Uninterrupted power in the city that never sleeps

A cogeneration plant and microgrid provide reliability, quality control, resilience and fewer emissions

By Serge Zinger and Jason Wittkamp

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Rising from what was a long underdeveloped area over a train-car storage site on the West Side of Manhattan, the 18-million-square-foot Hudson Yards today is a thriving urban complex. The project includes a high-rise residential community.

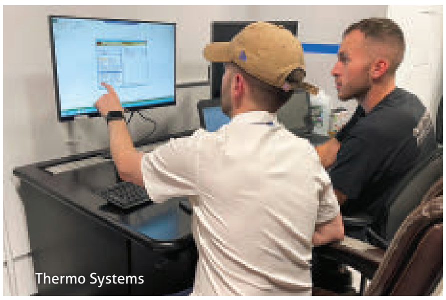
Manhattan's iconic skyline has been altered countless times – for better or worse – but it never ceases to amaze. In recent years, the city's West Side has seen one of its most dramatic transformations with the rise of an entirely new neighborhood: Hudson Yards.

Described as a "live-work-play community" by its developer, Related Companies, Hudson Yards is the largest private real estate development in the U.S. It includes 1 million square feet of retail and mixed-use space, 18 million square feet of commercial and residential space, 100 shops, 14 acres of parks and public space, a luxury hotel with more than 200 rooms – even a public school. The project's private residences sit in 88 stories of a glass and steel tower.

These numbers were born from humble beginnings. The 28-acre property was historically underdeveloped, used primarily as a storage site for the Long Island Rail Road. Hudson Yards was on top of the rail yard on two concrete platforms with a total base footprint of 660,000 square feet.

What does it take to power an urban community of this magnitude? Situations like these are where district energy can shine.

On the 12th floor of 20 Hudson Yards, a cogeneration plant and microgrid provide electricity and hot and cold water to the complex by running natural gas reciprocating engines coupled with absorption chillers. A control system that connects the generators provides numerous innovative features, including the ability to move thermal energy across buildings through a loop. Absorption chillers that use exhaust gas to heat and cool water are connected to the generators. These systems save about 24,000 metric tons of CO_2 equivalent (MTCO2e), which is



The gas-fired system serves a 28-acre complex that has dozens of tenants and is monitored with 24/7/365 attention that includes remote service and phone support.

The project took years to approve after other site plans had been rejected. Left, construction in 2017. Above, buildout.

equal to the annual emissions of 5,100 cars. The microgrid also gives Hudson Yards resilience; if the grid in New York City's surrounding districts fails, the complex would still have power.

The location – between 30th and 34th streets and 10th and 11th avenues – is so valuable that potential projects to add infrastructure over the top of the rail yard date to the 1980s. Proposals included a new stadium for the New York Yankees and an Olympic sports complex as part of the city's bid to host the 2012 Summer Games. Ultimately, the development that came to be known as Hudson Yards was approved in 2008.

The project design included a cogeneration facility that would support a microgrid – a huge selling point since, as groundbreaking commenced in late 2012, New York City was still reeling from the aftermath of Hurricane Sandy. Corporate tenants today include Coach, KKR, L'Oreal USA, WarnerMedia and Wells Fargo.

To attract high-profile companies like these, the project had to promise power-production safety and resilience. A cogeneration microgrid solution met that goal, offering lower-cost energy, control over power quality and better overall uptime. It was the clear and logical choice for a project of this size and significance.

A DISTRICT SOLUTION FOR THE LONG TERM

The cogeneration plant includes four Jenbacher gas-fired reciprocating engines, each capable of generating 3.3 MW of electricity. The generators' excess heat is captured and used to heat and cool the neighborhood's buildings. Power can be distributed directly to three buildings on site via the microgrid and indirectly to others through an agreement with the local utility company, Con Edison, to transmit power over its system. In parallel mode, the plant and the utility company jointly provide power to the microgrid; in island mode only the plant itself is kept running; in microgrid mode it can disconnect from the utility and be the sole provider of electrical power on the microgrid.

Coupled with each reciprocating engine is a 660-ton absorption chiller that uses the engines' waste heat to produce hot water, chilled water or both, depending on the season and on building loads. The plant's hot- and cold-water production is part of a larger district loop system.

Because it generates both electrical and thermal production, the plant requires an advanced design and unique operational considerations. To maximize return on electrical production, the power it produces should be kept at the level of consumption of the Hudson Yards buildings. The plant's efficiency depends on the waste heat of the engines being captured and used as thermal energy. For these reasons, the final determinations on how the plant should be run minute to minute must consider thermal and electrical demands alike. Thermo Systems, an experienced provider of district energy and cogeneration control systems, was hired to provide a solution that would meet those requirements.

The result was the installation of two separate Rockwell Automation PLCs, or programmable logic-controller-based systems, one – the power management system, or PMS – for electrical distribution, the other – the balance of plant system, or BOP – for thermal energy distribution. The two could function as stand-alone systems but are closely coordinated to provide simultaneous thermal/electrical decision-making. Layered on top of this Thermo Systems apparatus are certain controls provided by other vendors (see sidebar, "The case for ultrasonic flow meters"). Thermo Systems' role also included providing a Supervisory Control and Data Acquisition, or SCADA, system to provide plant operations with a single point of monitoring and control of equipment.

The power management system's primary function is to monitor and meter electrical distribution. It controls the breakers connecting the utility, local generators and customers with the microgrid. The operating mode of the plant (parallel, island or microgrid) is determined by this system, and in the event of a disruption to the utility, the PMS can automatically load-shed and restore down to the 480v distribution level.

The BOP coordinates the auxiliary systems of the cogeneration plant, which include condenser water, chilled water, hot water, gas supply, engine-cooling water and hazardous gas detection. Additionally, the BOP controls the loading and unloading of engines and end users' consumption at their respective energy transfer stations for hot and chilled water.

Both of these systems are relatively standard in a plant and microgrid of this size, but in this case the coordination between the two adds unique value. Thermo Systems, working with the developers and with their consulting partners Source One and RG Vanderweil Engineers, developed a control scheme that maximizes the efficiency and profitability of the plant while maintaining its reliability and resilience. Considerations were made for scenarios in which electrical demand is higher than thermal demand and vice versa; how to handle excesses and/or shortages in thermal or electrical generation; and balancing the generation of chilled and hot water from the plant. Excesses in electrical production can be sold to Con Edison, and excess waste heat from the engines can be discharged into the atmosphere if required. Shortages of electrical generation can be covered by purchases from the grid; shortages of thermal energy can be made up by existing equipment in the district energy loop.

The case for ultrasonic flow meters

By Izzy Rivera

Hudson Yards – which covers more than 28 acres of prime real estate and offers residential, retail and commercial services that make it a city within a city – challenged its designers to accurately capture the heating and cooling consumption of each tenant.

The FLEXIM Ultrasonic BTU flow meter offered a solution that helped allow customers to maintain a comfortable environment while providing system operators the data needed to bill and manage consumption precisely.

Thermal energy flow meters, also known as BTU meters, monitor hot and cold water that feeds heating and air conditioning systems like those at Hudson Yards. Such meters incorporate supply and return temperature sensors so that both volume and BTUs consumed can be tracked. Flow meters are typically installed wherever a main line branches off to a specific tenant.

Several other sites owned by the developers were using a more conventional impeller meter installed inside the piping. These meters work like a pinwheel in the wind. Rotational speed is picked up by a sensor and converted to a velocity and volumetric flow rate.
Hudson Yards' developers opted instead for clamp-on ultrasonics out of concern about traditional issues with impellors. As one might expect, a small spinner in contact with moving liquid can pick up debris from pipe scaling, minerals and slime, all of which can cause drag and result in inaccurate measurement, if not complete failure. (This had become a serious maintenance issue at properties elsewhere.)

The Hudson Yards design team chose FLEXIM clamp-on meters, which use ultrasonic technology to measure flow rates and do not require placing a sensor inside the pipe and flow stream. Sensors mount onto the exterior of pipes and direct two beams of ultrasonic energy through their wall. One opposes the direction of flow while the other follows it.

The ultrasonic controller measures the difference, which is computed to a flow velocity and volume, providing a reliable

Ultrasonic clamp-on flow meters have proven superior in several ways to traditional impeller technology.

reading even at fractional gallons per minute and at flow velocities as low as 0.02 feet per second.

CLAMP-ON ULTRASONIC FLOW METERS OFFER SEVERAL SELLING POINTS:

- Each comes pre-configured with a wiring harness that can connect to BACnet, the data communication protocol for building automation and control networks. Through BACnet, each flow meter can be monitored remotely.
- •Their simplicity of installation is notable, in this case bringing 500 meters online quickly across an enormous project.
- Their superior precision allows for accurate and timely billing.
- Their far lower installation costs makes up for their higher price.
- Because clamp-on meters have no moving parts, they don't require frequent recalibration or maintenance, in this instance eliminating roughly $250,000 annually for maintaining, servicing and replacing failed insertion meters.

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RESILIENCE FOR CUSTOMERS LARGE AND SMALL

The cogeneration plant's ability to deliver three forms of energy (electricity, hot water and chilled water) without being connected to the grid provides deep resilience. As the world pivots to more electrification, the production, transmission and distribution of electricity by utility companies will requires vast upgrades. This will be no small task, especially in places like Manhattan that are hobbled by aging infrastructure. Hudson Yards, in essence, provides tenants a shield from grid uncertainty.

The resilience of the plant is tied to the PMS with its electrical gear and breakers spread across the campus but with visibility from a single control room, allowing only a couple of operators to simultaneously manage many locations at once – and to do so with agility and appropriate speed. Some system management is automated in the event of abrupt change. Upon loss of grid electricity, for example, the PMS would temporarily shed loads at the 480v breaker level, allowing the plant time to convert to island mode and prepare to be the sole electricity provider to the campus. In such instances, thermal energy production at the plant is confirmed, and operators can initiate an automatic load restoration sequence. To restore power, the PMS will cycle through a predefined list of loads organized by priority. The system will actively monitor available power production at the plant and only bring on loads as they can be supported. The PMS will also lock out local control of breaker loads in each building. This is to protect against a building operator bringing on loads out of order and potentially exceeding the plant's available power production.

Resilience has been tested in late-night pull-the-plug, or PTP, tests in which utility power is disconnected so operators can experience a real-life outage scenario to be prepared for an unexpected one. Coordinating these tests of course requires extensive planning and buy-in.

The construction phase of Hudson Yards proved to be only the beginning of what has grown into a long-term relationship between Related and Thermo Systems, and today the two companies have a multiyear preventive maintenance and support agreement in place. Services covered include 24/7/365 attention with four-hour on-site response, remote access and phone support. The arrangement allows the on-site operations team peace of mind, knowing that its partner is invested in the health and optimal uptime of the system.

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