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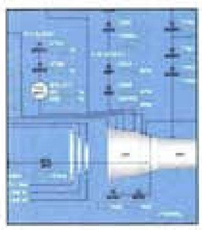

NON-INVASIVE EMISSION CONTROL

POWERING DATA CENTERS

OFFERING A MORE RELIABLE SOURCE THAN THE GRID, MICROTURBINES PROVIDE OVER 90% EFFICIENCY IN A TRIGENERATION MODE AT SYRACUSE UNIVERSITY

A data center is a facility used to house computer systems and associated components, such as telecommunications and storage systems. In the past, data centers housed redundant or backup power supplies.

Today's data centers can now save more than just information. Powered by microturbines, they could save money through reduced energy bills (Figures 1, 2).

Continuous availability of electric power is critical to the survival of data centers. But, the electric power grid is not reliable enough to guarantee this. Extended utility outages are becoming more common — and data centers can ill afford the outages. Recent weather-related power outages and the continued threat of terrorist disruptions are reminders of how fragile the aging electric infrastructure really is.

Data centers are among several industries that cannot afford even minor power disruptions and have quit relying solely on utilities to meet their power needs. Remote oil-and-gas sites, hospitals, manufacturing plants, universities, hotels and wastewater treatment plants are turning to microturbines for improved power reliability and energy efficiencies.

"While backup power is critical for securing a round-the-clock energy supply, traditional backup gensets typically sit as idle assets and do not always perform when they're needed," says Jim Crouse, Capstone Turbine's Executive Vice President of Sales and Marketing. "At data centers, microturbines can provide continuous power through a highly efficient Combined Heat and Power (CHP) or Combined Cooling Heat and Power (CCHP) systems, and can also provide emergency power at critical times."

In comparison to traditional reciprocating engines, microturbines have greater reliability, require less maintenance, have fewer service intervals and emit significantly less emissions. For instance, the Capstone microturbine has one moving part and is air-cooled, which makes the system dry and void of such maintenance-heavy components as water pumps, oil pumps, oil filters, radiators and fan belts. These components are present in wet systems (reciprocating engines) and have high probability for unplanned failure.

Figure 1: Twelve Capstone C65 Hybrid UPS microturbines are installed in Syracuse University's Green Data Center. The center is designed to use 50% less energy than traditional data centers

Microturbines typically have much higher reliability and availability than recips. Capstone says that each microturbine operates for 25 more days than a reciprocating engine in a year. This averages to 92% availability.

Further, microturbines can operate connected to a utility grid or provide stand-alone power to critical loads. Transition time between these two operating modes is less than 10 seconds, allowing customers to secure their critical power needs while mitigating the risk of detrimental data loss.

Trigeneration efficiency

Global data center capacity is rapidly increasing, consuming more energy while emitting more greenhouse gas emissions. According to a report on data center energy efficiency by global management-consulting firm McKinsey & Company, "With their enormous appetite for energy, today's data centers emit as much carbon dioxide as all of Argentina. If left on their current path, data center output will quadruple by the year 2020."

The U.S. Environmental Protection Agency estimated that, in 2006, data cen-

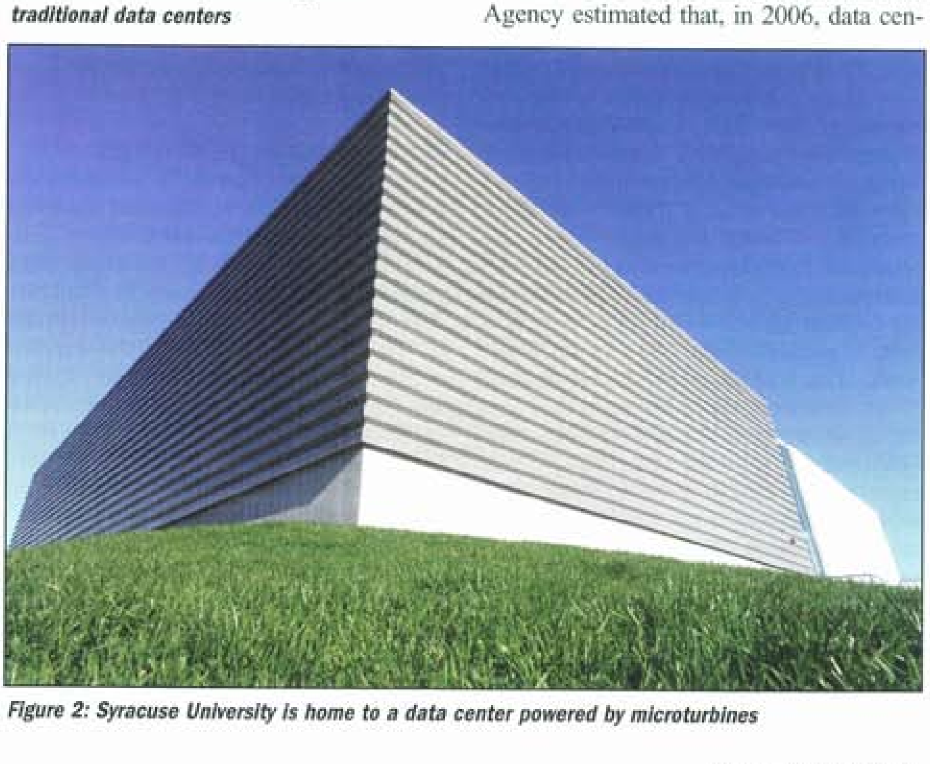

Figure 2: Syracuse University is home to a data center powered by microturbines

Figure 3: With trigeneration or Combined Cooling, Heating and Power (CCHP) applications, the heat output of Capstone C65 ICHP microturbines can be used to both heat and air condition a facility via absorption cooling

ters consumed 1.5% of the country's electricity — more than all of the nation's TVs combined. Without significant changes, the EPA estimates that energy use at U.S. data centers could double this year.

The behemoth buildings require power to operate equipment and to keep servers from overheating with air conditioning, thus creating heavy power and cooling loads. With trigeneration or CCHP applications, the heat output of microturbines can be used to both heat and air condition a facility via absorption cooling (Figure 3). For data centers, microturbine-based CCHP systems increase power efficiency by capturing waste heat from the electricity-producing microturbines and using the heat energy for heating or to produce air conditioning. Energy efficiency levels of microturbine-powered CCHP systems often nears 90%.

Helping to cap carbon

Syracuse University in upstate New York opened a Green Data Center in 2009. The university is regularly ranked among the Top 100 in the U.S.

The 12,000 sq. foot facility is designed to use 50% less energy and produce fewer greenhouse gasses than traditional data centers. Key to the center's energy savings are 12 patented Hybrid UPS microturbines from Capstone Turbine Corp. that power the entire facility. The Hybrid UPS is an onsite power system that integrates C65 (65 kW) microturbines directly with a dual-conversion UPS to provide power for mission-critical loads.

Capstone distributor BHP Energy integrated the design of the CCHP system so the 12 natural gas-fired microturbines produce electricity and supply heat and cooling power to the data center and a nearby building.

Traditional data centers rely on power from the utility and have banks of batteries that keep servers and equipment running during a short power loss. A standby emergency diesel generator is typically used for longer outages. At Syracuse, the microturbines allow the data center to be isolated from the utility, yet draw on the utility as a backup power source. A 40-ton EnerSys battery bank with enough power to carry the maximum load for 17 minutes is available for rare catastrophic situations.

IBM, a major partner in the project, provided $5 million in design services, support and equipment, such as "cooling doors" that use chilled water to cool each server rack independent of its neighbors. This reduces cooling and energy costs.

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Two 150-ton Thermax absorption chillers convert exhaust heat from the microturbines into energy that chills water used to cool the racks and the entire building. A Cain Industries heat exchanger can be used at the same time as the chiller to produce hot water to heat peripheral areas of the data center and the building next door.

The system also employs free cooling when the temperature outside is low. A heat exchanger is used to produce chilled water directly from a cooling tower on the roof.

IBM also provided computer equipment that operates from a Direct Current- (DC) powered distribution system, thus eliminating traditional power losses associated with converting Alternating Current (AC) electricity from the utility to DC to provide power to the servers.

Validus DC Systems supplied the project with high-voltage DC equipment, including AC-DC rectifiers. "If data centers around the world employ trigeneration technology using microturbines for reliable, low emission onsite power, we will have the ability to cap excessive greenhouse gas emissions levels," Capstone's Crouse says.

DATA CENTER SPECS

Location: Syracuse, New York, USA

Commissioned in December 2009

Fuel: Natural gas
Propane-air mixture as backup fuel if natural-gas system fails

Technologies: 12 Capstone C65 Hybrid UPS microturbines used in a CCHP application
Two 150-ton Thermax absorption chillers.
Cain Industries heat exchanger.
Validus high-voltage AC-DC rectifier.

One 40-ton EnerSys battery bank to carry the data center's maximum load for 17 minutes in rare catastrophic situations.

Results: The data center is designed to use 50% less energy and produce fewer greenhouse gasses than traditional data centers. Capstone's Hybrid UPS generates power while also using utility power to meet the center's electrical load demand. This allows the system to operate at the optimum point, which is a balance between electrical requirements and heating and cooling demand. The power system always operates in an N+1 redundancy configuration with the high level of reliability required by a productive data center.