The Impact of Distributed Generation on Local Distribution Companies

Submitted to:

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July 2000

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ES.1 BACKGROUND

Recent developments in the electric power and power supply industries have raised a great deal of interest in distributed power generation (DG). Advances in power generation (e.g., micro-turbines, fuel cells) and power control technologies have made DG increasingly competitive with conventional grid-supplied electricity in certain regions and for numerous applications. Changes in the operations of the electric system (e.g., reduced reserve margins, more price and supply volatility) and changes in the way electricity is priced (e.g., real-time pricing, competitive transition charges) have created new opportunities for supplying power on a value basis rather than a cost basis. Also, legislative and regulatory changes have reduced the cost of owning and operating DG. Overall, DG offers many customers, especially small to mid-sized commercial / industrial (C/I) customers, the potential to reduce costs and increase reliability and flexibility.

These changes provide gas local distribution companies (GLDCs) with significant new opportunities, including the potential to increase gas throughput, load factors, and operating margins; enter new businesses, e.g., unregulated engineering or energy service company (ESCO) subsidiaries; and offer new services, e.g., maintenance, insurance, and financing.

ES.2 OBJECTIVE

Because of the significance of DG to electric power supply in general and to gas LDCs in particular, the American Gas Association has requested SAIC to analyze the impact of distributed generation on the gas distribution companies. The objective is to provide a management-level review and 15-year outlook on market risks and opportunities, technologies, applications, gas sales, etc.

ES.3 SCOPE

This report addresses the potential impacts of DG on the gas LDCs from the perspective of customer value -- where does DG add value to the customer and under what conditions is it likely to succeed. The report covers technologies, applications, rules-of-thumb for commercial success, the response of the electric LDCs, and related factors.

In this report DG means a small electric power plant constructed at the customer's site to serve onsite loads, or constructed at the end of a distribution line to support the distribution system. The size of these plants is usually from a few tens of kW (excluding individual residential applications) to about 5-10 MW. Plants larger than 50 MW and merchant power plants selling at wholesale to the grid are excluded. Discussions with members of the industry indicate that DG (as an emerging concept) is usually limited to plants below 5-10 MW. Above 5-10 MW, DG is viewed as a continuation of the established trend towards on-site generation and cogeneration.

ES.4 FINDINGS

A review of the literature on DG would suggest that technology drives the DG market: reciprocating engines, combustion turbines, micro-turbines, and fuel cells. This perspective is misleading. DG is not driven by technology. It is driven by value -- value to the customer, to the electric power system, and to society. DG is about demonstrating this value in a complete package, e.g., design, analysis, procurement, installation, operation, maintenance, financing, leasing, etc. DG also affects the value of the gas LDCs through increased throughput, higher load factors, and new opportunities for services. Table ES-1 summarizes the potential benefits from DG.

Table ES-1 Potential Benefits from Distributed Generation

- Reduced energy ($/kWh) and demand ($/kW) costs
- Increased reliability, including provision of standby or emergency power
- Reduced transmission and distribution line losses
- Reduced spinning and non-spinning reserve margins
- More peak shaving and interruptible loads
- Deferral of transmission and distribution expansion
- Reactive power support and power quality
- Cogeneration capability
- Improvement in utility load factors
- Fuel diversity
- Emissions reductions
- Reduced energy congestion
- Less societal disruption
- Faster response time
- Emergency start capability
- System operations benefits

Sources: Adapted from Liss, 1999a; Skowronski, 1999.

From the gas LDC perspective, peak shaving and standby are established markets for many types of customers, especially the multi-megawatt customers. The emerging opportunities offered by DG expand the market to smaller loads, especially loads below about 2 MW, and expand the market to more gas-intensive applications, including baseload, full requirements, and cogeneration. These trends imply significant increases in incremental gas sales because of the large number of units sold for these applications and because of the much higher load factors for baseload, full requirements, and cogeneration applications.

Assuming that the DG technologies discussed in the present report meet their cost and performance objectives, i*ncremental* installations of DG units for baseload applications (baseload, full requirements, cogeneration) could reach 2,000 MW per year by 2005 and 5,000 MW per year in the 2010-2015 period and beyond.[1] These numbers compare to an expansion of the grid in the range of 25-30,000 MW per year, excluding replacement capacity, and as much as 40-50,000 MW per year, including replacement capacity, through the 2015 period. Retirements of nuclear units become significant in the latter part of the 15-year forecast period. Overall, baseload DG units could capture a double-digit percentage of the total market for capacity additions. The rate of growth in DG installations would level off in the 2010-2015 period due to saturation of the key markets. At 2,000 MW per year of incremental baseload DG capacity, incremental sales of gas for DG would reach 100 trillion Btu per year. At 5,000 MW per year of incremental baseload DG capacity, incremental gas sales would reach 250 trillion Btu per year. LDCs, not pipelines, are likely to supply most of this gas. Below about 20 MW, it is usually not economical for the DG operator to bypass the LDC and go directly to the pipeline. Above about 20 MW, or if the DG is almost literally right on top of the pipeline, bypass becomes a factor.

Incremental installations of gas-fired DG units for peak-shaving and standby applications could also reach 2,000 MW per year by 2005 and 5,000 MW per year in the 2010-2015 period. At these levels, incremental gas sales would reach 20 trillion Btu per year by 2005 and 50 trillion Btu per year by 2010. Almost all of these DG units would be customer-owned and would use gas supplied at retail by the LDCs.

Overall, total sales of gas by the gas LDCs to the incremental DG market could reach 120 trillion Btu per year by 2005 and exceed 300 trillion Btu per year by 2010. At retail prices averaging $4.00 per million Btu (heavily weighted towards C/I rates rather than the residential rates), the total market opportunity is in the range of $500 million per year by 2005 and more than $1.2 billion per year by 2010.

Key observations relating to these points include the following:

- **Market Potential --** DG has the greatest long-term potential in markets where electric transmission and distribution costs are naturally high (e.g., the Northeast) and where the reliability of delivered power is less than adequate (various areas). The value placed on reliability is a particularly important factor. Because the value of reliability is often orders of magnitude greater than the price of electricity, especially for commercial / industrial users, small gains in reliability from

[1] Incremental installations are installations above those that would take place at the current level of technology cost and performance. Achieving the incremental installation levels requires reaching the gas industry goals for cost and performance. Goals for turnkey costs (including the interconnection) are roughly $500/kW for gas engines, $500-600/kW for micro-turbines (at 30 percent electrical efficiency), and $1,000-$1,200 for fuel cells (at 40 percent electrical efficiency or higher). For gas engines, these cost goals are perhaps 25-35 percent less than current levels. For micro-turbines and fuel cells, the cost goals are 25 to 50 percent less than current levels.

DG will translate into large gains in market size. This relationship is especially important for DG systems providing baseload or full requirements service.

The contraction of spark spreads throughout the country (i.e., the difference in the prices per Btu of electricity and gas) will erode markets based on currently high electric generation costs relative to natural gas prices. Table ES-2 shows some of the key requirements for commercial success in the mid-sized, grid-connected C/I market. This market is one of the largest potential markets for DG. The values on Table ES-2 should be viewed in the context of a complete application, including opportunities for tradeoffs among the variables, not as individual values that must each be met for each variable.

DG has the least short-term potential in markets where exit fees and stranded cost recovery charges are high and unavoidable, e.g., Pennsylvania. Over the longer term, the elimination of these fees and charges will allow a market to develop. DG has little long-term potential in markets or applications that are based on mispriced peak resources. Retail access and performance-based ratemaking will eliminate arbitrage opportunities in these markets. Excluding high reliability applications, DG has little long-term potential in markets that have naturally low central station generation and T&D costs.

- **Market Evolution** -- During the next 10 years, rates for baseload power will decline the fastest in the regions and to the customers where DG is currently the most attractive, e.g., mid-size C/I customers in the Northeast. Success in this market will require marketing and packaging techniques that go beyond spark spreads.

  Technology alternatives to non-utility DG, such as highly efficient MW-scale turbines, and economic alternatives, such as pricing electricity on a value basis, will narrow the market opportunities for DG and for gas LDCs.

  Special circumstances in certain states or by certain companies offer opportunities for the DG industry and the gas LDCs. Some companies are targeting customers for isolated operation to avoid competitive transition charges. Others are targeting new customers to avoid both transition charges and exit fees. Many companies are targeting high-reliability customers and explicitly incorporating the value of avoiding outages into the payback calculations. Other companies are targeting residential customers with the highest electric rates. A common approach is to define the DG equipment as a break-even proposition and plan to profit from the increased gas throughput.

Table ES-2 Key Value Elements for Grid-Connected Commercial / Industrial DG

Element	***Favorable***	***Comment***
Load	200-2,000 kW	With current DG technologies, economies-of-scale become very important for loads exceeding about 200 kW. Smaller loads may be economical in certain applications, e.g., high-value cogeneration (for the user) or high-value gas throughput (for the LDC). Loads above a few MW tend to have existing opportunities without any changes in DG technology, interconnect standards and costs, restructuring, etc.
Load Factor	>60%	Sixty percent is often cited as the breakpoint needed to spread the fixed costs of the DG system over the kWh. Deviations from the 60 percent level would depend on offsetting factors, e.g., thermal value.
Thermal Value	>1 cent/kWh- equivalent	Capturing thermal value, e.g., water or space heating, requires additional equipment and systems. Unless the thermal value exceeds about 1 cent/kWh-equivalent, it is rarely economical to add these heat recovery systems. Thermal value rarely exceeds 2 cents/kWh-equivalent.
Spark Spread	>4	The spark spread is the difference between the delivered price of electricity and the price of the fuel input to the electric plant in some common unit. The convention is to compare electricity in cents/kWh to gas in $/MMBtu. In this convention, a spark spread exceeding "4" (e.g., electricity at more than 8 cents/kWh and gas at less than $4/MMBtu) is a favorable relationship.
Installed Cost	<$700-800/kW	The $700-800/kW price range is the most common breakpoint for most applications, assuming the electrical efficiency of the generator approaches 40 percent. For micro-turbines, where current efficiencies are no more than 25-30 percent, capital costs would have to be lower. For fuel cells, capital costs could be higher.
New Source Review Status	Non-attainment area	The higher the non-attainment category, the greater the advantage for fuel cells and micro-turbines, especially in NO_x non-attainment areas. If non-attainment is a minor issue or no issue, lower cost reciprocating engines are typically favored.
Reliability	Explicitly valued	In applications where reliability is the driving factor for DG, it is important for the reliability benefit to be explicitly valued and explicitly included in the payback calculation. The common

Element	*Favorable*	*Comment*
		practice of implicit valuation understates the benefits from DG.
Gas LDC Load Factor	Increase	Sales of gas for DG increase throughput on the gas system and thus help spread fixed costs. Sales of gas that increase the LDC load factor are the most beneficial. The greater the load factor benefit, the more incentives the gas LDC can afford to offer for DG investment.
Electric LDC Constraints	Significant	To the extent the electric LDC is significantly constrained from providing reliable, low-cost service (e.g., distribution congestion, unreliable peak supplies, etc.), the value to the customer from a low-cost, reliable alternative increases. Moreover, the incentives the electric LDC can afford to offer for DG investment increase. In these cases, coordinated activities among the three parties (gas distribution, electric distribution, and customer) have the maximum value.

Source: SAIC Estimates.

- **The Electric LDC Response --** To retain markets at risk from DG, electric LDCs will expand the use of real-time pricing, increase backup or standby charges relative to energy charges, and may seek to site their own large DG (e.g., multi-megawatt turbines) at or near substations or industrial loads. Some electric LDCs are likely to delay or obstruct DG by requiring case-by-case reviews of interconnections and system impacts. Conflicts between the electric LDCs and potential DG users and within combination LDCs will increase. Electric LDC ownership of large-scale natural gas-fired DG may provide some benefit to the gas LDCs, depending on how the gas is procured, but less benefit than retail sales to mid-sized and large C/I customers. Electric transmission companies may be more supportive of DG, depending on the ability of DG to defer the need for new transmission capacity.

- **Technologies –** Reciprocating engines and small combustion turbines hold the most immediate potential for large-scale DG market penetration. While micro-turbines and, to a much lesser extent, fuel cells are entering commercial service today, large-scale market penetration is 5-10 years away for micro-turbines and 10 years or more for fuel cells. This stretched schedule is partly in recognition of the difficulty in commercializing new generating technologies and partly in recognition of the dynamic nature of the market for electric power generation and delivery. General issues in accelerating the acceptance of the new technologies include interconnection cost and technical barriers; and proof of reliability, maintainability, and operability. Specific issues are tied to the value propositions of the various applications, e.g., isolated operation and cogeneration potential.

1.0 INTRODUCTION

This report provides a management-level review of the market opportunities, risks, and issues facing the gas distribution companies in dealing with distributed generation (DG). In this report, distributed generation (DG) means a small electric power plant (less than 50 MW, and usually less than 25 MW) constructed at the customer's site to serve onsite loads, or constructed at the end of a distribution line to support the distribution system. Merchant power plants are excluded. Discussions with members of the industry indicate that DG (as an emerging concept) covers an even smaller range -- a few tens of kW (excluding individual residential applications) to about 5-10 MW. Above 5-10 MW, DG is a continuation of the established trend towards on-site and industrial cogeneration. Service from a DG plant may be in parallel with the grid, isolated from the grid, or alternating between parallel and isolated operations.

1.1 BACKGROUND

Numerous changes in the electric power industry in the past few years have raised a great deal of interest in DG. In particular:

- Advances in power generation and power control technologies have made DG, primarily natural gas-fired DG, increasingly competitive with conventional grid-supplied electricity in many applications in many parts of the U.S.

- Changes in the operations of the electric system (e.g., reduced reserve margins, more price and supply volatility) and changes in the way electricity is priced (e.g., real-time pricing, competitive transition charges) have created opportunities for non-traditional methods of supplying power on a value basis rather than a cost basis.

- The emergence of transmission and transmission-related issues (siting, interchange pricing, wires charges, capacity reservation, etc.) as obstacles to efficient, reliable power flows within and across utility and regional borders.

- Restructuring of the electric industry has made ownership and operation of DG less costly and less complicated than in the past.

Capitalizing on these changes is a key to success for the parties on each side of the electric meter:

- DG offers many customers, especially small to mid-sized commercial / industrial (C/I) customers, the potential to lower their electric and thermal power costs and increase their electric reliability and flexibility.