The Competitiveness Of U.S. Nuclear Power Plants Under Market Prices

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The U.S. nuclear power industry is very concerned about what the coming competition will do to its potentially stranded costs. Now another worry has raised its head—what will market prices be and can nuclear power plants compete in this highly competitive, price-driven environment? The answer is that some will and some won't. Often perceived as a monolith, in the nuclear power industry, like others, there are winners and losers. Despite very impressive improvements in O&M costs and output in recent years, we have found from a recently completed study that with a very reasonable set of market price and O&M cost forecasts, about 40 percent of the nuclear power capacity in the U.S. is vulnerable to shutdown because costs are higher than expected prices. This does not mean that all these plants will shutdown but that unless performance improves and even some of the best performers are able to cut costs to match their region's low projected prices, some will not make the grade.

The analysis is based on conservative estimates of the performance of plants and the prices those plants will compete against in the region they sell their output. The analysis assumes that operation and maintenance (O&M) costs will stay at the levels of 1993 to 1995 for all plants. It assumes that electricity prices will remain stable until 2005 despite a widespread assumption that prices will decline. It assumes a 10-year period (including internal preparation) for extending reactor licenses, even though there is a common belief that it may take longer. The analysis also assumes that there will not be any major capital expenditures in the foreseeable future. And, it assumes that extensive stranded cost recovery will be permitted so that utilities will be able to operate generating stations on a marginal cost basis without the burden of associated debt and other legacies of the past. Even with these conservative assumptions, a number of nuclear plants are vulnerable to shutdown.

These findings have taken many by surprise, probably because of the optimistic assumption that market prices wouldn't be very much different than rates obtained through the regulatory process—in spite of much evidence to the contrary. For example, our 1997 annual survey of electric power industry executives, sponsored by the Washington International Energy Group and the Canadian Electricity Association, found that only 44 percent of the respondents believe that nuclear power can compete in the coming environment. This study put numbers to this expected price drop and found that many well operated plants are now believed to be vulnerable to shutdown because annual O&M costs per kwh may be higher than market prices in the region they are located.

We started by a cost analysis of the U.S. nuclear power industry which evaluated how well the owners of individual plants were performing with factors under their control. This is a somewhat unusual approach compared to most nuclear cost studies that concentrate on external factors over which owners and operators have little or no control. The time period was from 1990 to 1995 because this coincides with about the time when the fruits of industry initiatives to take control of costs and output became evident on a sustained basis. For most nuclear plants, the 1990s have been a period of sustained improvement.

The cost and output performance analysis included the 71 nuclear sites (consisting of 107 individual units) for which data are available for 1990 to 1995. These divided fairly unambiguously into three categories, 32 sites in a group of top performers, 22 sites in a group of good performers, and 17 sites in a group of poor performers. Although much has been written about substantial improvements in cost reductions and increasing output of nuclear power plants, these have not been shared by all units. When including all sites, non-fuel O&M costs trended down an average of 4.4 percent from 1990 to 1995. However, for the top performers, this figure was nearly 27 percent, for good performers, about 15 percent, and the for poor performers this cost **increased** over 26 percent. Similar changes occurred for capacity factor—substantial improvement for the top performers, some improvement for the good performers, and a **lower** capacity factor for poor performers in 1995 than in 1990.

But cost and output performance is only one side of the equation when competing for customers. Among the 54 sites that are top or good performers, 20 are vulnerable to shutdown because projected annual production costs are higher than projected prices in the market. Because many of these units have excellent capacity factors that approach a maximum level, they have little opportunity to improve their performance through increased output and will, instead, have to reduce operating costs without sacrificing performance.

In addition, all 17 sites that have a poor performance record over the past several years are vulnerable to shutdown, again because production costs are higher than the market price each will face. Some of these sites may be able to improve performance and survive. These 37 sites represent 40 percent of the nuclear generating capacity in the United States, providing just over 40,000 megawatts (mW) of generating capacity that produced nearly 250,000,000 megawatt hours (mWh) of electricity annually in the 1993 to 1995 time period. These sites are vulnerable to shutdown because the market price each is likely to face in their particular region will be less than their annual production costs, even if prices remain level—which most experts believe is unlikely.

Important regional concentrations are evident in nuclear site shutdown vulnerabilities. The vast majority of sites are in the Northeast and Midwest, and are frequently among the older units. These are the regions with the highest population density as well which accounts for the clumping of plants. For example, all of the six sites in New York; all seven sites in the Ohio-Michigan area; over 60 percent of the capacity in Minnesota-Iowa-Nebraska area; about half the capacity in New England and the mid-Atlantic region; and somewhat less than half in Illinois-Wisconsin are vulnerable to shutdown.

Expected regional prices vary considerably—an important reason why planning for the competitive era cannot stop with individual plant or site analysis. Simulated annual mid-peak prices for 1997 range from $22.25 per mWh in New England, to under $15 per mWh in the Nebraska-Iowa-Illinois (except for the northern tier) where the cheapest coal-fired output tends to be located. This explains why many plants in the Midwest are vulnerable to shutdown, in spite of good operating performance. By contrast, some New England, mid-Atlantic, and Florida sites, where average operating costs for non-nuclear generation may be relatively high for various reasons, are judged to be competitive, in spite of comparatively high O&M costs.

What would be done to replace electric generating capacity if these nuclear plants are shut down? Obviously, not all of the lost megawatts would have to be replaced and those that were replaced would come from a variety of sources. For perspective, consider what would happen if all of it is replaced by natural gas. (Over the past decade, about 60 percent of new capacity has been natural gas.) If all 37 sites close down, there would be opportunities for up to 1.55 trillion cubic feet (tcf) of natural gas use per year in electricity generation, which is equivalent to approximately 45 percent of the natural gas used for electricity generation in 1995. Realistically, increased demand for gas would be lower since several fuel sources will be called on and improved efficiency in the electric industry will reduce the need for a one-to-one replacement and will compete against other facilities.

The analysis went beyond economic performance and market competition, and analyzed a number of other external dynamics to determine if they would affect shutdown. These include shortage of capacity for on-site storage of nuclear waste, further delays in off-site storage and disposal, the need to renew the NRC license, decommissioning requirements, and low safety performance as rated by NRC. When combined with other problems, these may lead an owner to shut down a facility. However, none of these in isolation is likely to force the decision. The bottom line is that cost and market economics will drive the future for the nuclear power industry.

The study looks only at actual operating costs and assumes stranded cost recovery and other means of reducing corporate debt are not direct factors in affecting the shutdown decision on individual plants. The report assumes that whether or not stranded costs are recovered, plants will have to sell output at marginal or market-based prices. Of course, poor corporate performance may negatively affect nuclear facilities. These results also assume that there will **not be:**

- safety problems requiring long term or permanent shutdown at a facility;
- costly generic retrofits;
- complete political gridlock on resolution of waste management; or
- onerous financial requirements imposed by the NRC in responding to the move to competition.