CASE STUDY:
DUKE UNIVERSITY MEDICAL CENTER

World Renowned Medical Center an Incubator for Critical Power Infrastructure Solution

BY DON RUST

Software prototype introduced to remotely monitor and control back up generators at Duke University Medical Center develops into a fully realized energy asset management system

The Duke University Medical Center has grown considerably since its inception in the late 1920's, with services now fanning out across the state from the original campus in Durham, NC. Duke University Health System now operates three hospitals -- the flagship Duke University Hospital on the Duke University Medical Center campus, Durham Regional Hospital, and Duke Raleigh Hospital -- as well as dozens of primary and specialty care clinics and support facilities in communities throughout the region. The main medical campus alone encompasses 90 buildings on 210 acres.

Expansion over recent decades has obviously translated to more energy assets for plant personnel to cover over a wider territory, but the stakes are a bit higher for medical facilities. All medical facilities are required to meet quality criteria for both CMS (Centers for Medicaid and Medicare) and The Joint Commission, covering all major infrastructure necessary to ensure patient, employee, and visitor safety. These criteria extend to all power production and distribution assets, particularly the emergency systems. The geographic spread of these facilities meant they were not centrally-managed as a portfolio to take advantage of utility program opportunities or proactively manage grid failures.

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Compliance oversight is far more rigorous now than in decades past, when demonstrating that you had a functioning emergency supply system was the only requirement. Strict reporting mandates now in place ask for monthly testing of every component of the campus generation portfolio and logging of historical data from each instance when on-site generation was called into service for outages and/or power quality events. Failure to properly report testing and performance data jeopardizes Medicaid and Medicare

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reimbursements to institutions. If operations are found out of compliance, a hospital reimbursement can be placed in immediate jeopardy and a new plan has to be submitted documenting how a facility will remedy any issues.

Importantly, it's not solely regulatory compliance that compelled Duke to pursue a sophisticated critical power management system. The significant and certainly increasing reliance on electronics and automation within hospital operations makes uninterrupted power even more important. From electronic medical records, smart infusion pumps and sensitive patient devices, Duke is now, more than ever, reliant on quality and secure power supply for the care of the most critically ill patients. This same high reliability power standard applies to other areas of the Health System, notably sensitive experiments, equipment, and the animal facilities that are the cornerstones of the research division at Duke.

Limited team; many exposure points

With over 50 electric generators of varying makes, models and vintages spread over a wide area; meeting the required testing and reporting standards placed a high demand on Duke facility management resources. It was extremely difficult to know precise operating conditions or diagnose potential readiness problems throughout the Duke system. Monthly testing of each backup system was an inefficient process in which a maintenance technician had to travel to the site, manually transfer normal power, take all readings, check fuel levels, log handwritten notes, operate for a required amount of time (up to an hour) and bring the data back. An electrical fault or unplanned event miles away could mean precious time lost while dispatching personnel to a clinic or research facility where patient safety, research environment stability and 100% power reliability are mandates.

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Following a failed experience with another technology, in 2006, Duke reached out to a firm that would become present day Blue Pillar, a developer of an automated energy asset management system for distributed energy resources. Blue Pillar had created prototype software born out of industrial applications that promised deterministic control of distributed assets. The criteria were very basic: build an asset agnostic system that allows personnel to remotely monitor data, as well as test and control all emergency power supply equipment.

Duke University Health System Core Clinical Labs was the first location to test the new system. The complex is eight miles from the main campus and was having recurrent power interruptions from the utility grid for this critical clinical function. Since that time the system has been expanded to other vital systems both on campus and at remote locations.

Automated Configuration Arrives

Each backup power system includes transfer switch(es), switchgear and generator(s). Existing remote terminal unit (RTU) equipment was coupled with Blue Pillar-provided devices interfaced with existing sensors and metering equipment, feeding a single software application. A system-wide Ethernet network backbone provided communications from the Blue Pillar devices to the Microsoft-based Avise server.

A rapidly-configured beta test conducted in early 2006 on a laptop PC outside in the Lab Building parking lot proved successful. Upon opening the HTML user interface, the equipment's disposition and

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operating data were all presented in real time. A transfer test from normal power, to emergency power and back to normal power went off without a hitch. Duke requested that both microphones and webcams be included at each installation so that they could have the added dimension of hearing and seeing how the equipment was operating at any given time and provided an additional layer of safety as Duke could visual that no one was working on or was near the equipment before initiating a test.

Duke moved forward with 6 additional locations serving the main clinic complex in 2007. Blue Pillar's beta application seemed like a victory for Duke, as the new system achieved the goals it set out to accomplish, albeit on a limited basis. During the initial role out of these six locations one site was discovered to have been running for an extended period (over 24 hours) without the original alarms alerting the maintenance technicians, on site stored fuel depletion presented an exposure to the facility. The Blue Pillar technology was able to identify the situation and thus the crisis was resolved eliminating a serious exposure for the facility. Duke Medicine executives were convinced of Blue Pillar's critical importance to operational safety and the need to extend the system to other facilities.

Duke properties have generating equipment and automatic transfer switches from virtually all major manufacturers, including Cummins, CAT, Detroit Diesel, John Deere, Allis Chalmers and Generac. Blue Pillar quickly developed the application and hardware layers of the system to include a standardized RTU to accommodate any manufacturer's equipment. The first six beta systems were replaced with a more robust, productized version of Avise that also included an alarm notification system that automatically email alarms and conditions to technicians. Subsequent software enhancements (there have been 40 since) include sophisticated fuel monitoring, oil pressure monitoring, emissions estimates, power factor monitoring, and load profiling; enhancements that have been released remotely without system downtime.

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A newer installation included multiple CAT Generators and ASCO switches with built-in intelligence and a sophisticated paralleling infrastructure. Blue Pillar's product adapted to the multiple generators in parallel configuration through a simple data connection between the new equipment and the new, standardized RTUs (a "flush" install). Another innovation developed during this phase was a project management function for Avise that takes all manually recorded nameplate information from the equipment and automatically generates a complete electrical schematic diagram for the enabled power infrastructure. It's this "embedded catalogue" that permits seamless, productized deployment in days vs. months.

Blue Pillar later introduced a cloud-based enterprise portal called Aurora, allowing personnel to gain secured access to Avise through any server without having to navigate a VPN. Now, engineers may view real-time asset status information from any web connection, an important tool when managing complex, multi-site energy resources. The current fleet includes 19 generators and 52 transfer switches.

Barely scratching the surface

In addition to having circuit-level control capabilities, Duke can also generate all regulatory compliant reports (including tests, outages and load shed) for all emergency assets through Avise, including Joint Commission and National Fire Protection Agency (NFPA 110) documentation, as well EPA reporting applied to the operation of diesel-powered generators. The system helps them stay in compliance with all required

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mandates for on-site energy assets.

Five years after the beta and successive expansions, Duke has yet to scratch the surface of the energy management system's capabilities, but has used the Blue Pillar technology as a means to move from asset risk management to asset optimization via greater participation in Duke Energy's demand response programs and through best understanding consumption trends on a circuit-by-circuit basis.

A primary benefit of Blue Pillar's granular data and control layers is a highly-accurate, real-time load profile of each enabled building and the capability to act on developing conditions through on-board controls. Duke had traditionally participated in demand response on a limited basis, by curtailing small, remote loads, but has incrementally expanded this participation (and related energy savings) by nominating load across areas of the medical campus once thought to be "off limits" to such participation. Duke believes Blue Pillar could extend emergency power to other energy assets including chillers, thermal storage and co-generation plants, for those facilities that rely on such infrastructure. Such a single-platform system would enable large campuses to nominate higher amounts of curtailable load among combined assets without impacting any critical circuits.

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This case example holds many possibilities for greater energy efficiency and tighter asset lifecycle management, two major factors in controlling operating costs. Recent events both at home and abroad teach us that it's definitely worth any institution with widely distributed energy assets and mission-critical uninterrupted power needs to consider a similar path as part of a larger strategic preparedness and business continuity plan.

About the Author

Don Rust recently retired after 44 years as assistant director of Engineering and Operations for Duke University Medical Center.

About Blue Pillar

Blue Pillar delivers campus-wide, critical power infrastructure security, operating efficiency and financial return through precision monitoring, diagnostics, and control in one software product platform. Blue Pillar systems manage hundreds of critical power infrastructure assets at some of the most prestigious medical centers and universities in the United States. Blue Pillar maximizes customer participation in demand management programs by unlocking stranded distributed energy resources based on load profiling, emissions constraints, on-site circuits served and market pricing.