PROSPECT OF ADVANCED GENERATION TECHNOLOGIES IN A COMPETITIVE MARKETPLACE

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ABSTRACT
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To meet the challenge of deregulation and customer demands for a free competitive market, the electric utility industry in the U.S. (and, for that matter, throughout the world) will experience tremendous changes over the next five years. These changes will be driven by two major forces: the deregulation of the industry and, therefore, no guaranteed return on investment but more importantly, the demands of customers for a free competitive market in the electric utility industry where they can achieve the lowest cost for the commodity. This will force utility companies to position themselves as low-cost producers. Although low cost does not necessarily mean success, it is obvious that cutting and/or reducing capital expenditures will play the most important role.

Unregulated markets encourage product diversity, as firms look for "niche" profit opportunities. A pervasive lesson from other industries that have recently been deregulated clearly shows that unless properly planned, these companies will not only do poorly but may be completely wiped out from the market. Generation Planning (base load vs. peak load, long-term vs. short-term) will become more important since two-thirds of the capital investment is tied to generation facilities. While low-cost utilities will have greater flexibility in adapting to competition, they will be far from immune to industry changes.

Under a fully competitive marketplace, all generating plant assets/investments will come out of a rate base. Since all companies will be exposed to competition, high-cost generating assets would no longer be subsidized by ratepayers. This will force the utility companies to invest in low capital cost generation only, at least during the next ten to fifteen years.

This paper will briefly discuss the status of various advanced generation technologies with respect to their costs, applicability and limitations, where these technologies are expected to be cost effective and finally how these technologies compare with the state-of-the-art combined cycle gas-turbine technology. It is predicted that as environmental regulations tighten on pollution, advanced generation technologies may benefit at the expense of current fossil fuel technologies. However, it is not certain whether economic growth in the U.S. can be sustained if new regulations on pollution force to add new plants with advanced generation technologies, compared to continuing with today's generation mix. It will be examined how, when and where the advanced generation technologies would play an important role in penetrating the market on their own merits.

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INTRODUCTION

The restructuring of the electric utility industry has been placing an additional burden on electric utility managers to become low-cost producers through better asset management. The current regulatory requirements in the U.S. on the other hand, continue to put on a different kind of pressure, due to which generating assets are very much underutilized. During 1995, the average capacity factor of the 750 GW of total generating capability in the U.S. electric utility industry was below 50%, although coal-fired and nuclear plants operated at 65% and 74.6% capacity factors, respectively.

Based on the DRI study, the demand of electricity is expected to grow at an average rate of 1.3% annually for the next 20 to 25 years. If the existing underutilized generation facilities (and, hence, assets) could be optimally utilized, it may allow the deferral of base load generation in most areas of the United States by 8 to 10 years at the least.

It is important to acknowledge that the restructuring of the industry from a cost-based price structure to a market and/or performance-based price structure will have a huge impact especially with respect to new base-load coal-fired addition. Until the rules of the newly restructured marketplace are fully known, electric utilities (including IPPs) will be reluctant to add new generation facilities (especially base-load generation). The pending change in the industry has already resulted in the deferral of previously approved and budgeted construction expenses for the construction of new plants in the U.S. Therefore, it is very unlikely that the commercialization of the clean coal technologies (CCTs) in the domestic electric utility industry would be a reality in the foreseeable future, mainly because of their comparatively higher initial capital cost and concern on reliability. It is believed that before any new generation addition, utilities would take advantage of the existing generation assets by optimally utilizing their capacity factors and/or by life extension of those units where possible.

Furthermore, it is not yet clear if the “obligation to serve” will still exist in its present form. We believe that the decline in electricity price due to industry restructuring as well as drop-in coal prices due to fierce competition will force utilities to rethink options and postpone the commercialization of CCTs. However, if the regulation for NOx emissions becomes more stringent, CCTs could have some additional benefits over life extension of existing facilities.

On the other hand, in Japan, Germany and/or in some European countries where average cost of electricity (bus-bar cost) is over 6 cents/kwh, CCTs could play a very important role for new power generation facilities. Even the changing utility and regulatory environment in those countries may provide opportunities for CCTs to serve as a competitive generator in this market. However, under the new business climate, there is a need for providing a decision maker with information and methods of evaluating competing technologies that are more applicable to actual market conditions, which this paper hopes to deliver.

STATUS & ROLE OF CCTs

The CCTs under consideration here include Advanced Pulverized Coal (PC), Integrated Coal Gasification Combined Cycle (IGCC), and Pressurized Fluidized Bed Combustion (PFBC) technologies. Although coal-fired power plants will continue to provide a significant share of this country’s electrical power demand well into the 21st century, it is not at all certain that CCTs will play an important role prior to year 2010. This is because of the high degree of uncertainty in the future market price for power.

To date, the U.S. Department of Energy has done a commendable job in obtaining technical, economic, and environmental performance data on CCTs through a multi-year clean coal demonstration program. Originally during the early 80’s to late 80’s, DOE intended to make long-term performance data available to utilities to help commercialize the technologies. The approach included electric utility participation in developing the projects and making the public informed about the lessons learned through these programs with respect to technical, cost and environmental performances.

The key factors in assessing the status of the technologies included, but not limited to

- Demonstrate long-term operability of the process
- Reliability of performance
- Operations and maintenance requirements
- Fuel flexibility
- Overall efficiency and environmental performance

The overall success of the CCT programs initiated by the federal government will be ultimately measured by the degree to which the technologies are commercialized both in the U.S. and overseas, and by the contribution the technologies make to the production of low cost energy and clean environment. However, these goals can only be achieved if the decision makers are convinced that these technologies are competitive with other alternative options through either efficiency improvement and/or enhanced environmental performance. Thus far, it can be said that the CCT program has proven to an effective means by which government can work cooperatively with the private sector in demonstrating new technologies for introduction into the commercial marketplace.

To date, fourteen projects with a total estimated completion cost of over $4.7 billion are demonstrating advanced electric power generation technologies in FBC, IGCC and advanced combustion/heat engines. In our judgment, most of the CCT program technologies were and/or have been operating at sufficient large scale and in actual utility environments to provide useful and meaningful results to assess commercial performance potential. However, some of the advanced power generation projects are not expected to generate useful operating data until the late 1990’s.

Of all CCTs, only coal gasification technologies have been successfully utilized in the oil and chemical industries for over forty years, long before USDOE began to promote this technology for electric power generation. These gasification plants are normally accepted as economically attractive commercial operations for production of high value synthesis gas-based chemicals, generally in situations where gasification has advantages over the natural gas/steam reforming alternative. It is expected that commercially proven combustion turbines, gasifiers, and commercially available gas clean-up (low temperature) can produce electricity with 39 to 42%
efficiency and lower emission levels than any other coal-based commercial technologies.

We believe that the future markets for coal gasification technologies are quite attractive. However, the single most important factor is the ongoing deregulation of all the energy industries, and especially the electric utility industry. Although, the proponents of gasification technology believe that it assures maximum flexibility for the uncertain new world of competitive energy, we from the utility perspective see it differently. The data presented here may explain our perspective.

PROSPECT OF CCTs

The deregulation of electric power generation represents, perhaps, the biggest change in the energy industry since the oil embargo and the crude oil price/supply shocks of the 1970's. The significantly lower electricity costs resulting from competition in Argentina, Brazil, England and Norway assures that deregulation in the U.S. is here to stay. The key to competitive power generation is the economic incentive of being paid only for the power generated and economically dispatched. Under this scenario, the cost of electricity (busbar cost) is expected to drop by 25 to 30%. Although, the current regulated system has disincentives to innovation, in general it has considerably lower risk in introducing any innovative technology and options once it is proven "used and useful." Because of this fact, it may be even difficult for an IPP to build a CCT plant since the current average rate base cost in the U.S. is approximately one-third the cost of a fully mature IGCC plant. Note that for the same capital cost, operating cost, debt and return, IPP can provide power at ten to fifteen percent lower during the first six to seven years than that by a utility, although "levelized cost" during the life of the plant may be equal for a utility and an IPP. Hopefully, this inequity will be resolved once the "stranded assets" issue is resolved, but that may not be known within the next few years.

A great deal of short-term confusion currently exists in power generation markets due to excess capacity and "underutilized assets," uncertainty of deregulation with respect to time, and/or other alternative options for new power generation such as state-of-the-art combustion turbine—simple and combined cycle, and lower natural gas prices due to deregulation of the natural gas industry. However, the long-term future is clear—under a fully competitive marketplace, only the low cost power generators will survive.

The attached charts (Fig. 1 through 4) clearly show that if and when base load capacity is needed, it will likely be a natural gas-fired combined cycle plant until the year 2010 in the U.S. and in the other parts of the world with easy access of natural gas and LNG. This may be bad news for coal gasification technology in the near-term, but in the long-term this may be the best news for this technology.
Irrespective of claims by natural gas producers about its abundance and price, natural gas prices will increase at a much faster rate than that of coal as excess natural gas supplies dwindle. It is estimated that if the historical price ratio of natural gas and coal reaches 3 (current natural gas to coal price ratio on $/MMBtu basis for electric power generation is less than 2), natural gas could be replaced by coal gasification.

Based on the growth potential of electric generation, the maximum potential market for traditional central power plant exists in the Pacific Rim. We believe IGCC would represent at least some percentage of all new generation in Asian countries. However, as mentioned previously, that percentage will be quite small until natural gas price increases.

In our judgment, however, gasification technology which has been successfully utilized in chemical industries for more than 40 years can produce electricity with higher efficiency and considerably lower emission levels than are possible with any traditional steam cycle alternatives. Although no serious attention has been paid to the technology by electric utilities for base load generation thus far, utilizing heavy distillate residues and petroleum coke form oil refinery offers the most competitive generation option in the near future.

Both heavy residue distillates and petroleum coke are considered low grade fuel but have very high energy values, and normally cannot be used for power generation and/or generation of valuable chemical feedstocks except in gasifiers. There already exists a large established gasification market that is primarily based on the production of chemicals and premium fuels. Since most of the current interest in advancing gasification technology is for combined cycle power generation, most utility managers forget the current use of gasification in refinery and chemical industries that began more than 40 years ago.

Because of deregulation of the utility industry, many combined oil refinery and power projects are being seriously proposed in Europe and south Africa. The introduction of IGCC plant in combined power generation/oil refineries may be the best chance of marketing this technology during the next 10 to 15 years. From the utility’s perspective, it will have a source of inexpensive fuel (which constitutes 75 to 80% electric production cost), and from the oil company’s point of view, it represents achievement of two major goals such as elimination of high sulfur fuel oils, and capabilities of processing those heavy/high sulfur crudes and distillates at any and/or all times to produce a high value product, namely electricity. Figure 5 shows how such a concept works and each partner’s distinct area of operation.
CONCLUSION

In the future, gasification technology will probably be one of the most important energy technologies because it offers strategic flexibility with respect to fuel in the uncertain world of competitive environment. Furthermore, IGCC plants has environmental superiority over any other coal-based technology. However, this may not be true for any other CCTs now under development and/or are developed and waiting for commercialization.

Almost all electric utilities in the United States today face the reality of increasing competition in its core energy business at a time when the nature of the business, changing technologies, and slow economic growth threaten to erode earnings growth. Under these uncertainties, it is highly unlikely that any utility management will take an additional risk of investing in a new technology at an initial capital cost estimated to be two to three times higher than the current embedded cost in their generation plants. Furthermore, there is no guarantee that most utilities even will be able to recover their current embedded cost.

Based on rigorous analysis of energy available and energy demand, it is estimated that energy price including capacity charge (or backup cost) will be around 2.5 cents to 3.0 cents/kwh in the year 2000, which is assumed to be the first year of deregulation. If the energy generated from an IGCC plant is to compete with 2.5 to 3.0 cents/kwh energy price, it will be able to tolerate a maximum capital cost of $650/KW for a stand-alone power generation unit—a highly improbable task. $650/KW is the current estimated cost of a state-of-the-art NGCC plant, whereas a fully mature IGCC plant would probably cost in the range of $1,200 to $1,300/KW and the first generation IGCC plant could cost over $1,500/KW.

If the new base load capacity is based on natural gas combined cycle and in the future natural gas price increases, natural gas could be replaced by medium Btu gas generated by gasifiers. In our judgment, gasification is the only technology that can provide a fuel alternative to natural gas and distillate oil prices and, thus, maintain the future market stability.

As discussed before, the oil industry represents the best opportunity for the future power generation utilizing coal gasification technology. We believe that the dominant use of gasification for high value chemicals could give a major boost to this technology for power generation. It is almost certain that the importance of large, new power plants is over for the power industry under deregulation and in a competitive marketplace. However, the same deregulation and additional demand on environmental issues are likely to increase the value of IGCC technologies' strategic advantages once the energy market becomes stable and existing plants are retired and/or new base load generation becomes a necessity.

References

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