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GUEST EDITORIAL

Advanced Gas Turbines: An Alternative to Nuclear and Coal Plants

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Recent developments in gas turbine power-generating technologies, arising in large part from U.S. Defense Department support for research and development on jet engines, make possible a more hopeful outlook future for electricity than that presented by those who warn that more and more large nuclear and coal plants must be built in order to avoid economically crippling power shortages.

Large new nuclear and coal plants have proved to be very costly, accounting for much of the 60% increase in the U.S. average, inflation-corrected price of electricity since 1970. Growing concerns about nuclear safety and acid rain are likely to lead to further regulatory constraints on nuclear and coal power, which will make it difficult to reduce these costs. In addition, future growth in electricity demand is highly uncertain. By investing in large plants that take a decade or more to build, utilities risk being caught up in a vicious circle. If demand grows more slowly than expected, the resulting excess capacity will necessitate higher customer rates, which will reduce demand further, leading to still higher rates, etc.

Advanced gas turbines are a promising alternative. While conventional low capital-cost, low-efficiency gas turbines have been used by U.S. utilities mainly for meeting peak loads, advanced gas turbines — e.g., advanced gas turbine/steam turbine combined cycles, evaporative-regenerative gas turbines, intercooled steam-injected gas turbines, and turbo-charged steam-injected gas turbines — make it possible for utilities to produce electricity at lower cost than with coal or nuclear power, in plants one-tenth the size. Like peaking units, these advanced turbines have low capital costs. But unlike peaking units they are efficient, requiring 30 to 40% less fuel per kWh. Requiring only two or three years to build, these technologies are uncertainty: utilities can wait to see how demand is evolving before deciding to build. Moreover, these technologies offer the flexibility to switch later to gas derived from coal. Using coal this way would generate much less air pollution than would burning it in steam-electric plants. For the more efficient options, the switch to coal gas could be delayed a long time — well beyond the year 2000.

Despite such attractions, utilities are not rushing to buy advanced gas turbines nor are manufacturers rushing to build them. The bias against gas turbines began in the mid-1970s, when natural gas was being used up at a much faster rate than new supplies were being found, leading the U.S. Congress to pass the Powerplant and Industrial Fuels Use Act of 1978 (FUA). FUA barred electric utilities from using natural gas in new plants and required that they shift existing plants off gas by 1990. Since then the price of new natural gas has been decontrolled, additions to gas reserves have been comparable to production, and there is presently a gas supply surplus. Natural gas is still not an abundant resource, but it has important roles to play as a transition fuel. However, present U.S. law inhibits its efficient use. In 1981 the FUA provision that utilities shift existing plants off gas by 1990 was repealed; thus today utilities are allowed to use gas inefficiently (in existing plants), but are prohibited from using it efficiently (in new plants).

In practice, the FUA constraints are not absolute. But few utilities are interested in obtaining exemptions — in part because they have not yet adapted to thinking of the gas turbine as a major power-generating option and in part because many utilities don't need new generating capacity. Even if there were no need to expand capacity, however, it would be cost-effective to replace existing gas-fired steam-turbine plants with efficient gas turbines, because the total cost of producing electricity with new advanced gas turbines would be less than the operating cost with existing plants. For the U.S. as a whole, so doing could save natural gas supplies equivalent to about 1/2 million barrels of oil per day while providing the same amount of electricity. But because regulations do not adequately motivate utilities to retire old usable but significant replacement market is developing for new gas turbine systems.

Finally, manufacturers are not pushing these new technologies with potential buyers, both because the utility market is so uncertain and because the U.S. Department of Defense provides a steady stream of revenues by purchasing military aircraft with jet engines.

Ironically, the high energy performance that is achievable with new aircraft-derivative gas turbines is, to a large degree, a direct result of U.S. Defense Department R&D on jet engines, which averaged $425 million per year over the last decade. The most efficient technology identified to date for utility applications, the intercooled steam-injected gas turbine (ISTIG) with a power generating efficiency of 47% (based on higher heating value), is derived from an engine used in the U.S. Air Force's KC-10A Extender tanker/cargo plane. Though still on the drawing board, the ISTIG could be commercialized in three years for an incremental R&D investment cost of about $100 million.

Though U.S. manufacturers are not eager to bring the ISTIG to market, this and other advanced gas turbine technologies are so inherently attractive and their development costs so low, that they will be developed somewhere. A Japanese consortium is already being organized to finance the development of utility-scale steam-injected gas turbines.

New gas turbine technologies appear to spell the end of the era of the nuclear and coal powered giants. The speed of the transition to these new technologies and U.S. manufacturers' roles in marketing them are, to some extent, dependent on public policies. Ending restrictions on utility use of natural gas, providing incentives for utilities to replace economically inefficient equipment, and redirecting a modest amount of military R&D money to utility gas turbines could all help shape a formidable capability in these new gas turbine markets for U.S. manufacturers, building on their commanding lead in jet engine technology.

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