TAKING CONTROL

Distributed generation is a practical way for utilities and electricity users to manage risks and maximize profits in increasingly volatile energy commodity markets

By Michael A. Devine, Caterpillar Inc.

Conventional thinking says electricity users should approach distributed generation with caution because it carries financial and operating risks. But there is another side to the story: The status quo has risks of its own.

In fact, when applied intelligently, distributed generation can be safer than the status quo for public utilities and businesses that purchase large volumes of power. That's because it provides a measure of control in energy markets that increasingly responds to unpredictable market forces.

For evidence, one can look to Heber Light & Power (HL&P), a municipal electric utility based in Heber City, Utah, about half an hour east of Salt Lake City. When power shortages hit California in summer 2000, utilities and their customers in surrounding states felt the effects. HL&P did not experience the rolling blackouts that beset California, but like most utilities in the western United States, it did see spikes in wholesale power prices.

Heber Light & Power in Heber City, Utah, avoids purchasing power at wholesale prices by running natural gas and diesel generator sets at peak-demand hours.

Fortunately, HL&P was prepared. By increasing run time on its distributed generation resources, consisting of natural gas and diesel engine-driven generator sets, HL&P avoided purchasing wholesale power at prices that rose from the typical $20 per MWh to as high as $200 pr MWh at peak-demand hours.

After the crisis passed, HL&P took further steps to protect reliability and stabilize prices, investing in three new advanced gas-fueled generator sets rated at a combined 5.52 MW. With those new units on line as of July 2002, the distributed generation facility has nine gas and two diesel units delivering 11.97 MW of capacity. It provides economical load following year-round and shields HL&P customers against future swings in wholesale power prices.

It also provides a valuable backup power supply: In case of a major wholesale supply interruption, the facility could carry a substantial share of HL&P's load, keeping the majority of its customers in service.

Clearly, more distributed generation reduced, rather than increased, HL&P's financial and reliability risks. The same can be true for end users, such as industrial or commercial customers, who install distributed generation after carefully weighing their options.

-more-

Weighing the possibilities

Distributed generation has come of age in recent years as investor-owned utilities see the benefits of installing small-scale generation near the point of use. The approach lets these utilities put new capacity online quickly and affordably, while delaying the expense and risks of centralized power plants and the transmission lines needed to carry the power to market. In the bargain, localized power sources help utilities deliver consistent voltage on their distribution systems and so meet customers' rising expectations of power quality.

A decade ago, most distributed generation systems consisted of diesel-fueled engine-generators, hosted by facilities with large electric loads or by a public utility. These systems typically operated just a few hundred hours per year to augment the investor-owned utility's peak-hour generating capacity, generally on the hottest and coldest days of the year.

Today, utilities look to distributed generation to support a larger portion of the load curve. The trend is toward systems operating for 700 to 3,000 annual hours and in many cases using natural gas to comply with air-quality regulations.

For investor-owned utilities adopting distributed generation, a key challenge has been finding hosts for the generating equipment. Historically, many power users have held back from investing in generating sources on their property.

Some prefer to focus attention and capital on the core business instead of dealing with the complexities of operating generators and working with energy commodity markets. Others wrestle with conventional means of calculating return on investment or simple payback, weighing equipment capital cost, depreciation, maintenance, fuel consumption, fuel and electricity prices, and other factors.

Today, such conventional analyses tend to highlight the “risk” side of the picture. As they watch gas prices and electricity prices fluctuate, sometimes dramatically, managers question whether they can accurately predict their payback and cost-justify investments in generation.

Seeing the big picture

The reality, however, is that traditional payback analyses tend to ignore the real value in distributed generation. The benefits go much farther than marginal differences between the cost of producing power on site and the price of buying it from a utility. A true analysis of distributed generation examines at least five potential benefits – some far greater and more strategic than simple price-based comparisons.

Load management incentives. Investor-owned utilities, realizing the benefits of distributed generation, often provide substantial incentives to customers who host generating equipment. In a typical arrangement, the utility retains authority to dispatch the units at times of peak demand on its grid. The customer, in return, receives substantial energy-price or demand-charge reductions based on the amount of capacity installed. These incentives dwarf marginal generating cost vs. purchase price differences, often enabling the customer to achieve payback on the initial investment in two to four years.

-more-

Electricity price hedging. A distributed generation host with dispatchable capacity can avoid swings in wholesale power prices, in effect capping its price of power at the cost of running its own generation units.

Greenwood Utilities, a municipal utility based in Greenwood, Miss., serving about 10,000 customers with a peak electric demand of about 70 MW, uses gas- and diesel-fueled generator sets for summer peaking and price hedging. Its generator sets provide a combined 13.175 MW of capacity; they augment two coal-fired generating units totaling 26 MW.

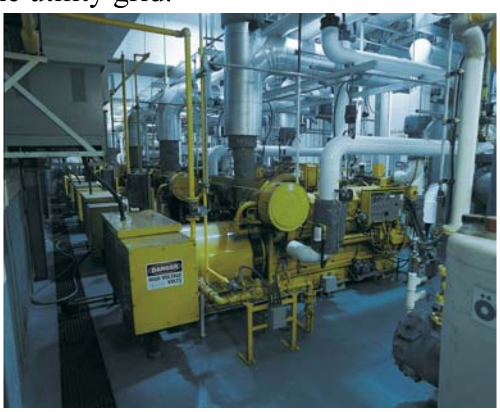
Greenwood's operating strategy is to dispatch the engine-driven units as needed as demand increases with the onset of warm weather in April. In May and subsequent warm-weather months, the utility base-loads one or both coal-fired units, then uses the engine-driven generators as necessary for peaking or price hedging.

Each day, Greenwood personnel monitor the gas and diesel units' generating costs as fuel prices fluctuate. In summer 2002, the gas-fueled generator sets produced electricity at $50 per MWh and the diesels at $62 to $67 per MWh.

Profitable power sales. In an increasingly market-based electric utility industry, the gate swings both ways: Distributed generation owners can not only cap their electricity purchase price but also sell electricity at a profit on power exchanges. For example, a power producer able to generate electricity at $50 to $70 per MWh, and operating interconnected with the utility grid, could benefit significantly during times of shortage when market prices spike to $100 to $200 per MWh.

Critical process protection. A benefit potentially far greater than leveraging utility incentives and power markets is the ability to use on-site power to ensure continuity in the core processes that generate business revenue. Distributed generation enables owners to continue operating through utility power outages and to ensure consistent power quality irrespective of disturbances on the utility grid.

Kuntz Electroplating, Inc. in Kitchener, Ontario, maintains power quality and reliability using natural gas generator sets with CHP systems.



For example, Kuntz Electroplating, Inc., based in Kitchener, Ont., used to experience as many as 15 utility outages per year, typically lasting only seconds, yet causing major process disruptions.

The local utility's service was generally reliable, but each year Kuntz experienced brief outages when transmission lines touched during wind storms or when squirrels or birds nested in substations. Such events interrupted power for just a few seconds, but that was long enough to stop production for as long as one hour. The outages interrupted the continuous filtering of electroplating solutions. After each outage, solution pumps had to be restarted and effective filtration re-established before plating could resume.

-more-

Power quality was another concern for Kuntz, located in a heavily industrial basin. While the utility generally delivered quality power, the company experienced voltage disruptions when nearby businesses turned on arc welders, arc furnaces or large electric motors. The changes in voltage damaged solid-state process controllers, sometimes as often as once per week. Repairs typically shut down the affected electroplating line for about 45 minutes.

Kuntz responded by installing five advanced natural-gas-fueled generator sets with a combined 4.075 MW capacity. When operating at rated load, the units carry roughly 65 percent of total plant electric load.

In case of utility power interruption, control switchgear is configured so that non-critical plant loads are shed while the generator sets operate the critical process loads in an island mode. When utility power is restored, the generator sets automatically resynchronize with the grid, and the utility breaker closes.

Combined heat and power (CHP). A distributed generation system that is financially attractive based on the above criteria becomes even more attractive if its owner can economically recover heat for space conditioning or for production processes.

Kuntz Electroplating recovers heat from its engines' exhaust and jacket water/oil cooler circuits to help satisfy a process heat load of 18 million Btu/hr for parts-cleaning and electroplating tanks. The company projects simple payback on each combined heat and power unit at about six years, based on savings on electricity and steam.

Heat recovery does not need to be that ambitious to have a meaningful, positive effect on distributed generation economics. Almost any installation can profit from a simple heat exchanger capturing low-grade heat from the engine coolant.

For example, a single-pass shell-and-tube heat exchanger costing just a few thousand dollars can capture heat from the engine cooling circuit to produce hot water at 180° to 225° F. That hot water is completely suitable for applications such as:

- Space or domestic hot water heating.
- Seasonal cooling (by way of absorption chillers).
- Desiccant dehumidification.
- Heat for light production processes.
- Process cooling.
- Condensate or make-up water preheating for boilers.

Consider a small or mid-sized manufacturer with an on-site generator set and a hot-water load amounting to roughly one-third of the heat recoverable from the engine cooling circuit. A heat exchanger in the engine cooling loop, with a thermostatically controlled diverter valve to regulate the flow to the in-plant load, could cost-effectively satisfy the hot-water requirement.

An automotive parts plant on the East Coast of the United States used such a system with a 1,600 kW generator set operating about 500 hours per year under an already profitable distributed generation contract with a utility. The CHP system yielded an average of $1,800 per year in added fuel savings for a one-time, $7,000 incremental investment in heat recovery equipment. Simple payback was less than four years.

-more-

Multiple options

Clearly, power users can benefit in multiple ways from investments in distributed generation. They also have a range of choices of prime mover technologies to meet their needs. Today, there are essentially five technically and economically viable prime-mover choices, each with definite benefits for specific applications.

A leading industrial manufacturing plant in Deer Park, Texas, commissioned four gas turbine generator sets to provide 18MW of reliable heat and power to support the company's operations and to protect against power outages.

Gas turbines. An established and proven technology, turbines are well suited for peaking and base-load generation. Turbine systems for distributed generation typically range from 500 kW to 25 MW, or larger. Turbines are generally most cost-effective for large-scale applications involving long, continuous run times at full load. They also perform most efficiently at moderate altitudes and moderate humidity and ambient temperatures.

Newer turbine technologies have proven themselves reliable and cost-effective in serving variable heat and power loads in combined heat and power applications. For example, an innovative process called steam turbine assisted cogeneration (STAC) now delivers the benefits of combined heat and power to a wide range of energy users, large and small, in a broad spectrum of industries.

Fuel cells. Those mysterious black boxes that always seem to be just over the horizon are now available for commercial applications. Prices are dropping, efficiencies are rising, and production capacity stands ready. Prospective users can now pick up the telephone and obtain a complete, turnkey quote for a fuel cell-based power plant.

Fuel cells can be used as primary power sources with the grid used for back up.

Research and development are helping to drive down fuel cells' installed costs, which now average about $4,500 per kW. In the long term, fuel cells promise extremely efficient power. For example, molten carbonate fuel cells in the 1 MW class routinely run at 49 percent electrical efficiency. Fuel cells also produce extremely low emissions and exceptionally consistent voltage.

Today, fuel cells are well suited to off-grid applications such as remote cellular phone sites, airports or military bases where reliability and power quality are essential. In addition, some utilities are looking at fuel cells as environmentally conscious customers demand the option to buy "green" power. As the technology improves and as prices come down, the range of fuel cell applications will grow.

-more-

Diesel reciprocating engines. Distributed generation in large measure began with diesel engines in short-annual-hours utility load management applications. Diesel units' high power density and low installed cost make them extremely attractive for installations requiring up to about 500 run hours per year. They are also ideally suited to remote sites lacking access to reliable utility power and supplies of pipeline natural gas. In standby applications, they have the added advantage of black start capability.

Manufacturers continue to make progress in combustion and control technologies to reduce diesel emissions, while at the same time lower-sulfur fuels make diesel technology inherently cleaner than in the past. As these improvements continue, the role of diesel prime movers in distributed generation has significant potential for expansion.

Gas reciprocating engines. Generator sets fueled by natural gas represent an increasingly popular distributed generation technology. They are proven in standby, prime power, cogeneration and peaking service and over the past decade have provided a fast-growing share of the world's generating capacity additions, especially where air-quality regulations are a major consideration.

Like diesel reciprocating engines, gas units perform well in intermittent service and operate efficiently with variable, cyclic loads. The technology is simple and well understood. Qualified service technicians and replacement parts are readily available worldwide. The units can operate on a variety of gaseous fuels: pipeline natural gas, landfill methane, digester gas, coal seam methane and others.

Installation is fast and simple: mobile, packaged generator sets can be delivered and installed within hours; permanent systems can be online and producing power within a few months from the date ordered, at attractive installed system costs from $450 to $600 per kW. Units are relatively straightforward to site and permit; multiple units can meet power requirements of virtually any size. Finally, in the growing market for distributed power applications requiring 500 to 3000 hours of annual operation, gas-fueled generator sets deliver electricity at highly competitive prices.

Hybrid systems. Prime mover technologies can be readily combined to meet specific owners' needs. For example, the Heber Light and Power and Greenwood Utilities distributed generation systems use a combination of natural gas and diesel generator sets to provide operating flexibility and fuel diversity – important considerations for ensuring stable prices and reliable service. Hybrid systems also can be configured to combine base-load and load-following capability. For example, a distributed generation owner may install a turbine or fuel cell for continuous base-load power, combined with gas or diesel engine-driven units to carry seasonal or daily variable and peak loads efficiently.

-more-

Hybrid systems consisting of fuel cells and gas-engine generator sets, totaling 3 to 7 MW, are commercially available. Any number of fuel cells and generator sets can be combined to fit a particular load. The cost of the fuel cell is significantly offset by the highly competitive cost of the engine-generator – hybrid systems can be installed for $1,800 per kW, or even less. A hybrid plant may be a sound distributed generation choice where one or more of these conditions exist:

- Base load is steady, but peaking loads fluctuate widely.
- No other technology can meet air permit requirements.
- Blackouts, brownouts and voltage sags are common.
- Environmental advocates oppose conventional engines and turbines.
- Gas costs are high because of pipeline restrictions or local fees.
- Electricity prices are high.
- High efficiency is needed to squeeze the maximum power from a limited gas volume.
- There is a corporate or community commitment to green power.

A concept whose time has come

The past decade has proven distributed generation both technically sound and economically essential in the changing electric utility industry. All that remains now is for potential users to understand the full range of benefits for all market participants – investor-owned utilities, public utilities, industrial and commercial customers and, in the end, consumers.

The risk does not lie in deploying cogeneration. The real risk lies in failure to consider and develop its full economic potential.

# # #

Michael A. Devine is Gas Product Marketing Manager with the Electric Power Group of Caterpillar Inc., based in Mossville, Ill.