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# THE NATURAL GAS NUCLEAR POWER PLANT: STRATEGIC PARTNERSHIP FOR ECONOMIC VIABILITY OF EVOLUTIONARY L/HWR

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Today, nuclear energy faces increasingly stiff competition with other energy sources. Where gas is available at low prices, combined cycle gas turbine (CCGT) plants appear especially formidable competitors against nuclear power plants. The relative cost composition of electric power differs in gas and nuclear generation. In the nuclear industry, operation and maintenance (O&M) and fuel costs are relatively low, while construction costs are the major component of investment. Contrarily, for the CCGT fuel costs are significantly higher than capital costs. Therefore, the economic competition between technologies is mostly determined by the relationship between the price of gas and the capital cost of nuclear plants, which varies from region to region.

Considering the most favorable scenarios, nuclear power costs at least 36 mills/KWh, whereas gas power generation ranges between 29 and 45 mills/GJ in Europe, and between 20 to 29 mills/GJ in Argentina, where the gas is abundant and inexpensive. Clearly, in regions where gas is available at low prices, generation by CCGT is a formidable competitor against nuclear energy. A major obstacle to profitability in nuclear power plants is the relatively low efficiency of their thermal conversion cycles. In effect, water-cooled reactor performance is limited by the primary coolant temperature, which cannot exceed 300 °C due to materials constraints.

During the 60's, when the thermal efficiency and reliability of LWR were still low, a few nuclear power plants with secondary overheating using fuel oil were constructed (i.e., Indian Point 1 in USA, Garigliano in Italy and Lingen in Germany). However, the performance of the combined cycle was questionable, due to low load factors and material failures. Now, the technology of thermal power plants, nuclear and conventional, is much more reliable (90% load factors). Consequently, it is reasonable to reconsider the feasibility of combined advanced cycles that produce vapor by means of nuclear power —taking advantage of the lower thermal costs— and superheating the secondary flow by the exhaust gases from gas turbines [1]. The concept combines the lower costs of nuclear fuels with the higher thermal efficiency of CCGT.

An assessment of the economy of combined nuclear-gas power plants was performed, viewing the merger as a convenient "strategic alliance" between both types of fuels, which offers electric power at lower costs. An interesting conclusion of this analysis is that gas price is the parameter determining the competition between the energy sources. Wherever the gas is expensive, nuclear power plants would be recommended whereas, in regions where the gas is available at low prices, CCGTs are preferred. In this scenario, the combined nuclear-gas cycle appears as the most convenient alternative in the range of moderate gas prices.

Figure 1 shows different countries in a map of competitive regions. The map plots gas prices and construction costs of nuclear plants in a two-dimensional plane, where the best alternative for power generation can be visualized by zones. Interestingly, most of the countries fall in the region

where the combined nuclear-gas cycle is more competitive. The dashed line indicates the competitive boundary without considering the combined option, that is, separately comparing nuclear against gas. It can be seen that many countries are close to this boundary and countries like the UK and Argentina are constructing CCGT as the best option compared with nuclear alone. It is worth noting that the scenario may change completely if the combined nuclear-gas cycle is seriously considered a feasible power generator.

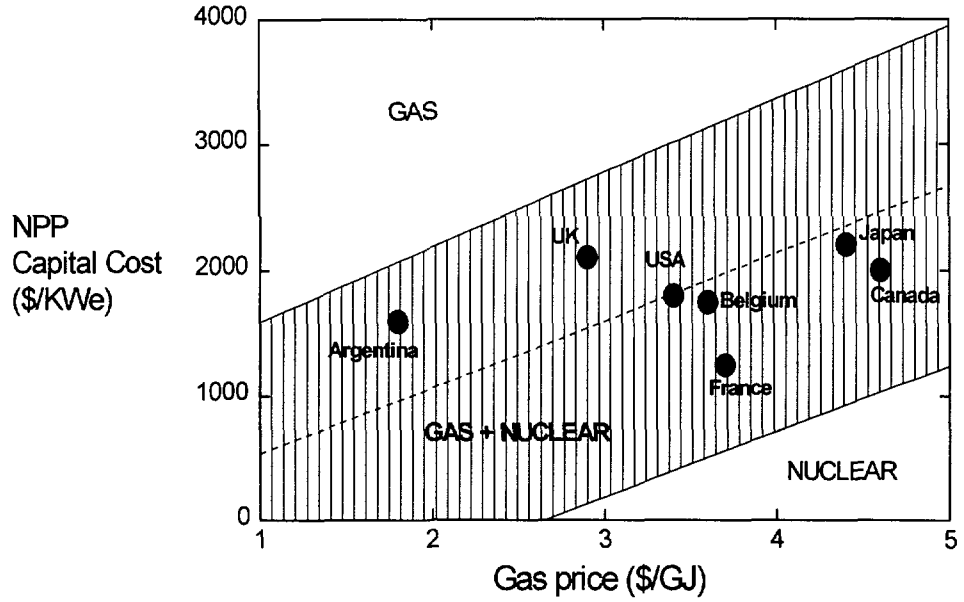


*FIG. 2. Competitiveness map showing the most convenient alternative.*

Contrary to trends from classical assessments of nuclear and gas power generation taken separately, the maximization of the superheated temperature was not found to be a good design criterion. In situations where gas prices are high, the optimum superheating temperature can be less than that technically achievable. Moreover, within rather wide cost ranges, the combination of nuclear and gas presents interesting possibilities for successful competition in the near future electric market.

## REFERENCE

[1] ROGERS, J.T., H.L. DODDS Jr, P.C. FLORIDO, U. GAT, S. KONDO, N.S. SPINKS, "Development potential for thermal reactors and their fuel cycle". Nuclear fuel cycle and reactor strategies: Adjusting to new realities, Contributed Papers, IAEA – TECDOC – 990, Vienna. December, 1990.