US nuclear production costs. The costs per kWh rose steadily until the mid 1980s, after which time the rate of increase has actually been below the rate of inflation in the USA. The increasing cost trend was clearly established by the mid 1970s and continued with little change through 1979 and on into the 1980s.

In parallel with the increase in nuclear costs was a declining trend in coal generated electricity costs. On average, nuclear became more expensive than coal in the mid 1980s. Shortly after nuclear become more expensive, we note a halt to the upward trend in nuclear costs and then the subsequent decline. It is worth noting that an important part of the reduction in coal costs came from the introduction of competition into the US railroad industry. This has had a favourable impact on the cost of transporting coal to the power plants.

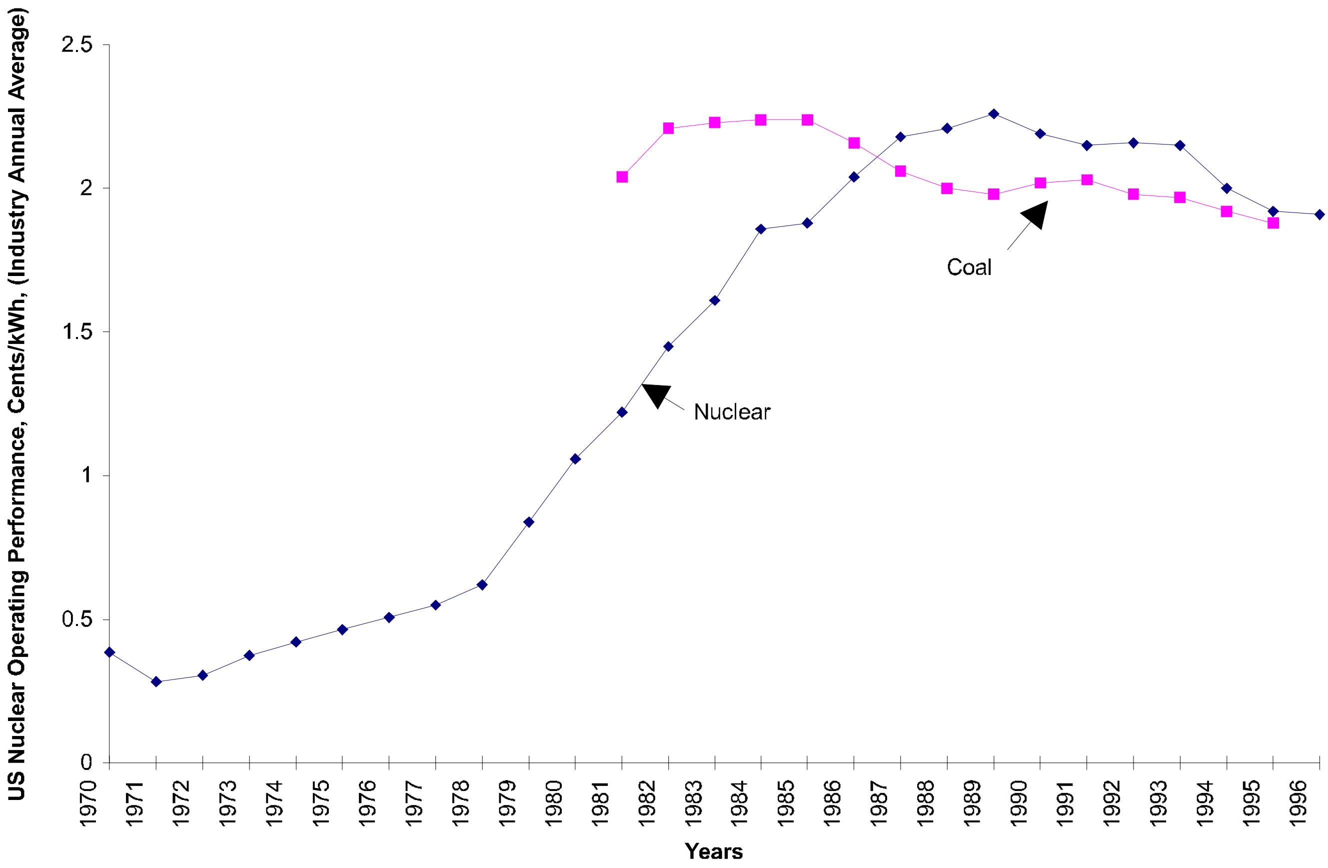

Figure 6. Average unit cost of production of US nuclear plants compared with US coal-fired power plants.

I would like to share one final chart that compares plant operating performance in cents / kWh with plant regulatory performance as measured by the NRC Systematic Assessment of Licensee Performance (SALP). Figure 7 shows a scatter plot of these two performance measures. A least squares fit trend line is included. Note that the power plants with the best regulatory performance, as indicated by low SALP scores, are also better than average in economic performance.

Reviewing competition as a method for improvement reveals:

- competition has resulted in improved nuclear designs outside the USA;
- nuclear costs turned downward as coal costs declined;
- regulatory performance and economic performance are compatible.

Competition Is Inevitable in the USA

While the debate over the advent of competition in the US electricity market continues, it is today in terms of when and how, not whether. Some in the US nuclear industry talk about how nuclear can retain its protection against price competition, or other such protection via political or regulatory mechanisms. Such a strategy might even work in the short term. However, it is a doubtful prospect that reliance on any such public policy will provide any future success. While there is reasonable public support for nuclear power as a concept, it is questionable that there would be any support for a policy that would in essence be a public subsidy.

Conclusion

Let us return now to the earlier position that future nuclear success depends upon the opportunities provided by a competitive environment.

In a rate regulated environment, the financial reward is fixed at an average point less than that appropriate for the financial risk associated with nuclear investment. In short, for nuclear, in a rate regulated environment the reward does not justify the risk. The result is an investor environment that drives utilities to a risk reduction strategy their nuclear operation. This situation leads to disincentives for investors to put new money into the industry, wide variations in the quality of nuclear performance, and the ceding of responsibility to the NRC for industry improve-

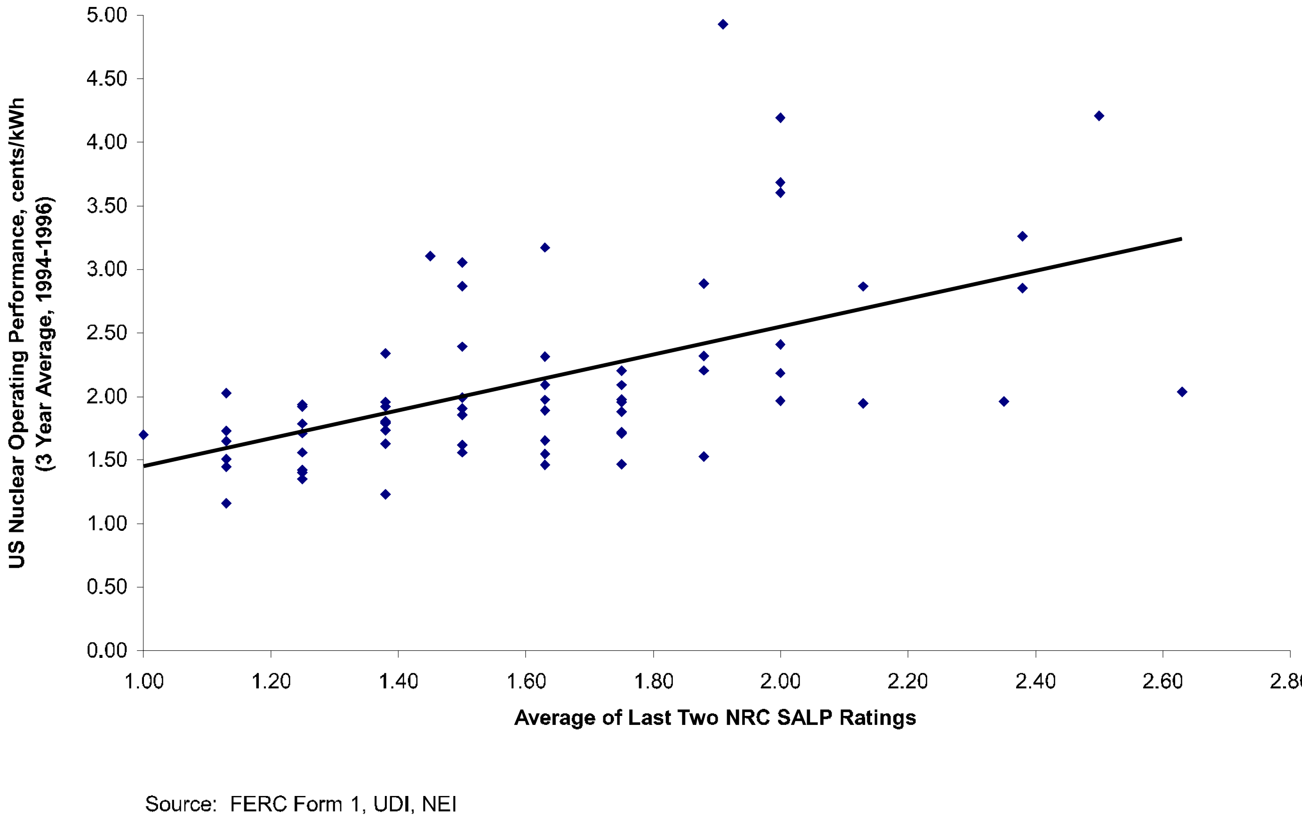

Figure 6. Relationship between unit cost of production of US nuclear plants and regulatory performance (NRC Systematic Assessment of Licensee Performance, SALP).

ment. None of these contribute to future nuclear success.

There is evidence that competition is a method for achieving improvement in the nuclear industry. One example is the success of US reactor designers in improving their designs for markets outside the USA. A second example is the improvement in US nuclear operating performance compared to coal. A third is the compatibility of good economic and good regulatory performance.

And finally, there is the fact that competition is inevitable. In the USA, competition is recognised as the ultimate test of value. Future nuclear success is assured if it is openly chosen by customers and investors, and not dependent upon public policy or subsidy.

Going Forward

So, if a competitive environment is necessary for future nuclear success, and we do not have one yet, and if the rate regulatory environment that we do have does not support future success, where do we go from here? Here are three thoughts for current nuclear power plants.

First, we must resolve the issue of the decommissioning liability held by current owners. Financial and regulatory mechanisms need to be developed that allow current owners to fulfil their decommissioning obligations, while not tying future ownership to the requirements of a rate regulated environment. With resolution of the decommissioning liability, the transfer of assets would be made possible between current owners who want to sell and future investors who want to buy.

Second, avoid mandates or agreements that trade future nuclear operation for the recovery of “stranded investment”. The very vigorous debate on this topic in the USA, which is occurring state by state as restructuring spreads, is probably the most compelling evidence of utilities pursuit of financial risk reduction in their nuclear operations. Exchanging the financial risks of operating a nuclear power plant for the assurance of a steady stream of guaranteed revenue is a tantalising thought on the mind of every nuclear investor in the USA.

Third and most important: do not fear competition, embrace it. For management, it provides opportunities to take initiatives, internally and externally, that improve value to investors. Such recognition of value by investors is key to future success. Experience with competition in both the USA and the UK has shown remarkable ability to improve performance. For the regulator, it offers opportunity to focus directly on the central issues of nuclear safety. Overall, remembering the graph that shows the positive correlation between cents / kWh and SALP ratings and that the economic and safety goals are the same, competition offers the prospect of a safe reliable operating nuclear power plant.

Some of our current plants may not survive the transition to competition, but given the opportunities competition provides for rewarding initiative and innovation, I believe it will reinvigorate our industry. It will provide new life to our existing plants and, most importantly, provide the opportunity for the construction of new and improved designs appropriate for the next century of nuclear electricity generation.