GE Power Systems

**Next Generation Gas Turbine (NGGT)
Systems Study
Interim Topical Report**

**Market Assessment Needs for the
Next Generation Gas Turbine**

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Next Generation Gas Turbine -- Market Assessment Needs

Overview

Arthur D. Little, Inc. (ADL) performed a strategic evaluation of the mid-sized gas turbines for the U. S. Department of Energy in 1998-1999.¹ DOE commissioned this study primarily to assess the market potential for a Next Generation Gas Turbine (NGGT), or in ADL's terminology an "Advanced Mid-sized Gas Turbine". GE Power Systems (GEPS) has entered into a contracted study program to develop a next generation gas turbine, but believes that the market assessment study should be updated to confirm viability of this product before extensive development expenditures are committed.

GE Power Systems generally finds the methodology and approach used by ADL to be sound, although several important dynamic changes have taken place since the ADL analysis and they should be addressed in the updated analysis. For example, current oil and natural gas prices are almost twice as high as considered by the ADL analysis. Changes to fuel prices can have significant impacts on market penetration analyses for gas turbine based technologies. Additionally, the recent market for new capacity additions in the USA has been extremely more robust than had been assumed in the ADL analysis. This large influx of new capacity additions will significantly change the operational landscape under which new technologies will be operating. Finally, the impact of the "new economy" and internet-driven load growth not specifically addressed by the ADL analysis needs to be considered in any USA market load growth scenarios in evaluating market viability.

These significant changes are continuing in the power industry and information is available to GEPS today that was not considered in the ADL study. This report describes the results of GE PS's review of the ADL study and identifies the specific actions GEPS intends to take to update the market view.

Market Size and Market Penetration Assessment

Estimated Technical Market Potential

The Estimated Technical Market Potential for the U.S. market (2005-2015)² should be revisited in light of updated economic projections and electrification trends currently being observed. The size of the potential market also needs to be expanded to include the global market. There are approximately 100 energy consuming countries included in the potential market for the NGGT, and non-U.S. markets may well represent a major fraction of new generating equipment purchases during the study's time horizon.

¹ "Strategic Evaluation of Needs and Opportunities for U.S. Mid-Sized Gas Turbines in Intermediate Load Applications", A. D. Little, Inc., April 13, 1999.

² ADL Final Report, page 26.

Intermediate Load Market Analysis

ADL's four-step process is a reasonable approach to analyzing the intermediate load market. However, General Electric's Multi-Area Production Simulation (GE-MAPS) tool may be utilized by GEPS to expand the detailed analysis to directly consider all regions of the U.S.

While the methodology is sound, the assumptions require updating in light of unprecedented U.S. order activity since the time of the original study. The broader range of market conditions developed through a comprehensive analysis of US markets provides a basis for global market assessment as well. A "pattern recognition"³ approach allows GEPS to extend the expected U.S. market response to the global market.

Displacement Market Potential

The ADL study shows that the NGGT will find its most attractive market in intermediate load service (nominally 2,000 to 5,000 operating hours per year). A substantial part of the volume in this market segment is associated with displacement of existing fossil-fired generating units. In evaluating displacement potential, ADL assumed that the frequency of high priced hours in the future would be at the same level as had been experienced in the past. However, this assumption needs to be tested, because the generation additions added to the system can change the marginal cost curve and the resulting economic evaluations. ADL appears to assume that units with lower marginal generating costs are displaced in preference to those with higher marginal costs. This assumption needs to be carefully examined, considering the "going-forward" costs for existing units.⁴

The equipment market has been expanding at an unprecedented rate during the two years since the ADL study was completed. For example, ADL shows 1600 MW to 3400 MW of merchant CTCC being added to New England.⁵ As of today, however, over 8000 MW of new CTCC generation is either in operation or under construction. Additional projects continue to be developed. These expansion units will consume many of the displacement opportunities identified by ADL. A similar analysis applies to the NERC (North American Electric Reliability Council) region ERCOT (Electric Reliability Council of Texas), although the analysis in this case is complicated by the more extensive use of co-generation.

The still-changing market rule atmosphere, such as market price-caps, and permitting difficulty has delayed development of new generating projects in California. The recent power shortages and correspondingly high prices are likely to lead to more rapid addition of new generation. Since these additions will precede availability of the NGGT, they must be considered in predicting the displacement opportunities that the NGGT will see.

While the rapidly expanding generation system will decrease displacement opportunities for the NGGT, higher natural gas prices such as those observed this year, will tend to improve displacement opportunities. In addition, more stringent environmental controls may cause plant

³ Current generating system capability, consumption patterns, and fuel price and availability are considered in selecting the U.S. region that most closely corresponds to a international market area. The relative opportunity and penetration in the global market is estimated by appropriately adjusting the corresponding U.S. results for specific factors in the other market.

⁴ Going-forward costs comprise those expenses that could be avoided by a plant owner by retiring the generating units. These include fixed O&M, property taxes, insurance, G&A, etc., but do not include debt service, return on invested equity, or return of invested equity. These costs define the minimum long-term revenue required to maintain plant viability (although not necessarily the viability of the current plant owner who may still be obliged to debt contracts).

⁵ ADL Final Report, page 53 and 55.

owners to retire current generating units rather than to invest in additional pollution controls. The ADL displacement analysis should also be updated to reflect current views on these factors.

Market Penetration & New Entrant Effects

ADL assumes an “S” curve for technology substitution⁶, but presents no details regarding their assumption. GEPS will apply our own new technology adoption estimates based on our experience in introducing new generation products.

ADL briefly addresses the potential for competition with the ATS gas turbines and, for various reasons, concludes that the NGGT will not directly compete with the ATS. NGGT's displacement potential, however, must consider ATS turbine market success. Since ADL assumes the ATS to be commercially available 6-8 years before the NGGT, this factor could be significant.

The market potential for NGGT should also consider the possibility of other new technologies (e.g. distributed generation based on fuel cells). While we do not anticipate a large penetration by small distributed generation, this is a risk factor that should be considered.

Public Benefits

NGGT purchase decisions will primarily reflect the economic analysis of the purchaser. Developers will internalize some public effects (e.g. emission credit costs, and the impact of NGGT introduction on the market price of power) in making project and equipment decisions. Other factors, while useful input into a decision to pursue the NGGT, will remain external to the purchase decision and therefore need not be directly considered in evaluating potential market size. The GEPS Marketing study does not intend to update ADL's Public Benefits assessment at this time.

Design and Operating Requirements

The ADL NGGT analysis focuses on intermediate load applications, but recognizes peaking, repowering, ancillary services, cogen, and green power requirements. In light of identifying new markets, GE will re-examine the changing customer needs since the original ADL study. The priorities of this potential customer base can be structured into key requirements for a broader cross-section of customers and applications, and a balanced view identifying the key potential customer segments will result. Given the potential for non-U.S. market segments, a broader global approach will be adopted.

GEPS will translate these customer segments into customer needs, further testing the requirements listed in the original study. These customer needs will be prioritized and compared so that a balanced view of performance requirements will be identified. The performance requirements will be translated in specific design requirements for a potential AMGT-type product.

⁶ ADL Final Report, page 77