A Secure Solution

Many facilities are adopting onsite power as a way to secure operations and improve energy efficiency.

BY ED RITCHIE

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20V Series 4000 engines

The year of 2013 may well see a landslide of market gains for distributed energy in facility settings. Why? The reasons are numerous, and moreover, compelling. But if we were to examine just one—efficiency—the benefits would prove irresistible. But why not consider security, technology breakthroughs, price drops on generation hardware, new funding strategies, demand response profits, corporate sustainability efforts, and government support? Sure, it's a rather long list, and we could devote a rather long article to each of those market drivers. But if your facility is ready to profit from the many benefits of generating power onsite, then you've come to the right place to see a variety of solutions and methods that have helped others make the leap.

Facilities that use distributed energy in the form of combined heat and power (CHP) will see the highest gains in fuel efficiency, and that fact has captured the attention of many state and federal agencies. Then, too, the industry's surge in momentum has captured the attention of market analysts such as Pike Research. The company released a report in December 2012, predicting that CHP capacity additions for commercial buildings will more than double by 2022. That's based on a current worldwide tally of 39 GW, rising to 79.5 GW.

By Order of the President

If President Obama has a say, the US will contribute 40 of those new gigawatts. And if Ohio's Governor Kasich has his say, 9,270 new megawatts will be located in his state. Much of the growth President Obama seeks, could come from state programs such as the focused drive for CHP in Ohio, where Governor Kasich recently signed state energy legislation that qualifies CHP and waste energy recovery as a resource to satisfy the efficiency mandates of Senate Bill 315. (SB 315: Electric utilities are required to implement energy efficiency and peak demand reduction programs that result in a cumulative electricity savings of 22% by the end of 2025, with specific annual benchmarks.)

The Public Utilities Commission of Ohio (PUCO) announced support for SB 315 with "a pilot project with the US Department of Energy [DOE] to remove educational and regulatory barriers to combined heat and power development in Ohio and across the nation." And they're doing an impressive job if their website, www.puco.ohio.gov, is any indication. The information provided covers major issues such as the interconnection application process, field-tested equipment, financial risk, capacity limits, and interconnection queue transparency, plus a wide range of other concerns for anyone considering CHP.

The pool of candidates that should be considering CHP is large due to another driver in Ohio—and any other state that has a legacy of industrial/commercial boilers—courtesy of EPA's Clean Air Act industrial Boiler MACT, finalized in December 2012, with a three-year compliance window. It's an urgent issue, and PUCO warns that Ohio-based facilities with non-complying boilers must shut down, or choose from retrofitting existing boilers or replacing oil/coal burning units with natural gas,

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Four 2,500-kW gensets at the Medical Regional Healthcare System, GA

or installing new CHP systems as a natural gas option. Not surprisingly, PUCO makes a strong pitch for CHP as the best choice, touting efficiency performance benefits of 65–80%, plus lower operating costs and lower environmental impact. For those skeptical of the claims, a look at the success of CHP at the University of Cincinnati in Ohio can be an educational experience.

Between the campus and six hospitals, the two utility production plants at University of Cincinnati (UC) serve about 100 buildings. A pair of 12.5-MW Titan 130 Gas Turbine Generators from Solar Turbines, a division of Caterpillar, Peoria, IL, plus a 20-MW steam turbine generator provide about 90% of the electricity demands of the campus, and 80,000 pph of unfired steam for both heating and cooling. All told, the plant attains a 70% efficiency rating. Not surprisingly, UC's distributed energy system has earned awards from EPA for its environmental impact and from the DOE for its efficiency performance.

Avoiding Utility Tariffs

There's been no official award for the financial benefits, but they are equally impressive, according to Joe Harrell, executive director of Central Utilities at UC. Harrell notes that just the free steam alone saves UC $2,590,000 per year. And the electricity plant's peak shaving capabilities save even more; under the PJM utility formula of tariff demand rates are set based on the summer peak from the highest of 3,096, 15-minute intervals. So what's that mean for the bottom line? One bad 15-minute period could cost UC over $6,100,000 in demand and ratchet fees. And finally, the savings from reliability must be considered, especially with two hospitals and their sensitive electronics. So far, UC has logged a 99.98% energy reliability rating.

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Paralleling switchgear at Columbus Regional Healthcare runs routine power system testing and energy management during peak periods.

Blackout and power interruptions are costly for universities. For example, at the Illinois Institute of Technology (IIT), the campus suffered 12 power outages during 2004–2006, accounting for substantial losses in damaged hardware, compromised research, expenses for alternative student housing, and more. The solution was a partnership with the DOE to build a $13 million microgrid. The system is based on smart switches for enhancing reliability, rooftop solar panels, wind generation units, flow batteries, and charging for electric vehicles), and it's all networked to smart buildings (equipped with campus and building controllers).

The microgrid can be operated as a standalone power system during grid failures, and administrators estimate that the campus saves about $1 million dollars per year in electricity costs and damages linked to blackouts. The good news for other facility managers is that IIT's Galvin Center leadership is actively working with interested parties to replicate its microgrid model for facilities, including locations that are either community scale, or sized for facilities such as corporate parks, sports centers, and, of course, educational institutions.

It's efforts such as IIT's that lead the number crunchers at Pike Research to predict a bright future for microgrids. The company's researchers expect that annual vendor revenues from utility microgrids, public power grid-tied, and remote microgrids will grow to just under $3.3 billion in 2018. According to Pike senior research analyst Peter Asmus, market drivers include information technology (IT) advances, sophisticated software, and new islanding inverters for (mostly) cleaner renewable generation-to-network resources. Moreover, decades of utility resistance to the concept of microgrids are falling as confidence in the benefits grows. Confidence is high at GE, Fairfield, CT, and the company recently released its Multilin Microgrid Control System designed to help permanently islanded or grid-connected microgrid operators integrate renewable energy and fossil fuel-based resources to optimize microgrid operations and minimize energy costs. According to Juan Macias, general manager, Grid Automation for GE's Digital Energy business, the demand is growing from sources such as military installations, and various institutions seeking options to maximize energy use.

For a compelling demonstration of utility cooperation and confidence from state energy agencies we can look to the University of California San Diego (UCSD), where the California Energy Commission (CEC) recently approved funding to advance development of a pioneering microgrid and expand electric vehicle charging resources. The campus has two 13.5-MW Solar Turbines generating about 27 MW of electricity, then there's an additional 3-MW steam turbine. The entire CHP system produces 140 MMBtu per hour of steam to satisfy 95% of campus thermal demand. At efficiency levels of 66%, the system uses 26% less fuel than your average onsite thermal generation and purchased electricity. The university reports that its power plant saves about $670,000 per month in energy costs. Additional savings come from renewable energy resources. The campus also hosts a 1.2-MW photovoltaic (PV) system and a 2.8-MW fuel cell plant fueled by methane from a wastewater treatment plant, plus a 300-kW solar water heating system.

As a microgrid, the system can run securely by disconnecting from parallel operations with the grid to run independently in "island mode." This benefit proved invaluable during a disastrous countywide fire in 2007, when UCSD was able to disengage from drawing 3 MW from the local utility SDG&E and, within 30 minutes, begin exporting about 4 MW of excess power to bolster the grid's failing assets.

Such benefits haven't gone unnoticed by the CEC. Starting with an initial investment of $4 million in 2008,

it has leveraged more than $4 million from other funding sources—public and private—and, as mentioned earlier, CEC recently approved additional funding for the project, noting that the return on investment (ROI) extends far beyond the San Diego campus. Some of that funding trickled down to Viridity Energy, Philadelphia, PA, a demand-response company that won a $1.66 million grant to develop a distributed energy optimization project at UCSD. Financially, the benefits of reducing demand or exporting power can well exceed six figures for large facilities with high power and high demand reduction opportunities.

California's support of microgrids and distributed energy is impressive, but federal agencies are also helping facility managers with financial and technical support. No doubt most have heard of President Obama's executive order in support of CHP. The order stated that the federal government should overcome barriers and support investment in industrial energy efficiency and CHP, with coordinated engagement among a broad set of stakeholders including states, manufacturers, utilities, and others by encouraging private sector investment, setting goals, and highlighting the benefits of investment, improving coordination at the Federal level, partnering with and supporting states, and identifying investment models beneficial to the multiple stakeholders involved.

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Thirty-nine-kilowatt solar installation

The Fed's efforts could well build upon progress made by the Department of Defense (DOD) and the DOE. In 2011, the two agencies formed a partnership to strengthen American energy security and develop new clean energy technologies. Their goal includes investing $6 million for installing and operating 18 fuel cell backup power systems at eight military installations across the country. Some of these will integrate with microgrids. A recent survey by the US Secretary of Defense of DOD facilities revealed more than 40 US military bases either currently have microgrids, planned microcrids, or have conducted studies or demonstrations of microgrid technologies.

University campuses are another potential market for fuel cells. Along with UCSD, FuelCell Energy (Danbury, CT) has a unit at California State University Northridge (CSUN) and others sited at California State University, San Bernardino (CSUSB). The CSUN and CSUSB installations are the result of a California Public Utilities Commission mandate for two California utilities to pursue utility-owned fuel cell installations at state universities as part of a drive to adopt clean fossil fuels for distributed generation.

The use of fuel cells for backup power is seeing promising growth in data centers, and these applications could pave the way for use as distributed energy. In fact, it's already happening at Adobe Systems Inc. (San Jose, CA) where Bloom Energy Corp. (Sunnyvale, CA) has a total of 12 Bloom Energy Servers that supply 1.2 MW, or about 30% of Adobe's power requirements. Adobe, eBay, and Google have purchased Bloom hardware. Now Bloom's business model has evolved from selling energy servers to selling energy, via the new Bloom Electrons service. Electrons customers include Wal-Mart, Coca-Cola, Staples, Kaiser Permanente, and the California Institute of Technology. Bloom has partnered with Southern California Gas Co. for natural gas, and Adobe plans to purchase methane through a five-year contract with a Pennsylvania landfill.

Landfill gas-driven fuel cells are also performing well at Apple's North Carolina-based data center, as confirmed by Apple's recent filing of expansion plans with the North Carolina Utility Commission in January 2013. Bloom is installing 50 Bloom boxes to produce 10 MW of electricity. The original development started as a 4.8-MW project. Online auctioneer giant eBay has a large fuel cell farm for its data center under construction. The plan calls for 6 MW of output from 30 fuel cells.

Data centers also offer plenty of opportunities for both turbine and reciprocating engine-driven CHP systems, but there are challenges, according to a report from the Alliance to Save Energy, Washington DC. The report notes that electricity generated from biogas-based CHP systems at wastewater treatment or waste-to-energy plants could furnish data centers with significant amounts of base and peak load electricity and compliment sustainability efforts. However, many state utility commissions need to establish standard rules that provide clarity to firms considering the technology.

"A model standard, from the Department of Energy or another respected national organization, could provide states with the information and confidence to build sensible rules for CHP adoption," says author Jacob Johnston. Additional challenges include the need for integration with uninterruptible power systems (UPSs), batteries, and reactive load banks or ultra-capacitors and static transfer switching equipment to provide "ride-through" power.

China's First CHP-Driven Data Center

While progress is challenging for data centers in the US, China is making news about their intentions to pursue efficiency with a recent announcement that the China National Petroleum Corporation will install five GE ecomagination-qualified Jenbacher cogeneration systems at a new data center in the Beijing district of Changping. The system will provide 16.7 MW from five, 3.34-MW J620 Jenbacher units, and it's the first for a data center in China, where the China National Energy Administration Bureau plans to make the project a model for future data center CHP projects.

Returning to the US, one small step for progress within the

data center industry is that distributed energy has the attention of Microsoft, Seattle, WA. Currently, the software giant has a pilot project in Wyoming utilizing a molten carbonate fuel cell to power to a small data center. The fuel cell uses biogas from a nearby wastewater treatment plant, and the project qualified for a $1.5 million Community Readiness Grant.

The landfill-gas-to-energy market has been a long-term success for GE's Jenbacher division of reciprocating engines in Europe and now the US, according to Michael Wagner, marketing director, GE Jenbacher, Jenbach, Austria. Wagner notes that his company has 25 years of experience in the combustion of landfill gas, with products installed in more than 1,400 landfill gas systems.

Jenbacher customers have a variety of maintenance and monitoring options, according to Wagner. "We offer long-term service agreements up to the lifetime of the equipment. And the controls over the last 10 or 15 years have made great strides; all of our installations have the capability of remote control from the plant's facility, but it also can be controlled and monitored directly at a remote location. So, if a company has 20 locations it can control them from one central operation, and we provide the operator and customer the opportunity to monitor and access his plant from our service center for online help."

Europe represents one of Jenbacher's oldest markets, but Wagner sees growth tapering off as stricter laws divert organic material from reaching landfills. However, there are still plenty of opportunities in the North and South Americas, and especially in developing countries. "The United States has been a very important landfill-gas-to-energy market," he says.

Opportunities in the US for cogeneration fueled by biogas made a strong argument for a new manufacturing plant for 2G Cenergy Power Systems Technologies Inc., Orange Park, FL. With parent headquarters in Germany, 2G Cenergy claims more than 2,300 CHP biogas-fueled facilities using its gensets. Another company with roots in Germany, MTU Onsite Energy (Mankato, MN) has cited US facilities, such as hospitals and manufacturing plants, as a prime market for their gensets. The company specifies its compact Series 400 model as designed for natural gas, biogas, landfill gas, or sewage gas, with output from 128 kW to 358 kW.

The fact that landfill gas qualifies as a renewable energy resource makes it very attractive as a sustainable energy solution, according to Joel Zylstra, chief operations officer for Granger Energy Services, Lansing, MI. Granger has 13 landfill gas-to-energy projects in six states. In December 2004, three manufacturing facilities—Dart Container Corp., Advanced Food Products, and L&S Sweeteners—tapped into Granger's 12.77-mile pipeline that transports 3,500 cubic feet per minute (CFM) of landfill gas. In 2008, New Holland Concrete boosted its sustainability profile by using Granger's landfill gas, and, today, three additional companies—Tyson Foods, Case New Holland, and H.R. Ewell—also use landfill gas from the joint pipeline.

A Sweet Deal for Cogeneration

In late 2012, Granger launched a new project with L&S Sweeteners to install 2.2 MW of electricity at their location. "They wanted to continue to buy gas to generate steam and at the same time create electricity rather than take it from traditional sources," explains Zylstra. "It's a trend we're starting to see, where customers are electing to install onsite electrical generation. Dart Containers is another one that installed two five-megawatt turbines, and they have heat recovery. Historically, we sold the majority of our gas to Dart, and they used it to generate heat. But over the last year and a half they've installed the turbines, so they're producing electricity and using the heat from the turbines to produce steam in a true cogeneration operation with landfill gas, and it's a fairly recent development in Pennsylvania." Dart reports that it has invested more than $20 million in the cogeneration project and sees renewable energy as a strategy to reduce greenhouse gases, improve air quality and energy security, and boost the local economy.

A Captive Audience for Efficiency

We've talked about a variety of facilities from universities to factories, but there's another category that may not be as glamorous, yet presents an ideal market for distributed energy: correctional facilities. For example, Ameresco Inc. (Framingham, MA), an independent provider of comprehensive energy efficiency and renewable energy solutions for facilities, had a unique opportunity to boost the sustainability aspect of the Algoa Correction Center in Jefferson City, MO, by adding a landfill gas–fueled cogeneration installation next to the correction center. Moreover, the project didn't require new capital expenditures.

Ameresco offers ESPC (Energy Saving Performance Contract) services that allow customers to renew facilities and reduce energy costs without the need for capital expenditures. "We were awarded an energy efficiency contract for their prison, and our energy efficiency division suggested the site for locating a cogeneration plant that we were developing for Columbia Water and Light," recalls Michael Bakas, Ameresco's senior vice president, Renewable Energy. "Jefferson City and Algoa get the thermal energy at a steep discount, and they improve their overall energy efficiency."

The project starts with gas from a landfill owned by Republic Services. It's transported through a 4-mile pipeline to the cogeneration plant at the Jefferson City Correction Center (JCCC), where three GE Jenbacher engines generate 3.2 MW of electricity. Columbia Water & Light has a 20-year power purchase agreement for the energy. A steam piping system transports excess steam from JCCC to Algoa, and returns used steam condensate back to JCCC for reuse.

Blackout Insurance a Hot Topic

Distributed energy offers reliable and secure power, and those benefits factored strongly in upgrades to a CHP plant at Kyocera America's manufacturing facility in San Diego, CA, where the operational stability of two large electric furnaces is critical to the manufacture of ceramic packages for integrated circuits. If power fails and the furnaces cool abruptly, all of the working processes shut down, and several hours of downtime can result in million-dollar production losses, according to John Tanaka, manager of automation and plant engineering. Tanaka notes that, due to the unique nature of the ceramic manufacturing process, the furnaces can take three to four

months to recover from the damage.

The plant barely avoided such a disaster in September 2011, when San Diego joined most of the Southwest US in a blackout that won't soon be forgotten. When the lights went out, Kyocera's turned to its local Cat dealership, and a rental generator set keep power flowing to the most critical part of the plant. But the disaster put rush status on a plan to overhaul the plant's 23-year-old CHP plant. Kyocera cited problems with high maintenance and operation costs in addition to old emission controls that couldn't meet California air-quality standards (although those controls were grandfathered in and met emissions standards during lean-burn testing).

The legacy system had four 800-kW gas generators, along with two absorption chillers and one centrifugal chiller. The new plant consolidates energy production into two gas-fired gensets, a Cat G3520C and a Cat G3516C, for a total production rating of 3,690 kW. A Cat 3512C diesel generator provides 1,500 kW of standby power. The former cogeneration plant operated in parallel with the utility all the time, and each genset used the utility as a phase reference to stay in sync. If the Kyocera plant lost the utility feed from San Diego Gas & Electric, then everything would go down.

"We wanted to reduce our energy costs, and the island mode gives us a secure solution," says Tanaka. "The new plant operates in parallel with the utility, but if the grid fails the engines switch to island mode."

In island mode, the plant needed a diesel genset to support the gas engines and their load sharing and block-loading ability, while also having the ability to recover from a loss of utility power in a timely manner. The plant has a total of 14 different load centers, including furnaces, as well as 15 smaller ones.

The diesel generator will also back up the facility's data center, lighting, and security system. It can start up the entire plant from a dead bus, without lights and without any power.

"The 1,500-kW diesel generator has been online a couple times during the project and has proven to be good hardy engine," says Tanaka. "It started right away, and we ran it a couple of hours on and off and did load testing at 25, 50 75, and 100% loads, and it didn't even cough. Our guys were very impressed—they don't usually see that large of an engine, and when the power went out during testing we watched it start up, and it's been very close to 10 seconds each time. Overall, it was a good project from start to finish, and the engines work really well."

We mentioned the use of solar PV panels as a renewable resource at universities, but it's a technology that has seen consistent and significant price reductions that are helping to advance the industry. In fact, analysts at Pike Research say that solar annual renewable distributed energy generation installations will nearly triple (yes—triple) by 2017. The reason? Solar PV manufacturers have delivered on their promise to lower costs and raise production. Pike notes that worldwide solar PV module production capacity reached an estimated 50 GW by the end of 2011, and, according to their report, costs dropped from roughly four dollars per watt in 2006 to one dollar per watt in 2011.

With prices in the dollar-per-watt range, generating electricity with PV solar panels could have an impressive impact on a site's energy efficiency footprint, says Steve Birndorf, a project developer with Borrego Solar in Berkeley, CA.

"Although California is one of the states we specialize in, we work in western states and East Coast states such as Massachusetts, Maryland, Pennsylvania, and New Jersey," he explains. "Public utilities can't apply directly for the federal incentive of 30%; however, if a third-party structure is used, such as a power purchase agreement, they can capitalize on it."

Another option is to actually own the system, and take advantage of comprehensive maintenance packages. "We guarantee the kilowatt-hours, so even though they own the system, we're taking a long-term interest in its success," adds Birndorf. "And power from the facility gives them stability in planning their power expenditures, so it's a long-term hedge against energy price fluctuation because owners know how much their energy costs over 20 to 30 years."

Funding Methods Expand

In New Hampshire, a third-party could offer some significant savings, because the state gives businesses a rebate of up to $50,000, or 25% of project cost, whichever is less. The rebate is $0.80 per watt for solar electricity, $0.07 per kBTU per year for solar hot water. Solar systems are usually eligible for five-year accelerated depreciation if claimed as a business expense and amount to a deduction that can reduce tax liabilities up to 34% of a system's cost.

Third-party contractors are experienced at dealing with state and federal incentive programs, and handling the economics and operations are simple, Birndorf says. "Most utilities and water districts provide water services, and they're not in the business of managing and maintaining and operating a solar array. So, typically, in a third-party situation, we would sell the district energy at a rate that's lower than what they're currently paying, and we own and operate the system, so they're just buying kilowatt-hours."

Large companies in the ESPC arena, such as Schneider Electric (Palatine, IL), are finding that solar has unique advantages. For example, Schneider is implementing a comprehensive $50 million ESPC for the US Coast Guard facility in Puerto Rico that includes a 2.89-MW PV system on renovated rooftops. Based on the location and long-term data for PV performance, Schneider can guarantee production of more than 4 million kWh per year. In combination with new cool roofs that reduce the cooling load of the buildings, the Coast Guard will reduce their annual utility purchases by 40%.

The project is the first of its kind to combine the Renewable Energy Services Agreement financing structure with an ESPC financing vehicle, thus maximizing the incentives and overall value and enabling an extension of the financing term beyond 10 years. Funding the investment relied upon the US Department of the Treasury grant rather than

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the investment tax credit.

On a smaller scale, no capital expenditures and lower electricity costs passed the logic test for The Liberty Union High School District, Brentwood, CA. The district is installing solar panels at three campuses after Borrego Solar offered to install systems at no cost to the district. Borrego covers panel maintenance, and the project lets the campuses rely upon onsite energy production, yet retain a grid connection to cover power requirements when needed. The district should save a minimum of $16 million over its 25-year power purchase agreement.

Solar financing is also getting a boost from private financing in the state of Vermont, where Green Lantern Capital partnered with AllEarth Renewables, a Williston, VT-based manufacturer of the dual-axis AllSun Tracker, to work with host customers and install solar farms at the Poor Farm in the City of Rutland, Cold Hollow Cider Mill in Waterbury, Woods Market Garden in Brandon, and the Town of Williston. The projects totaling 600 kW were installed this fall and earlier this winter. In the case of the Cold Hollow Cider Mill, the facility now generates two-thirds of its power from the sun and saves money annually.

According to Andrew Savage, director of Communications and Public Affairs for AllEarth, while not totally unique, it's important to note that the financing in this arrangement is coming from private companies, not big banks. "The packaging of this financing is a game changer for getting renewables deployed and projects built," says Savage. "In this case, National Life and Green Mountain Power have a whole range of investment opportunities, but they sharpened their pencils and looked outside their back doors to make this investment happen. It's an exciting paradigm to see this local investment finance distributed generation projects. There's no doubt you'll see more and more of this in the industry."

Four PV projects totaling 600 kW may not represent a large-scale onsite deployment, but, by the same token, it shows that the lower prices of PV hardware are allowing even smaller projects to access affordable funding.

Overall, this progress and philosophy in funding is appearing throughout the distributed energy industry, no matter the technology. And with the continued efforts from city, state, and federal governments, it's a safe bet to assume that companies providing distributed energy to facilities can look forward to very positive market conditions. So for facility customers that need multi-megawatt systems from the international giants such as GE, to the smaller players requiring several hundred kilowatts from a local supplier such as AllEarth, there's a wealth of technology and the means to finance it that will meet your needs. DE

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