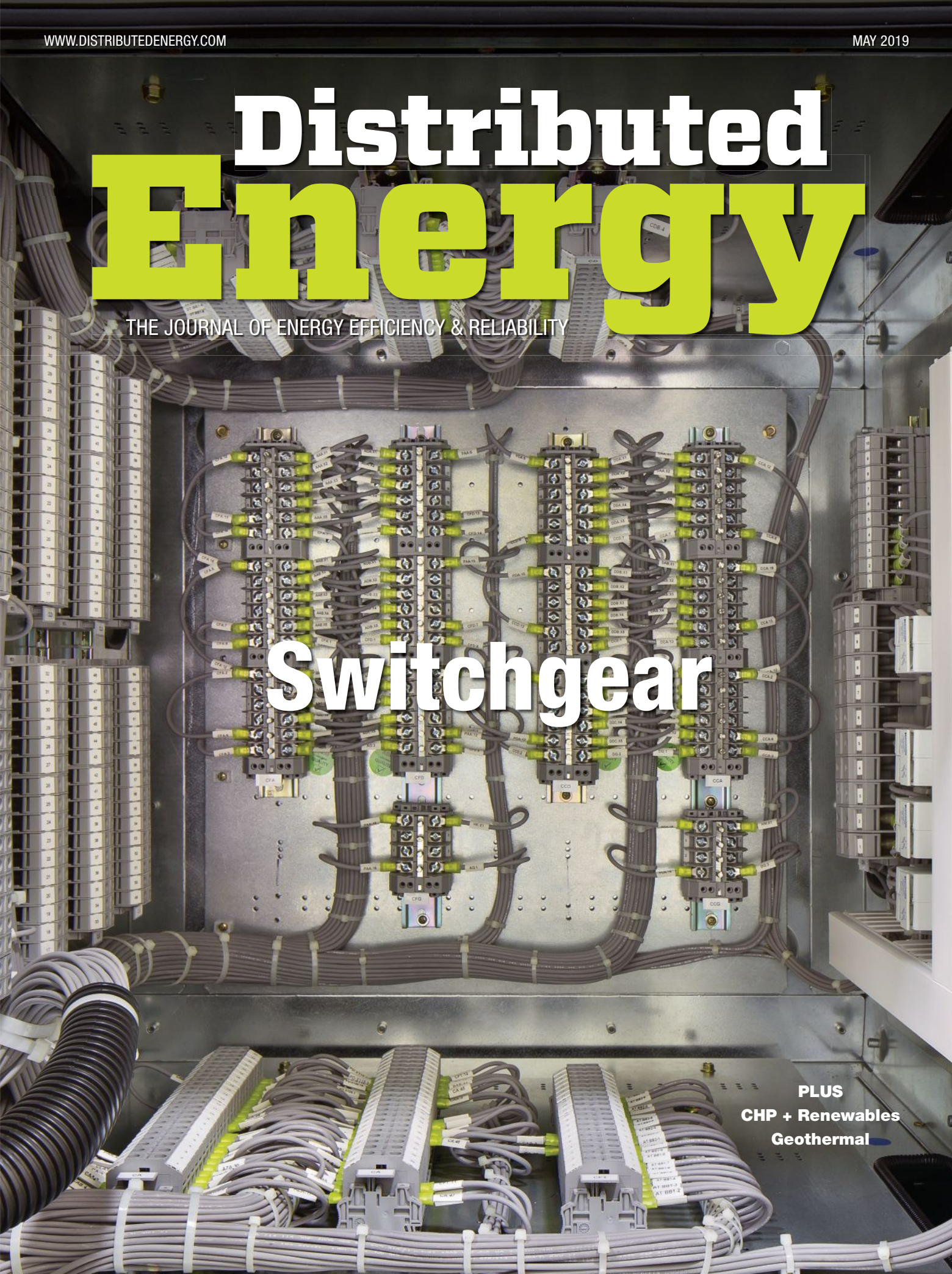
Distributed Energy

THE JOURNAL OF ENERGY EFFICIENCY & RELIABILITY



Switchgear

PLUS
CHP + Renewables
Geothermal

FlexEnergy

A CHP installation in California

Cogeneration Brings the Heat

CHP AND RENEWABLE ENERGY TEAM UP TO MEET MODERN ENERGY GENERATION GOALS.

BY MEREDITH RUTLAND BAUER

When St. Joseph's Hospital Health Center in New York began planning for an expansion, leaders knew choosing additional power and heating sources was going to be a challenge.

The expansion plans—made in 2008 and worth $220 million in building costs—couldn't have been supported by the local grid in Syracuse, New York, according to a case study on the hospital's final project by Cogen Power Technologies. The new building, combined with the hospital's already-large electricity needs, would have maxed out the grid. Hospital leadership needed a different solution. They turned to cogeneration.

Cogeneration, also called combined heat and power (CHP), is the process of creating electricity and heat simultaneously, rather than as separate processes with different fuels and independent wastestreams. Cogeneration can be accomplished by using a fuel source, usually natural gas or biofuel,

to generate electricity by creating steam to turn turbines. The steam can then be used to heat industrial, commercial, and residential buildings. Cogeneration is typically seen as a much more environmentally friendly option because it relies on the same fuel supply for two functions, and it is more economically efficient due to the reuse of steam that is typically considered a "waste" product of electricity generation.

St. Joseph's leadership needed a new electricity source, but they also wanted to keep costs manageable and limit their emissions of greenhouse gases. The hospital went with combined heat and power because, compared to the financial and environmental cost of adding an additional power line, it was the better option for the hospital's long-term goals.

"Meeting the hospital's goals with CHP allows St. Joseph's to generate their own power—improving reliability, reducing greenhouse gas emissions by 11,676 tons per year, and reducing the annual utility budget by approximately $1 million in its first full year of operation," the case study reads. The $15 million CHP project was operational in 2014.

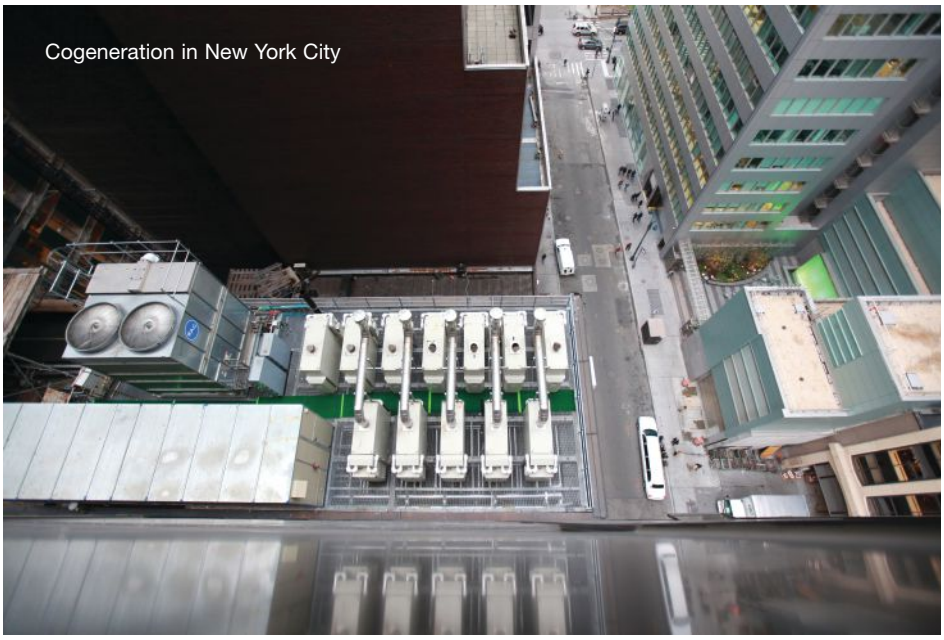
Cogeneration has been building steam in US and international markets, and market forecasts show CHP is poised to keep growing over the next five years. A report by Zion Market research stated that cogeneration globally is valued at about $16.2 billion, as of 2017, and is expected to generate $23.1 billion by 2024. In the US, the opportunities are driven by a desire (and often a federal or state requirement) to reduce carbon emissions, and the financial benefit of essentially eliminating heating costs.

"The North American region is predicted to provide significant growth opportunities in the combined heat and power market in the years ahead, owing to the growing demand for energy-efficient power plants to reduce carbon emission in the region," states a news release from Zion Market Research. "Replacing and retrofitting old power plants with new energy-efficient tools, equipment, and systems to maintain sustainability is expected to further drive the combined heat and power market growth in the North American region over the forecast timeframe."

While this power generation tool is trending, it doesn't

FlexEnergy

An installation on New York's Palace Hotel


Cogeneration in New York City

mean that it's a new technology. There are now newer ways of using CHP, but cogeneration as a concept is actually as old as the Industrial Revolution. Even though the method itself is old, cogeneration is finding its footing in today's technologically advanced world… and is looking to the future.

Anthony Weidner, North American sales manager for power generation at Elliott Group, a turbomachinery company, says cogeneration remains an important part of the energy generation puzzle.

"Cogeneration is important because it makes the most out of whatever fuel source is being used and increasing the overall efficiency of the entire process," he says. "Whether it is natural gas, coal, biomass, waste heat, or some other fuel source, the user is maximizing its use by combining both power production and heating needs from a single source."

Jim Crouse—executive vice president of sales, marketing, application engineering, and product management for Capstone Turbine Corporation, based in Van Nuys, CA—says cogeneration has created more efficient methods of power generation—which can lead to lower carbon footprints amid a growing climate change threat. It can also open doors for reliable electrical and heat production in areas of the globe that struggle to maintain a consistent energy grid flow and face frequent rolling blackouts.

Recent reports indicate that **cogeneration was valued at about $16.2 billion** in 2017 and is expected to generate $23.1 billion by 2024.

He says his company has been a part of more and more projects over the past five to seven years that are focused on bringing cogeneration to countries in the Caribbean. It's become common for these projects to be their own microgrids that run independent of their country's electrical grid system. Many of these projects start with biogas, natural gas, or propane systems, but some use or supplement with solar power, distributed wind power, and/or battery storage.

This reliability also provides added safety for residents after hurricanes, earthquakes, and other natural disasters that can knock out power grids, he added.

"They're able to achieve cost-effective, reliable power without having to have connection to the utility grid," says Crouse.

Mark Schnepel, President & CEO of FlexEnergy, a cogeneration company based in Portsmouth, NH, says the cogeneration industry has changed noticeably in the past few decades. For one thing, the engines they use are more powerful, making it possible for a system to generate more electricity and more heat.

When FlexEnergy started out in the 1990s, the company only offered a 250-kilowatt model. Now, they have several types of systems, including a multi-engine system that produces 1.3 megawatts. That sizable growth means more efficient systems and simply more available power to work with.

"In terms of technology, we are focusing on increased efficiencies and we are always looking at ways to further improve reliability," says Schnepel. "As part of our increased focus on solutions at the end-customer side, we have boosted our applications engineering capabilities and provided integration support to distributors and end-customers alike. We have also made considerable efforts to build technology partnerships with co-vendors."

Crouse says one of the ways cogeneration has changed is the increase in demand, which spurs companies to innovate based on their customer's needs.

"We've seen a gradual but continued increase in the number of cogeneration projects we're doing in North America," he says. "The pros are energy savings, which leads to economic benefit in reduction of utility bills."

One factor affecting demand for cogeneration is the increased availability of cheaper natural gas in recent years, Schnepel says.

"The change in the energy landscape in the US, namely the availability today of cheaper gas than was available 10 years ago, makes combined heat and power (CHP) a valuable financial tool for many companies in the US," he says. "There are very few investments an organization can make where they know the benefits will be immediately measurable in the bottom line."

For related articles: www.DistributedEnergy.com

He says CHP also provides a service that seems unrelated at first: getting rid of flare gas. That flare gas has been the subject of increased regulation for environmental and social reasons, as well as social pressure from surrounding communities. Schnepel says CHP is a way to turn that flare gas, which would otherwise be wasted energy, back into a productive product—as well as quelling the environmental impacts and societal (and perhaps customer) pressure that are associated with flare gas.

"Pressures on the oil and gas industry have also encouraged, if not forced, upstream operators to do something constructive with their flare gas," he says. "When they learn that our units can combust even the most challenging associated gases and that doing so also provides two key economic wins—namely getting rid of expensive diesel at remote sites and improving a site's operational uptime (and therefore NPV) alongside improved environmental performance—customers seem keen to adopt."

An urban CHP installation

Increased demand almost always leads to more innovation, including an increase in applications for CHP. Crouse says his company has expanded its application portfolio into chilled water and steam over the past years.

"We've found creative ways to use the thermal energy that we hadn't been doing a year ago," he says.

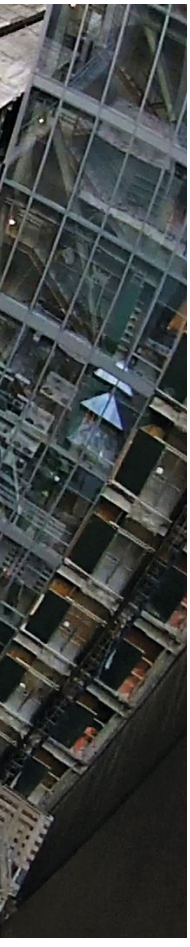
Excess heat from electricity generation can be used for much more than just heating a building, Crouse says. Some examples of those innovations are using the exhaust heat to dry ceramic tiles, bricks, and painted furniture.

He says Capstone Turbine company works with a customer in Tennessee to direct dry ceramic tiles using the heat from microturbines. It's the same concept as using larger steam turbines, but he says they've figured out the nuances of making the system work in a miniaturized setting.

FlexEnergy

"It's really working to understand what the customer's thermal needs are," he says.

Weidner says some applications Elliot Group has seen in recent years include end-users installing a back pressure steam turbine. This helps with several factors, he says, including helping to "reduce the pressure in the system for downstream heating or process needs and also generate power with that turbine. This makes use of the energy in the steam that would otherwise be lost by just reducing the pressure through a valve."



Weidner says this application has been used for colleges and universities, districtwide steam systems, and "miscellaneous industrial processes."

Some other innovative strategies energy managers are using within the field of cogeneration actually spread beyond hardware, although that is part of the bigger picture of innovation. Innovations around financing, application use, hardware, and software are all part of CHP's present and future, Schnepel says.

"For some time now, we have worked closely with customers to satisfy their interest in solutions, rather than simply supplying equipment," he says. "Nor is innovation confined to the technical side, as customers increasingly look for financing options."

He says in the CHP industry, his company's units can integrate with steam applications that use gas turbines (GT), duct burners, and heat recovery steam generators. One of their models, the GT333S unit, has a thermal output that is large enough to drive direct-fired, double-effect absorption chillers. The result is an extremely high coefficient of performance (COP), which represents the efficiency of the chiller.

Crouse says his company has seen many innovations that were driven by customer demand, such as the need for more off-the-grid resilience in the face of stronger, more frequent storms on the US's East Coast.

He says that it's common to see this sort of contingency planning among hospitals, pharmaceutical manufacturers, and manufacturers that do batch processing. Worst case scenario, a hospital loses power and their generator doesn't power up —scores of people reliant on ventilators, operating room equipment, and other essential tools could die. On the other side of the spectrum, but still subject to significant impacts, are batch processors that could lose a large volume of product as well as manpower hours due to a power outage. The economic impact to that company could be catastrophic.

"Some of the innovation within the past few years has centered around the use of cogeneration for resilience," he says. "After some of the natural disasters, hurricanes, and

Excess heat from electricity generation can be used for **much more than heating a building**, such as drying ceramic tiles, bricks, and painted furniture.

A cogeneration system often has solar or wind as **its primary electricity generation**, with battery storage to pick up any leftover energy for use at night or on days without wind.

superstorms that you tend to see more on the East Coast, people started looking for ways to use these solutions for more."

As for software management practices, Schnepel says he's seeing energy managers use SCADA systems or custom designed distributed control systems (DCS). He says the main protocols used by modern cogeneration managers are MODBUS and BACNET.

Crouse says he often sees energy managers within the CHP industry use control platforms that can manage several microturbines at once. He says his company focused on innovating within the software side of CHP as well, creating PowerSafe, a control platform that can be monitored and controlled remotely and that can run multiple microturbines.

FlexEnergy

A CHP installation in California

Renewable energy generation has significantly changed the potential for CHP by introducing a clean power generation source into a system that could conceivably one day provide electricity and heat without the use of any fossil fuels. Crouse says cogeneration is a great supplement to today's renewable energy generation products.

When a cogeneration system is installed, it can often have solar or wind as its primary electricity generation—or as a supplement alongside natural gas—with battery storage to pick up any leftover energy for use at night or on days without wind. As the battery storage market picks up speed and increases its product's capacity to meet solar demand, cogeneration stands to benefit as a supplementary product, he adds.

"Cogeneration, at a hospital or hotel or manufacturing factory, works just as well with solar generation (as with natural gas generation)," he says. "We can really match cogeneration with solar and even battery storage."

Schnepel agrees, saying CHP works well with renewable energy. CHP itself is seen as a more efficient method of using available energy resources, and customers often value the environmental and economic benefit that comes with that method—so adding renewables as energy generation is just icing on the cake.

"Premium CHP and/or microgrids have become more popular areas in the past year, focusing on traditional distributed generation power generation in conjunction with solar and battery storage technology," he says. "We think that most participants in the energy industry are happy to see renewables have a positive impact, especially in raising the importance of low air emissions and selecting technologies that can be used in air attainment zones."

At the same time, the CHP industry has been slightly negatively affected by the renewables industry because solar and wind often overshadow cogeneration when energy-efficient options are considered by customers, Crouse adds.

"While the technologies are very complementary for the right kind of customer, we tend to not be on the tip of the tongue of some of these customers. It's hard to argue with solar; it's hard to argue with wind," he says. "It gets a lot of attention, which is OK. For us, one thing is that as renewables have become more the standard, we have to compete for both the time with customers to educate them on the value and benefit (of CHP), and oftentimes with a limited budget we're competing for project dollars that would go to renewables versus cogeneration."

He says that doesn't mean cogeneration and renewables can't live in harmony—it just may take a while for the two industries to find the spots where they mesh the best as complementary products, rather than competitors.

Schnepel says he can imagine projects that could be built today where a large site's baseload electricity is created by a natural gas turbine that runs all day and all night, with daytime load increases and spikes handled entirely by solar panels.

"To us, that seems to provide huge value to adopters,"

FlexEnergy

A 12-row cogeneration system

he says.

He says government incentives inside and outside of the US and regional level incentives for more renewable energy have drawn some consumers toward CHP paired with renewable energy options. These installations offer "the most payback incentives toward these types of applications."

In general, when it comes to cogeneration, what are the pros and cons for energy managers? Experts had this to say.

The benefits of cogeneration include energy savings, which means lower electricity and heat bills from your utility; environmental benefit due to using significantly less fossil fuels for heating your building or for relevant applications; lower maintenance intervals as the CHP industry continues to mature; electrical and heat resilience in situations where the local grid is compromised; and the ability to switch between grid- and non-grid reliance.

Some of the downsides of cogeneration include long-term maintenance needs that require due diligence in selecting a supplier that will also act as a maintenance contractor, additional equipment to oversee and maintain versus choosing additional direct connections to a local grid, and some reliability concerns related to primary or supplementary renewable energy generation such as solar, wind, hydro, and tidal power, as well as the limits of current battery storage units.

Crouse says many of these downsides can be mitigated through well-planned maintenance contracts.

"For the end-user, it's important to choose the engineer appropriately and size it appropriately," he says. "It's important that the end-users are fully engaged in the process and understand what it takes from a user perspective to be successful, with the understanding that having a long-term maintenance contract with your supplier ties everyone together for success. If you try to do it on the cheap or take shortcuts, it may look good on day one," but will likely fail you in the long term.

Schnepel agrees, saying back-to-back maintenance contracts with a company with a good reputation for quality maintenance often avoids the issue altogether.

As for renewables, the concern about reliability is a problem that's bigger than the cogeneration industry—and one that multiple industries are making progress with year after year in energy generation and battery storage capacity.

Cogeneration may still be a small fish in the big pond of electrical generation and heat generation, but this age-old technology has gotten an upgrade and is stretching its legs in a big way as the industry is expected to grow economically and in geographic reach. The CHP industry is already established internationally, with solid growth expected in North America over the next five years alone.

With customers looking for new ways to save their budgets and to decrease their reliance on fossil fuels—whether it be due to their own environmental values, customer demands, or regulations from local, state, or federal officials—CHP stands to see some significant attention and economic growth as it positions itself as a tool for resilience and a partner to renewable energy generation. **DE**

Writer ***Meredith Rutland Bauer*** *focuses on environmental science and technology.*