



DISTRIBUTED GENERATION FORUM

The Role of Distributed Generation in Competitive Energy Markets

Distributed Generation:

Small power generation units (typically less than 30 MW) strategically located near consumers and load centers that provide benefits to customers and support for the economic operation of the existing power distribution grid.

This paper describes the role of distributed generation (DG) in current and emerging energy markets. The discussion focuses on the following topics:

DG Technologies	2
Applications for DG	5
Benefits of DG	8
Electric Industry Restructuring	10
Stakeholder Roles and Perspectives	13

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When Thomas Edison built the Pearl Street Power station to provide the first electric service to customers in New York City, he was essentially following a strategy that today would be called distributed generation – building power generation within the localized area of use. As the young industry grew, many industrial facilities built their own power plants both to serve their own needs and to sell to customers around them, another example of distributed generation. Rapid technological development led to larger and more efficient generating plants built farther and farther from the end-user. Large regional power transmission networks delivered this power to the local distribution systems and finally to the end-user. The industry was regulated so that these changes could occur efficiently without wasteful duplication of facilities, and the economic role of distributed generation became much more limited.

Since the 1970s, however, large central nuclear and coal-fired power stations have become increasingly expensive and more difficult to site and to build. At the same time, technological development has improved the cost and performance of smaller, modular power generation options – from 300 megawatt (MW) gas-fired combined cycle power plants down to individual customer generation of as little as a few kilowatts. The industry is also restructuring to allow customers to competitively select the optimum combination of energy resources to meet their needs.

Distributed Generation Technologies

Energy service providers and consumers can select from a wide range of distributed power generation technologies. Commercial technologies such as reciprocating engines and small combustion turbines already are used in a variety of applications from emergency power to combined heat and power. Emerging technologies such as fuel cells, microturbines, and photovoltaics will provide additional options for distributed power generation.

Reciprocating Engines

Reciprocating internal combustion (IC) engines (Figure 1) are a widespread and well-known technology. North American production tops 35 million units per year for automobiles, trucks, construction and mining equipment, lawn care, marine propulsion, and, of course, all types of power generation from small portable gen-sets to engines the size of a house, powering generators of several megawatts. Spark ignition engines for power generation use natural gas as the preferred fuel – though they can be set up to run on propane or gasoline. Diesel cycle, compression ignition engines can operate on diesel fuel or heavy oil, or they can be set

up in a dual-fuel configuration that burns primarily natural gas with a small amount of diesel pilot fuel and can be switched to 100% diesel. Current generation IC engines offer low first cost, easy start-up, proven reliability when properly maintained, good load-following characteristics, and heat recovery potential. IC engine systems with heat recovery have become a popular form of DG in Europe. Emissions of IC engines have been reduced significantly in the last several years by exhaust catalysts and through better design and control of the combustion process. IC engines are well suited for standby, peaking, and intermediate applications and for combined heat and power (CHP) in commercial and light industrial applications of less than 10 MW.

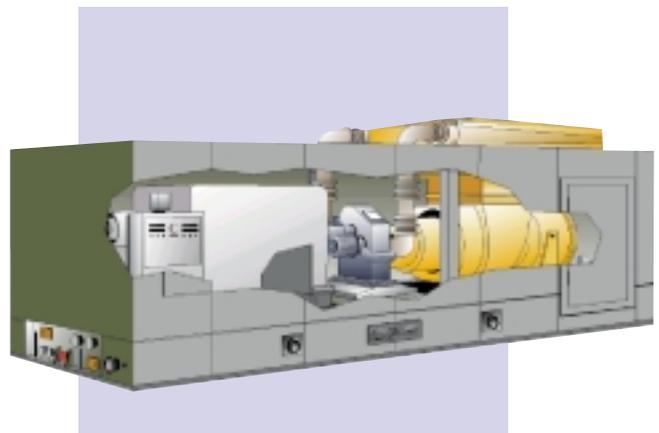
Combustion Turbines

Combustion turbines (CT) (Figure 2) are an established technology in sizes from several hundred kilowatts to hundreds of megawatts. CTs are used to power aircraft, large marine vessels, gas compressors, and utility and industrial power generators. In the 1-30 MW size relevant to distributed generation applications, over 500 CTs were shipped worldwide last year, totaling over 3,500 MW for electric power generation. Most of these units are sold overseas; the North American market represents an 11% share of these totals. CTs produce high quality heat that can be used to generate steam for additional power generation (combined cycle) or for industrial use or district heating. CTs can be set up to burn natural gas or a variety of petroleum fuels or can have a dual-fuel configuration. CT emissions can be controlled to very low levels using dry combustion techniques, water or steam injection, or exhaust treatment. Maintenance costs per unit of power output are among the lowest of DG technology options. Low maintenance and high quality waste heat make CTs an excellent choice for industrial or commercial CHP applications larger than 5 MW.

Figure 1
**Skid-mounted,
Gas Engine Generator**
Courtesy of Caterpillar, Inc.



Figure 2
**Typical Small Combustion Turbine
Generation Plant**
Courtesy of Solar Turbines, Inc.



Microturbines

Microturbines or turbogenerators (Figure 3) are very small combustion turbines with outputs of 30 kW to 200 kW. Individual units can also be packaged together to serve larger loads. Several companies are developing systems with targeted product rollout within the next two years. Turbogenerator technology has evolved from automotive and truck turbochargers, auxiliary power units for airplanes, and small jet engines used for pilotless military aircraft. Recent development of these microturbines has been focused on this technology as the prime mover for hybrid electric vehicles and as a stationary power source for the DG market. In most configurations, the turbine shaft spinning at up to 100,000 rpm drives a high speed generator. This high frequency output is first rectified and then converted to 60 Hz (or 50 Hz). The systems are capable of producing power at around 25-30% efficiency by employing a recuperator that transfers heat energy from the exhaust stream back into the incoming air stream. Like larger turbines, these units are capable of operating on a variety of fuels. The systems are air-cooled and some even use air bearings, thereby eliminating both water and oil systems. Low-emission combustion systems are being demonstrated that provide emissions performance comparable to larger CTs. Turbogenerators are appropriately sized for commercial buildings or light industrial markets for cogeneration or power-only applications.

Fuel Cells

Fuel cells (Figure 4) produce power electrochemically like a battery rather than like a conventional generating system that converts fuel to heat to shaft-power and finally to electricity. Unlike a storage battery, however, which produces power from stored chemicals, fuel cells produce power when hydrogen fuel is deliv-

ered to the negative pole (cathode) of the cell and oxygen in air is delivered to the positive pole (anode). The hydrogen fuel can come from a variety of sources, but the most economic is steam reforming of natural gas – a chemical process that strips the hydrogen from both the fuel and the steam. Several different liquid and solid media can be used to create the fuel cell's electrochemical reactions – phosphoric acid fuel cell (PAFC), molten carbonate fuel cell (MCFC), solid oxide fuel cell (SOFC), and proton exchange membrane (PEM). Each of these media comprises a distinct fuel cell technology with its own performance characteristics and development schedule. PAFCs are in early commercial market development now with 200 kW units delivered to over 120 customers. The SOFC and MCFC technologies are now in field test or demonstration. PEM units are in early development and testing. Direct electrochemical reactions are generally more efficient than using fuel to drive a heat engine to produce electricity. Fuel cell efficiencies range from 35-40% for the PAFC up to 60% with MCFC and SOFC systems under development. Fuel cells are inherently quiet and extremely clean running. Like a battery, fuel cells produce direct current (DC) that must be run through an inverter to get 60 Hz alternating current (AC). These power electronics components can be integrated with other components as part of a power quality control strategy for sensitive customers. Because of current high costs, fuel cells are best suited to environmentally sensitive areas and customers with power quality concerns. Some fuel cell technology is modular and capable of application in small commercial and even residential markets; other technology utilizes high temperatures in larger sized systems that would be well suited to industrial cogeneration applications.

Figure 3

Microturbine Generator

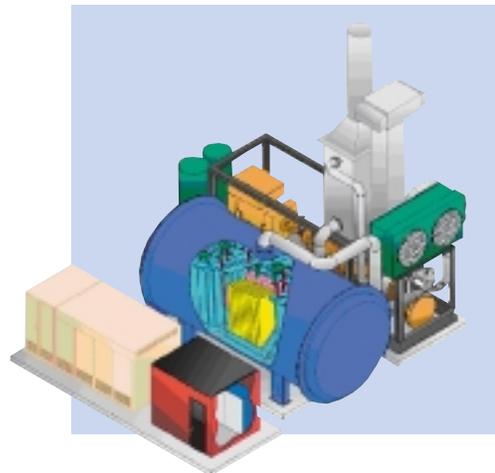
Courtesy of Allied Signal Corporation



Figure 4

Advanced Fuel Cell Power Plant in Combined Cycle with Gas Turbine

Courtesy of Siemens-Westinghouse, Inc.



Photovoltaics

Photovoltaic power cells (Figure 5) use solar energy to produce power. Photovoltaic power is modular and can be sited wherever the sun shines. These systems have been commercially demonstrated in extremely sensitive environmental areas and for remote (grid-isolated) applications. High costs make these systems a niche technology that is able to compete more on the basis of environmental benefits than on economics.



Figure 5

Photovoltaic Power Array in DG Service

Courtesy of Edison Technology Solutions, Inc.

Technology Comparison

In a broad sense, all of these technologies compete with each other and with utility and merchant power generation options. In a narrow sense, each technology is aimed at specific and often different market segments, so side-by-side comparisons must be viewed cautiously. Power generation economics depend on first cost, running efficiencies, fuel cost, and maintenance costs. Site suitability depends on size, weight, emissions, noise, and other factors. Table 1 shows the basic system performance characteristics for engines, turbines, turbogenerators, fuel cells, and photovoltaics.

Table 1

Economic Comparison of Distributed Generation Technologies

Technology Comparison	Diesel Engine	Gas Engine	Simple Cycle Gas Turbine	Microturbine	Fuel Cell	Photovoltaics
Product Rollout	Commercial	Commercial	Commercial	1999 – 2000	1996 – 2010	Commercial
Size Range (kW)	20 – 10,000+	50 – 5,000+	1,000+	30 – 200	50 – 1000+	1+
Efficiency (HHV)	36 – 43%	28 – 42%	21 – 40%	25 – 30%	35 – 54%	n.a.
Genset Package Cost (\$/kW)	125 – 300	250 – 600	300 – 600	350 – 750*	1500 – 3000	n.a.
Turnkey Cost – no heat recovery (\$/kW)	350 – 500	600 – 1000	650 – 900	600 – 1100	1900 – 3500	5000 – 10000
Heat Recovery Added Costs (\$/kW)	n.a.	\$75 – 150	\$100 – 200	\$75 – 350	incl.	n.a.
O&M Cost (\$/kWh)	0.005 – 0.010	0.007 – 0.015	0.003 – 0.008	0.005 – 0.010	0.005 – 0.010	0.001 – 0.004

*Commercial target price

Applications for Distributed Generation

To understand how distributed generation fits into the overall energy market, it helps to look at the nature of the service provided, location on the grid, and the benefits to customers, transmission and distribution (T&D) companies, and energy service providers. Competition has brought a greater awareness that electric service is, in fact, a bundle of services that can be provided and priced separately (i.e., unbundled) in a competitive market. The services provided can be described as follows:

- Energy – providing all the customer's kilowatt-hours
- Capacity – meeting the customer's peak load requirements
- Reserve – maintaining additional capacity for fluctuations and emergencies
- Reliability – the end result of the level of investment in facilities and labor and management
- Power quality – voltage and frequency support and reactive power
- Back-up and standby service – support for customers with partial generating capability.

As customers and energy service providers develop the freedom to contract separately for these individual services, there may be a greater opportunity to use distributed generation as a means to optimize the sum of services required.

DG applications can be designed to meet a wide variety of service requirements and fulfill the needs of many customers and energy service providers. The applications categories defined below represent typical patterns of services and benefits provided by DG.

Combined Heat and Power

Power generation technologies create a large amount of heat in the process of converting fuel into electricity. For the average power plant, two thirds of the energy content of the input fuel is converted to heat. This heat can be utilized by customers, but only if the power generation is located at or near the customer's site. Combined heat and power (CHP), also called cogeneration, can significantly increase the efficiency of energy utilization, reduce global emissions, and lower costs. CHP is best for mid to high thermal use customers: process industries, hospitals, health clubs, laundries, etc. The approach has been successful in large industrial markets that use significant quantities of steam.

The application of CHP was greatly expanded by the Public Utilities Regulatory Policies Act of 1978 (PURPA). In the past twenty years, over 50,000 MW of CHP capacity has been built. The cogeneration rules in PURPA were designed to increase efficiency of fossil fuel utilization and stimulate the market by requiring utilities to interconnect with cogenerators and buy power at avoided costs that were calculated according to regulated procedures. Some of these rules implemented at the individual state level have resulted in contracts with cogenerators that contained pricing and operating terms and conditions that accommodated the vertically integrated power system but are not economic under current market conditions. In a competitive power market, more flexible rules will be required to ensure that customers, developers, and utilities can negotiate appropriate relationships that optimize the benefits of CHP for each of the participants. In addition, CHP can provide social benefits in the form of overall reduction of air and water pollution, reduction of emissions of greenhouse gases that contribute to global warming, and local and regional economic development.

Standby Power

The electric power system in North America is extremely reliable. Customers count on uninterrupted electric service 24 hours a day, seven days a week, week in and week out. Outages do occur, of course, most of which are the result of storm or accident damage to overhead T&D systems. With few exceptions, such outages tend to be brief and infrequent. Nevertheless, some customers are so sensitive to outages that they have standby generators onsite to supply power themselves until utility service is restored. Some standby generators are required by law to maintain public health and safety, such as for hospitals, elevators, and water pumping stations. For other customers like telecommunications, retail, and process industries, the installation of standby generators is an economic choice based on extremely high outage costs.

Standby generators are a highly underutilized generating resource. They hardly ever run, they aren't counted as either utility or non-utility generating capacity, and they usually are specifically isolated from grid connection. Still, there may be upwards of 40,000 MW of standby capacity in place today. Some utilities recruit customers with standby generation for peak load reduction programs offering payments or rate relief for limited operation during utility peak periods – generally fewer than 200 hours per year. Customer choice of competitive power suppliers may stimulate the economic competitiveness of standby generators and increase the run hours for units in the field. Standby generation can be part of an optimal strategy that minimizes power costs and maximizes reliability through combinations of firm and interruptible power and onsite standby capability.

Peak-Shaving

The costs for power vary hour by hour depending on the demand and the availability of generating assets. Utilities see these variations, but customers typically do not. Larger customers often pay time-of-use (TOU) rates that convert these hourly variations into seasonal and daily categories such as on-peak, off-peak, or shoulder rates. With the advent of wholesale and retail competition in certain markets, more of these cost variations will be transmitted directly as price signals. Both TOU customers and those participating in competitive power markets could select distributed generation options during high-cost peak periods. Using DG for peak-shaving could reduce the customer's overall cost of power. In turn, this customer capability could reduce the need for the energy service provider to generate or contract to receive and redistribute very high cost power. TOU customers may find that their DG systems are cheaper than the peak TOU rates for much of the year. The closer that the price paid for power matches the actual hourly costs, the greater are the economic benefits to both the customer and the energy service provider in developing a peak-shaving strategy.

Grid Support

The power grid is an integrated system consisting of generation, high voltage transmission, substations, and local distribution. Selected use of distributed generation can provide system benefits and reduce the need for investment in other parts of the system. Potential DG benefits include:

- Voltage and frequency support to enhance reliability
- Avoidance or deferral of high cost, high lead time T&D system upgrades
- Reduction of line losses
- Reactive power control
- Transmission capacity release
- Reduced central generating station reserve requirements
- Fuel use reductions when solar, renewable, or high efficiency DG is applied in place of central station power.
- Emissions reduction from photovoltaics, fuel cells, and clean cogeneration

The evaluation of these benefits and the development of mechanisms whereby DG can provide grid support is an ongoing process. This process will likely occur more quickly in areas where the power industry is being restructured and costs are being unbundled.

Stand Alone (Grid Isolated)

In selected situations, grid isolated DG may be more economic than integration with the power grid. This would be true in very isolated or remote applications. In some cases, customers with CHP systems have separated from the grid due to an inability to negotiate economic back-up power from their energy service provider. It is expected that competitive power access would reduce the need for these customers to isolate from the grid.

Table 2 compares the applications described above with the individual service characteristics defined at the beginning of this section.

Table 2

Distributed Generation Applications and Services Provided

Services Provided	Combined Heat and Power	Standby Power	Peak-Shaving	Grid Support	Stand Alone
Energy	Simultaneous production of electricity and useful heat provide low cost energy to customers	Energy production is minimal and a small part of overall value	Provides alternative to high cost peak period energy	Reduces line losses, can be important in remote or congested parts of the T&D system	Must provide customer full requirements
Capacity	Provides capacity when running	Customer reserve capacity	Avoids high peak period system capacity costs	Can help to avoid T&D capacity constraints	Must provide customer full requirements
System Reserve	If the system is running at full load, by definition there is no reserve	Possible extension of current applications, but not part of most current standby systems	Could provide spinning and standby reserve during off-peak periods	Could provide spinning and standby reserve during off-peak periods	Must provide customer full requirements
Reliability	Systems are generally as reliable or more so than individual utility generators. Synchronous generators increase customer reliability by 90+% but don't contribute materially to system reliability	The primary purpose of these systems is to approach 100% reliability for health and safety reasons and to avoid economic losses from grid power outages	Increases customer reliability and can be part of a utility program to reduce shortage based outages	Increases reliability due to supply shortages, T&D constraints, and storm related outages	Must provide customer full requirements
Power Quality	Provides customer some protection from grid problems; can be part of a premium quality customer system	Not a primary issue but can be part of a premium quality customer system	May help customer to avoid voltage sags and brownouts that occur during system emergencies	Can be used for power factor correction and voltage support	Must provide customer full requirements
Back-up Service	For every 1% drop in generator availability, the system requires 87 hours of back-up service. Back-up for maintenance during off-peak periods, but forced outages can occur anytime	The system is the back-up service so separate back-up service is not required	Peak-shaving can be an extension of back-up service	Grid support enhances T&D system in general, not specific to back-up service	Must provide customer full requirements

Benefits of DG Applications by Stakeholder Group

The different DG applications provide various benefits to the stakeholders. Not all stakeholders benefit directly in all applications. CHP most directly benefits customers by providing lower energy costs. Social benefits from CHP include environmental benefits associated with combined heat and power production and economic benefits of higher productivity. Integrated electric utilities have, for the most part, not benefited from customer-operated CHP. However, in a competitive electric supply market, the T&D companies will be less affected by customer CHP and may receive grid support benefits. Standby systems meet customer reliability needs, but may be used by the T&D companies or energy service providers (ESPs) to provide peak load support for both supply and T&D constraints. Peak-shaving systems appear to

provide large benefits to both customers and the T&D companies and may be the first market stimulated by electric industry restructuring. Grid support systems can optimize operations for T&D companies, thereby providing benefits to customers and operators in affected areas. Historically, stand alone or grid isolated systems were often the result of adversarial negotiations on customer generation projects and could have provided larger benefits to both if the system had remained grid connected. In the future, grid isolated systems may be less likely unless stranded cost recovery rules allow customers to avoid high payments by leaving the system altogether.

Table 3 summarizes potential stakeholder benefits for the various applications discussed in this paper.

Table 3

Distributed Generation Applications and Benefits by Stakeholder Group

Stakeholder	Combined Heat and Power	Standby Power	Peak-Shaving	Grid Support	Stand Alone
Customer	Lower energy costs, higher overall reliability	Avoid economic loss due to system outage and satisfy critical life support requirements	Lower peak period energy costs	Customers generally benefit from the enhanced service provided, but may be isolated from competitive markets as a result	Customer option to avoid high cost back-up service for CHP system; remote communications and control systems
T&D System	Positive to negative depending on situation	Can be integrated with utility needs to provide both customer and grid benefits	Can be integrated with utility needs to provide both customer and grid benefits	Enhances grid stability and economic customer service	Loss of customer load and associated revenues
Energy Service Provider	Power and heat can be separately marketed, ESPs can also provide ancillary services to CHP customers	Can facilitate ESP marketing of interruptible power supplies, widely used strategy of municipal power systems	Can aggregate and sell customer peak period generation	Possible benefits as an owner-operator of the system	Possible benefits as an owner operator of the system
Natural Gas Industry	Benefit from high gas consumption, possible fuel switching benefit for oil-fired boilers	Minimal impact, but cost to service customers is high	Good match of gas off-peak period with electric on-peak period	Generally similar to peak-shaving benefits	Benefit from high gas consumption
Society	Environmental benefits, conservation, economic development	Public health and safety	Environmental benefits, economic development	Environmental benefits, economic development	Less likely in a competitive market to represent an optimum allocation of resources

Electric Industry Restructuring

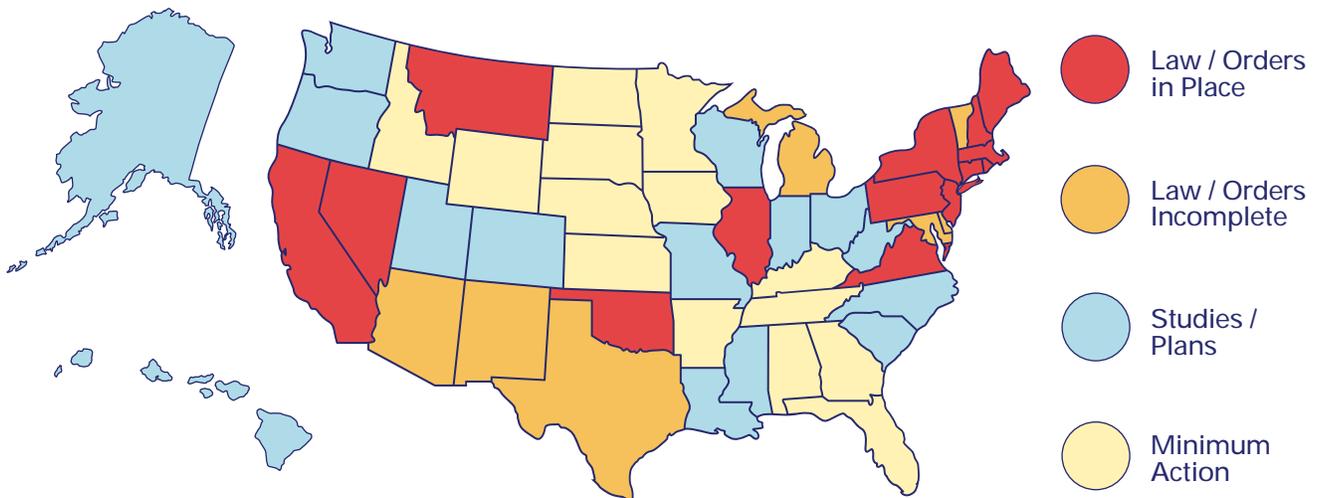
Restructuring of the electric power industry is underway with the objective of allowing customers to choose among competing power suppliers. The Federal Energy Regulatory Commission has already established rules to make wholesale power markets competitive. Retail competition is being enacted or proposed by many states, and generation is becoming an unregulated, competitive business. Six states have already initiated customer choice, and eight others have legislation or orders in place for implementation at a later date (see Figure 6). With some exceptions, the most activity has occurred in the high power cost regions of the country – namely California, the Northeastern and New England states, and Illinois.

In other states, especially the lower cost regions, the industry, the public, and regulators appear to be delaying a decision until more information can be gained from the experiences of the leading states – especially as transition problems emerge. This situation could well continue for several years, and it may be up to ten years before all states are restructured to allow competitive access. This delay will result in a high level of uncertainty among all parties to the process and a reluctance to proceed with investment at any level until the uncertainties are removed. Some critics have pointed to recent occurrences in the power industry, such as the blackout in the West in 1996 and the capacity shortage and high prices in the Midwest in 1998, as evidence that restructuring will threaten power reliability.

The changes underway are leading to a new industry structure as depicted in Figure 7. The changes will generally separate the generation, transmission, and distribution functions of the industry into separate entities with new functions. Critical aspects of restructuring are as follows:

- To ensure equal access to wholesale markets, transmission facilities are being placed under the control, but not ownership, of independent system operators
- Utility generating assets are being separated from the distribution companies and are being deregulated in order to develop a competitive market for power.
- Power marketers have emerged, creating an active power trading market.

Figure 6
Status of Deregulation by States (as of 3/1/99)



Source:
 George C. Ford & Associates

- Utilities are to be compensated for stranded assets – investments made and costs incurred prudently under the existing regulatory compact that must be written off during the transition to competition.
- New mechanisms are being evaluated for maintaining public interest programs after restructuring such as research and development, conservation, support for renewables, and social programs previously administered by utilities.

At the same time that utilities are changing their vertically integrated structure, many are seeking to integrate horizontally through mergers with other power companies, gas companies, and other energy service providers in order to increase their customer access and expand the products and services that they provide.

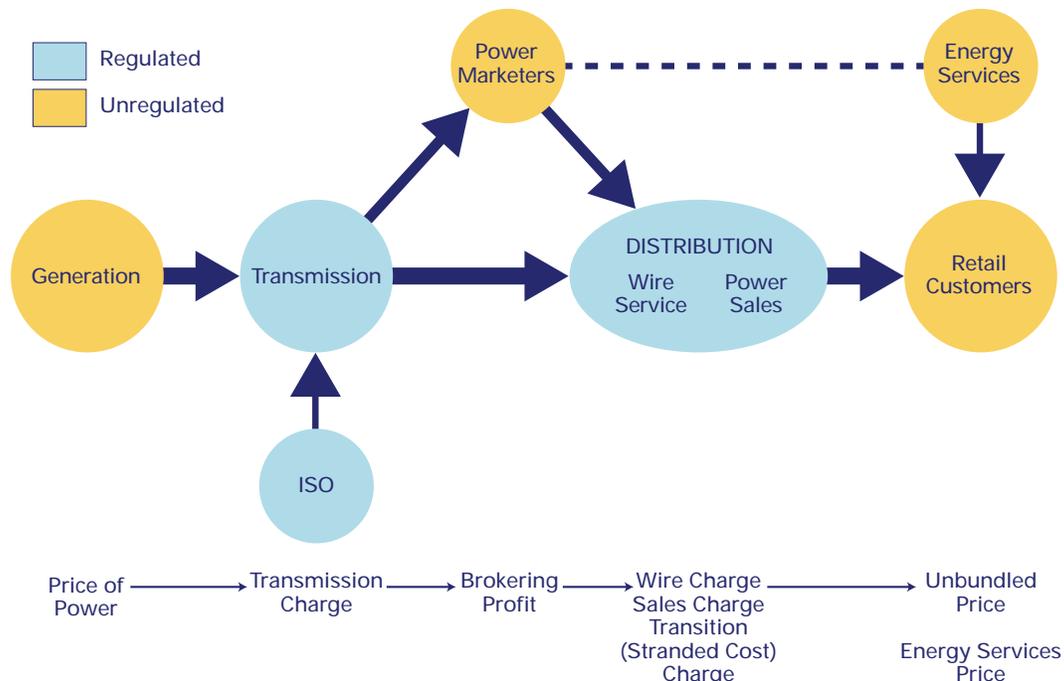
These industry changes are leading to new strategies by traditional utilities, independent unregulated new players, and customers in order to compete or take advantage of the new market:

- Competition for customers will lead to greater attention to customer needs. The regulated and unregulated industry players must respond to demands for choice of supplier and lower energy cost, better power quality, and overall energy services tailored to specific needs of each customer or customer class.

- In the commodity business of producing electric power, low cost will be the primary goal. Market risks must be avoided by minimizing capital investment and maintaining short lead-time for capacity additions.
- The potential attractiveness of small, dispersed sources has led to greater efforts to develop these technologies, including more efficient small gas engines, combustion turbines, microturbines, and fuel cells.

The electric capacity requirements during this ten-year transition period will depend on the future industry growth rate and the ability of restructuring to make more effective use of existing capacity, to cut reserve margins without affecting reliability, and to keep marginally economic plants operating. The future power requirements over the next ten years to meet new load growth and to replace retired capacity could range from 60,000 to 120,000 MW. This power will come from a combination of new central station generation plants, independent and merchant plants, and distributed generation.

Figure 7
U.S. Electric Industry – Expected Future Structure



The Potential Role of Distributed Generation in the New Electric Markets

Distributed generation will play a role in supporting available capacity to meet peak power demands, provide critical customer loads with emergency standby power, improve user power quality, and provide low-cost total energy in CHP applications. Potential customers include commercial and industrial users, distribution utilities, power marketers, and possibly even residential customers as well. Specific applications will be discussed in more detail below.

The key success factor for DG in a competitive situation can be best described as “providing the customer with the lowest cost solution to meet his particular needs.” In some cases, this may be lowest initial or production cost; in others, it might be the lowest cost after considering site-specific or strategic factors. Distributed generation faces a challenge due to generally higher specific capital costs (\$/kW) and production costs (\$/kWh) than larger generating systems. These challenges must be balanced against positive factors such as the opportunity for waste heat utilization, increased reliability at the site, avoidance of peak load constraints and price spikes, reduction of transmission and some distribution charges, avoidance of energy line losses, improved power quality, and greater flexibility to react to market changes. Providing a specific valuation and a market for these services will allow DG to compete effectively where the system needs are greatest.

Distributed generation has traditionally faced obstacles from lack of technology maturation, integrated utility use of its own generating capacity, and a number of technical and regulatory obstacles to launching a new project. These other obstacles include interconnection requirements, permitting and siting, and building and electrical codes. Industry restructuring will remove structural obstacles to DG and will provide greater incentive to developing strategies for implementation.

Certain details of the restructuring process will have a big impact on DG's role during the transition period and beyond:

- Charges for utility stranded cost recovery – Utilities are being permitted to recover stranded assets using various types of tariffs including exit fees, competitive transition charges, access charges, and other means. Policies for application of these charges to distributed generation could significantly delay the benefits of these projects. Regulators are generally concerned with fairness toward all ratepayers and reluctant to subsidize one group at the expense of others. However, certain social benefits such as environmental protection and regional economic development may justify special treatment. Most states intend to apply the stranded cost charge only to power purchased from the grid.
- Standby charges for connection to the utility power grid – Customer-owned generation requires in most cases a back-up source of power to meet load requirements during generation outages. Utilities now charge not only for the power used but for the standby generation and distribution capacity. In the future deregulated market, the generation back-up charge will be negotiated between the user and the generation supplier, and the distribution charge negotiated with the utility as it is now. Regulators will be involved only with the distribution charge and must try to balance the utility and user positions on what is a reasonable charge that is fair to all ratepayers. A somewhat related issue is the treatment of customers who “take” power from the grid for which they have not contracted. Appropriate penalties need to be developed to keep customers that purchase from the competitive market from jumping back to the utility during periods of very high prices.
- Utility ownership of distributed generation – The separation of generation functions from T&D functions provides for equal access to competitive markets. However, regulators in some cases have supported selected DG investments by electric distribution companies that can provide grid support for localized areas.

Stakeholder Roles and Perspectives

Distributed generation is one piece of the larger picture that will emerge as a more efficient and competitive power market. Uncertainty concerning the direction of change in the electric power industry in this country and the potential magnitude of these changes combine to delay a strong focus on distributed generation.

Large customers are waiting for expected lower energy rates; many would like to outsource responsibility for managing their energy needs to a competent provider so that they can focus their resources on their core business needs. Small customers are concerned about how they will share in the benefits of deregulation. The regulated electric power industry and the regulators have too many other priorities right now – sale of generating assets, stranded asset recovery, and restructuring. Independent power providers (IPPs) are focusing their efforts on large merchant power plants and renegotiation of existing contracts. Power marketers and energy service providers are busy building the structure of the new market and gaining customer and power access. ESPs and energy service companies (ESCOs) are looking to build multilevel service capability, and they do see distributed generation as an important component of a complete line of customer services and products.

Recognizing that all of these goals compete for the attention of these market participants, an important purpose for this paper is to focus attention on the benefits of distributed generation and to define active roles for the main stakeholders.

Federal Government

While electric industry restructuring is proceeding without a clear federal position, there are a number of federal initiatives that could facilitate the emergence of competition in both wholesale and retail power markets. The administration has prepared a comprehensive proposal, the Federal Energy Regulatory Commission has outlined its proposals to Congress, and there are at least 16 bills before Congress that address a wide range of issues. The expected aspects of a federal program are as follows:

- Federal directive for states to implement retail consumer choice programs by a certain date (January 1, 2003, in the administration proposal)
- Repeal of the Public Utilities Holding Company Act of 1935, which was designed to protect against market abuses foreseen in the 1930s but which, today, is an impediment to the type of restructuring needed to promote competition
- Repeal of the requirement for utilities to buy power from cogenerators and renewable sources at avoided costs (Section 210 of the Public Utilities Regulatory Policies Act of 1978) and establishment of a new policy toward renewable energy
- Establishment of a federal authority for determining reliability standards for the electric power industry
- Support for stranded cost recovery under state laws including nuclear decommissioning costs
- Extension of competitive access rules to federal power marketing administrations and to municipal utilities, including facilitation of sale of generating assets funded with municipal bonds
- Establishing a procedure for resolving disputes among states and regions and requiring reciprocity between states on power access
- Research and development to support cleaner and more efficient technologies
- Development of initiatives that promote environmental and conservation benefits from CHP projects. The recommended CHP initiatives include streamlined environmental permitting, nondiscriminatory grid access, and tax incentives.

State Governments

As defined in the opening discussion on restructuring activity, the 50 states differ widely on their progress toward competitive access. Restructuring legislation has been enacted in 12 states, but progress has been slow in other parts of the country. In a position paper issued by the National Governors' Association, the state roles are defined as follows:

- Ensure fair competitive access to the electricity transmission and distribution grid for electric generators
- Determine the amount and method for recovery of stranded costs resulting from the transition
- Continue to regulate the local distribution systems and ensure their reliable operation
- Evaluate the impact of competition on the fuel mix for power generation and assess associated environmental impacts
- Define a basis for continuing public interest programs in conservation, renewable energy, and other technologies that will benefit the customer.

States that have already begun implementation of restructuring have found specific operational issues emerging that need to be addressed as part of a smooth transition. These issues include revising the state tax codes to avoid revenue loss based on the new modes of purchase and sale of power, development of procedural requirements, and determination of appropriate affiliate relationships. The two most important roles at the state level that could exert a beneficial impact on DG development are:

- Examine and consider utility ownership of distributed generation assets or incentives for DG implementation where system benefits can be achieved by their implementation
- Encourage exemptions from stranded asset recovery for distributed generation projects that have overriding economic, environmental, and social benefits.

Electric Power Companies

The traditional electric utility industry is evolving in various directions to meet the changing needs of a competitive market. Many of the larger investor owned utilities are developing deregulated power generation activities, power and fuel marketing, and energy service companies. At the same time, mergers with gas companies and other power companies are providing the customer access and total service that is believed to be the cornerstone of a healthy restructured company. The suggested roles for the distribution business are:

- Aggressive efforts to minimize stranded assets – e.g., sale of generating assets and settlement of above-market power contracts
- Cost and value analysis in preparation for the development of unbundled services
- Evaluation of constrained areas and ancillary services and alternative means, like distributed generation, that can effectively provide grid support
- Integration of customer generating equipment into interruptible and load management programs to provide greater peak-load reliability
- Development of uniform rules for interconnection.

Independent System Operators

Independent system operators (ISOs) are taking over many of the decision-making functions of regional power systems including, in many cases, operating a competitive power market, deciding on peak power requirements and implementing emergency power programs, and defining and valuing ancillary services. ISOs are defining peak load control programs for customers with standby generation, creating rules for DG participation in the power market, defining ancillary services, and even developing demand-side customer bidding options.

Natural Gas Industry

DG provides a way for gas distribution companies to participate in the evolving power generation market and derive benefits such as growing gas load, increased asset utilization, and additional service opportunities through unregulated affiliates. The gas industry role includes:

- Participation in regulatory proceedings to ensure that gas interests are considered
- Participation with the electric power industry, regulators, and consumers in the development of uniform grid interconnect standards
- Education of key decision-makers regarding gas related issues
- Assistance in the development and deployment of DG technology and application demonstrations
- Communication with DG developers and manufacturers to ensure compatibility with gas systems.

Energy Service Providers / Energy Service Companies

ESPs and ESCOs are aggressively moving to become the source of "one stop" energy shopping for a wide customer base from large industrial and national accounts to the residential retail customer. These companies will provide fuel, power, energy services, project development and operation, management of customer energy facilities, risk management, and financing. Distributed generation represents an important part of this complete portfolio of services designed to improve the competitive position of these companies in the eyes of their customers.

In this context, ESPs and ESCOs will be the market-makers for distributed generation. Their roles will include market development; joint development of demonstration projects with customers, manufacturers, and utilities; development of improved matching of systems to site needs; and reduction in the costs associated with project development. In addition, public education on the uses and benefits of distributed generation is important, as is increasing the awareness of the issues and obstacles inhibiting electricity users from realizing the full potential benefits.

Equipment Manufacturers

The engine, turbine, and fuel cell makers and other manufacturers of generation systems need to work with the market-makers (distributors, ESCOs, and ESPs) to better target system performance, emissions, and life-cycle cost to customer needs. Ancillary equipment makers are also important in this process in the area of controls, communications, dispatch, fuel gas compression, power electronics, and emissions clean-up. They need to participate with the market-makers in project development, demonstration, and education activities. For the developers of emerging technology, the development of manufacturing capability and a sound marketing and service network is of critical importance. Equipment manufacturers should also assume the responsibility to work with agencies setting standards and certification procedures.

Customers

Customers will be faced with new responsibilities in the management of their energy use in a competitive market. Customers that do not prepare will be bombarded with a bewildering array of claims and choices from competing energy suppliers. Many large industrial and commercial customers already have energy management groups that control purchasing and operation of all energy matters. In some cases, customers want to outsource this activity on a contract basis so that they can focus on their primary business responsibilities. Customers can prepare for competitive access by undertaking the following activities:

- Evaluate energy requirements to determine cost-effective energy alternatives
- Identify load shifting or load shedding opportunities
- Quantify outage costs to determine if additional standby generation capacity is needed
- Identify opportunities for using existing or new generation to contract for lower cost interruptible power.

Finally, all potential beneficiaries from distributed generation have a stake in this process and can contribute to achieving the goal of maximizing the benefits from these advancing technologies.

Distributed Generation Forum

The Distributed Generation Forum is a membership organization composed of representatives from electric and gas utilities, their affiliate marketing and development companies, and manufacturers and developers of distributed generation and ancillary equipment. In addition, the Forum includes invited participation from government and private research and development, industry, and marketing organizations that have an interest in distributed generation. The mission of the Forum is to provide its members with technical, regulatory, and market information for their use in strategic planning, market development, internal and external education, and information exchange with trade allies, customers, and regulators. This paper represents the consensus view of the Forum based on the work undertaken during the previous two years, but may not represent the opinions of individual members. Gas Research Institute manages the Forum.

For further information on Forum activities contact:

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