BENEFITS OF CHP SYSTEMS FOR DATA CENTERS

Data centers are an excellent potential market for CHP, but uptake has been slow to date. Tildy Bayar of *Decentralized Energy* spoke with MTU Onsite Energy's Christian Mueller about the issues involved.

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Data centers use a tremendous amount of power. Estimates of the power consumed by data centers in the U.S. range between 1.5 and 2 percent of the nation's total electricity consumption. In Europe, data centers' electricity usage is expected to reach 104 TWh by 2020. Globally, the data center sector consumes around 2 percent of the world's primary electricity supply, according to a recent report.

Much of this power—up to 50 percent in some cases—is used for continuous cooling. In addition to environmental concerns, the need for power and cooling 24/7 makes data centers an excellent potential market for combined heat and power (CHP) applications around the world. However, CHP uptake in the sector has been slow. Data center operators are considered late adopters compared to other commercial users.

The reasons CHP is underutilized in this sector are fairly clear. Data center operators' business depends on keeping their servers up and running. Therefore, all data centers already feature one or more backup power systems, most in the form of double connections with major power supply lines, as well as both uninterruptible power supplies (UPS) and diesel gensets. Installing another power system may be seen as either unnecessary or economically unviable.

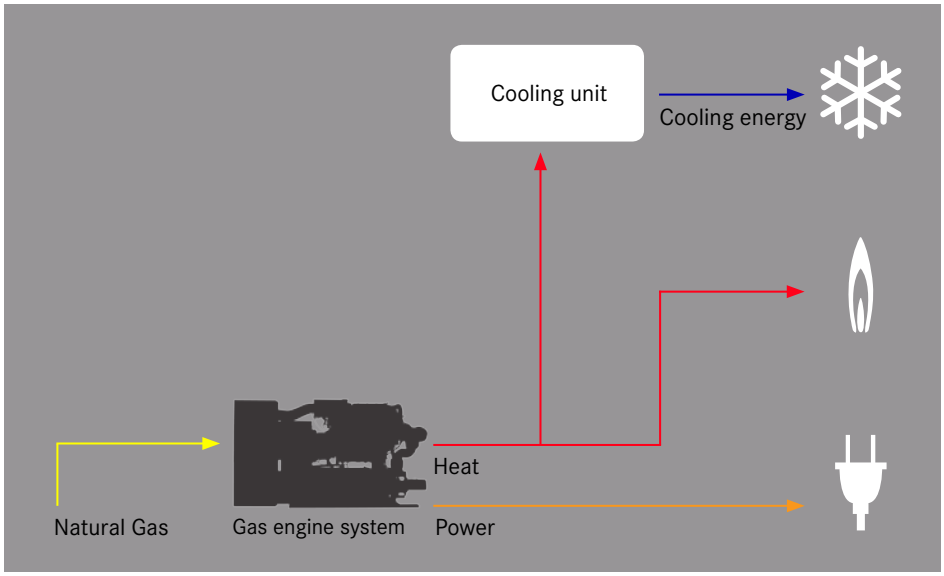
Christian Mueller, sales manager at MTU Onsite Energy, says "Cogeneration is fairly new, and there are not many data centers which actually use that aspect. It will take some time to reach a level of market acceptance. However, the market is growing as large tech companies such as Apple and Google become more concerned about being environmentally friendly and stepping up their investment in renewable technologies."

In these cases, cogeneration becomes more attractive because the firms can market its green credentials. Where the bigger companies lead, others will follow.

AN IMPORTANT COMPLEMENT TO STANDBY POWER

A data center typically features two layers of backup power. UPS battery systems provide uninterruptible power for the first crucial seconds until the diesel generators start up in, typically, 10 seconds. However, Mueller notes, "Cogeneration gas engines typically take a few minutes to start and reach full load, and therefore are not really suitable as a quick-start standby system. A CHP system can only complement a data center's existing backup power arrangement, constituting an extra layer of security which operators might be reluctant to install."

Mueller says, "Operators ask 'is it worthwhile to invest all that money in a cogeneration system—am I going to get the return on investment necessary to install it?' But an equally important question is: 'can I use a cogeneration system to save money in generating my own electricity and cooling?'"



Using a cooling unit such as an absorption or adsorption chiller, CHP systems can also create cooling energy with their generated heat.

Available figures suggest the answer to both questions is yes. A CHP system can significantly reduce a data center's expenditure on power, with a typical ROI of four to five years. It can provide cooling through an absorption chiller utilizing the waste heat from the gas engine—which will substantially reduce electricity demand when compared with electrically powered cooling systems—and it offers environmental benefits through reduced emissions.

"A cogeneration system is installed primarily for the economic benefits as a highly efficient method to generate power and useful thermal energy, and then also has a backup aspect to it," Mueller says. During a prolonged power outage, for example due to a storm, a data center operator could continue to run a cogeneration system, taking some load off the diesel generators and conserving diesel fuel. He explains, "You then have not only two standby systems (UPS and diesel gensets) but a third—the gas generator."

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In a recent project, MTU Onsite Energy installed a CHP system in a large data center, which was able to market that it had an additional layer of backup. Mueller says, "The project was particularly challenging. The data center customer did not begin by requesting CHP but looked into a number of different technologies, including fuel cells, to meet its needs for on-site power generation."

"It was really interesting to see the customer go from having this new idea, wanting to do something different, to the end where a cogeneration system with a gas engine was what was chosen," Mueller says. Among the challenging aspects of the project, he noted "finding what is the best technology which fits, examining the storage of liquefied or compressed gas on-site, and finding the best way to integrate with existing standby systems."

COOLING IS PRIMARY FOCUS

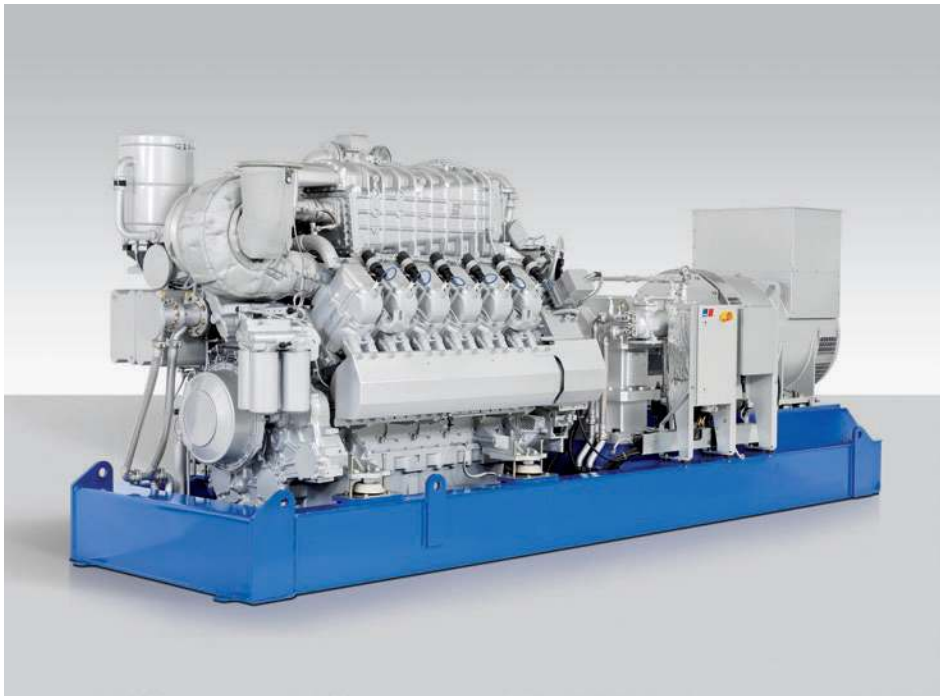
While the cooling ability of CHP in other facilities, such as hotels, is often secondary, a data center's primary use for thermal energy is for cooling. Data centers do not need much heating because almost all energy used in a data center in the form of electricity is then converted in processors, computers and data racks to heat. "The only thermal need a data center has is to get rid of all that heat," says Mueller. "This is true even for data centers located in cold climates."

A conventional data center is grid-connected. Approximately 25-35 percent of a data center's electric needs are for cooling, which is provided by electric chillers or compression refrigeration systems. A CHP installation at a data center uses an absorption chiller to produce cold water from the engine cooling water and exhaust heat, with the chilled water running through the facility in pipes.

SIZING CHP SYSTEMS FOR DATA CENTERS

Sizing a CHP system correctly can have a significant impact on reliability and corresponding uptime, both critical aspects for data centers. According to Mueller, a 50-100 percent operating load range is acceptable for a gas-based cogeneration system. However, a load between 80-100 percent is where CHP systems achieve maximum efficiency. A data center's load can fluctuate, and if this fluctuation is wide, the system's sizing becomes crucial in order to accommodate it. Careful load matching is key to correct sizing.

In addition, CHP systems depend on the ability to work with a network of peripheral equipment such as heat recovery systems, cooling



Natural gas-fueled CHP systems achieve total efficiencies exceeding 90 percent.

equipment, ventilation and electrical, as well as control systems. Each of these components must also be sized correctly, or the CHP unit will not operate optimally.

MTU Onsite Energy's CHP system is not a typical, standardized packaged solution. "A cogeneration system has to be sized, designed and built according to the customer's and site's needs," Mueller says. "You have to also consider the fuel, the ambient conditions, all of these factors and then build a customized package. For these sites you typically look to install in a building rather than in an outside enclosure; if you go into a building there's a bit more space." Space constraints for cogeneration installations can vary greatly. For example, data centers in tight urban areas will be very conscious of their footprint. However, most larger data centers are located in non-urban areas which offer more space for the installation.

To size a CHP system in the correct way, Mueller says, "You have to look at the thermal and electrical demands of the facility and how they vary throughout the day and year. The aim is to find a solution which enables you to run a cogeneration system at as high a load as possible for as much time as possible, and ideally 24/7."

"You have to size the unit so there is always enough electricity for thermal demand, cooling or heating, so it can run continuously throughout the year," Mueller says. "Typically, a customer looks at peaks—they will note that the maximum demand is so high—and asks for a unit that meets that. We go back and say we should size more toward baseload, in line with the consistent demand throughout the year rather than the peak, so the system can run throughout the year at a very high load factor. There is a greater risk of over-sizing than under-sizing."

In the U.S., he says, "most customers think of the generator set as a backup power system, so it has to provide for the maximum demand of the facility. For the CHP unit, though, we can make it a little bit smaller to increase the average load factor."

Integrating even a correctly sized CHP unit with other systems on-site can also be challenging. The unit must play well with UPSs, diesel generators and switching equipment, as well as other technologies designed to enhance reliability.

THE NEED FOR MAINTENANCE

Another reason the decision to go with CHP can be complex for data center operators is the need for scheduled maintenance. In contrast to diesel standby generators, cogeneration systems run continuously and therefore require more frequent service and maintenance at regular, recommended intervals. Visual inspections and routine systems checks must be performed, hoses replaced, parts updated on a schedule and filters changed. Keeping spare parts handy is a fundamental part of maintaining the system, and these parts must be stored close to the unit.

And, of course, there is the human element. "Typical [data center] operators are probably not initially familiar with this type of technology," says Mueller. So, when MTU Onsite Energy installs a unit, it offers in-house training for the operator because, "At the end of the day, they will be the one on-site every day and will be the first responder." Training courses are offered on the engine's mechanical and electrical components and control system.

The operator will be alerted to any problems or scheduled maintenance by the condition monitoring system, but operators can also "Be trained to identify situations where parts need to be changed," Mueller says. At the next level, MTU Onsite Energy's distribution service network can handle more complex maintenance. In addition, MTU Onsite Energy can troubleshoot many issues remotely through well-tested web-based access.

LONG-TERM THINKING

For a data center operator, installing CHP involves detailed planning. A variety of factors will come into play when determining economic viability, such as the costs of gas and electricity. "The higher electricity costs go, the more attractive cogeneration systems become," Mueller says. "But these external factors are, of course, hard to predict."

Changing energy efficiency regulations will also affect a data center operator's decision on CHP. Mueller sees today's stricter rules as a benefit that can encourage uptake, but he adds "you would prefer a cogeneration system to also be profitable without them, because you can never count on them 100 percent." And, of course, the rules differ from state to state. "In states like New York, with the NYSERDA program, they are focused on promoting CHP and the state has tremendous incentives which can cover between 50 and 80 percent of your cogeneration system if you qualify," says Mueller. In general, though, he confirms that incentives for cogeneration are greater in Europe than they are in the U.S.

In Europe, there is a voluntary energy efficiency initiative for data centers, managed by the European Commission's Joint Research Center. The Commission says this Code of Conduct was created in response to the need to reduce the environmental, economic and energy supply security impacts of data centers' growing power consumption. According to the Commission, 220 data centers have requested Participant status and 184 have been approved.

Participating data centers must commit to an initial energy audit designed to identify major energy-saving opportunities; submit an action plan and a timetable by which they will implement it; and allow regular energy monitoring.

CONCLUSION

Data centers can benefit greatly from CHP systems using trigeneration. Through increased efficiency of on-site power generation and cooling through absorption chillers using waste heat from the CHP, data centers can reduce costs of operation and greenhouse gas emissions.

Reliability and continuous uptime are also enhanced by adding an on-site power generation resource next to standby systems.

MTU Onsite Energy Corporation
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MTU Onsite Energy is a brand of Rolls-Royce Power Systems. It provides diesel and gas-based power system solutions: from mission-critical to standby power to continuous power, heating and cooling. MTU Onsite Energy power systems are based on diesel engines with up to 3,250 kilowatts (kWe) power output and gas engines up to 2,530 kW.