Automating energy monitoring on campus

Dartmouth pushes the envelope in steam cogeneration and energy efficiency

Application Note

Dartmouth College, a member of the Ivy League located in Hanover, New Hampshire, has a long history of striving to conserve energy. In 1904, it was the first college on the eastern seaboard to install a steam cogeneration system. That cogeneration system burned coal to produce superheated steam that drove turbine generators to produce electricity. The leftover steam was used to heat the 31 campus buildings through a central steam plant. By 1922 the college started converting from coal to oil.

Baker-Berry Library at Dartmouth College. Photo by Joseph Mehling

In 1950, Dartmouth had 3.5 miles of underground steam mains and was generating power in parallel with the local utility. Five years later, the cogeneration system used 2 million gallons of oil each year to produce 1.7 million kWh of electricity and heat 64 buildings. In 2010, it took 4.5 million gallons of fuel to heat more than 100 buildings spread across the 260-acre campus.

Expanding campus demands more energy

Since 2000, the college has continued to expand, and its heating and electrical plant has been upgraded and expanded accordingly. Its plant now includes an internal medium-voltage distribution network, three 13.2 kV utility lines, and several chilled water plants that use steam absorption and/or electric chillers.

Of course, along with that expansion has come significant increases in energy demand and costs. To address those increases, as well as to further reduce its carbon footprint, the college has redoubled its focus on energy conservation.

Cogeneration reduces costs, increases reliability

Dartmouth continues to use cogeneration to control costs and to achieve a more reliable heating and cooling system. That is important in an area known for freezing temperatures through much of the winter and an occasional nor'easter. Today the campus heating and electric plant can power a portion of the campus independent of the regional grid. To keep those systems working in top condition, the heating plant and electric distribution team use a number of Fluke tools, including the Fluke T5 Voltage Tester, 87V and 179 digital multimeters (DMMs), 365 and i410 current clamps, 9040 Phase Rotation Indicator, and the Ti20 Thermal Imager.

Currently Dartmouth produces 18 million kWh of energy at its power plant, which accounts for approximately 40 percent of the electricity required to power the central campus. The rest of its electricity comes from the local utility.

Automating energy monitoring

In addition to cogeneration, the college continues to upgrade lighting and HVAC systems and is creating an extensive networked metering infrastructure that measures electricity, chilled water, and mechanical steam condensation. Consisting of more than 300 meters, this network keeps the facilities staff on top of energy use across the campus. They use this data to identify opportunities to reduce consumption, resolve potential problems, and verify the results of recent efficiency projects. The data also informs internal budgeting and long-range planning.

"Before we started the upgrade in 2010, we had a lot of buildings with older electric meters that we only got a pulse from every kilowatt hour," says Jonathan Parker, technician at Dartmouth. "We were reading the meters once a month and writing the results in a book, which didn't give us enough information to efficiently manage our systems."

In 2010, Parker and other technicians, electricians, and steamfitters from the college began replacing those meters with new IP-connected electronic meters. "With the new automated system we collect a pulse count from those meters into our energy management software every 15 minutes, so we have almost real-time information about all of our buildings at all times," says Parker.

Dartmouth is also installing new ultrasonic flow meters to measure chilled water energy from the central chilling plant. Plus, it is adding more mechanical and magnetic flow meters to measure the steam condensate that is pumped from campus buildings back to the central heating plant. The new meters send over a million energy consumption readings to the campus energy management system each month.

Keeping information flowing

On a typical day Parker could be evaluating options for new metering system components, installing new meters, or troubleshooting any number of components of the HVAC system. To ensure that he's prepared for whatever comes his way, he carries a Fluke 87V DMM.

For example, in a single day he used the 87V from one end of the campus to the other. First he used it to check the amperage and power of air handler variable frequency drives (VFDs) in the college's main library. Later he brought it out to verify an uninterruptible power supply (UPS) installation for the control power and communications system for the new electric meters. In between, he used it to check the phasing of voltage and current inputs at some electric meters and for continuity on the pulse count circuit.

The accuracy of the 87V helped Parker resolve an issue where some electric meters in a new building were displaying negative kilowatts. "I used the 87V with extension leads to show the installing contractor a reading of 480V between phase A (brown wire) in an adjacent panel and the phase A input (brown wire) to the meter," says Parker. "The erroneous reading was likely caused by voltage and current inputs not being in phase. My Fluke meter confirmed that disparity, and the contractor corrected the phasing at the panel. It is easier to prove a point when you are holding a Fluke meter."

Early introduction to Fluke

Parker started using Fluke tools in 1999 as an apprentice, when he received a Fluke T5-600 Voltage, Continuity and Current Tester. He still uses that tool, as well as the 87V DMM, and has added a few more Fluke tools for their safety, reliability, and product support. He frequently uses a Fluke 724 Temperature Calibrator to set up the resistance temperature detector (RTD) inputs for GE-Sensing DF 868 ultrasonic energy meters, to read the resistance/temperature at the RTD on the chilled water pipe, and to calibrate the input card on the meters.

To test amperage on current transformer circuits for the energy meters and on individual building circuit loads, such as lighting circuits, Parker calls on the Fluke 365 Detachable Jaw True-rms Clamp Meter. "The detachable jaw with the extension lead on the 365 makes it easier to work safely while measuring individual circuits in an energized panel," says Parker.

In addition to automating the metering information collection, Dartmouth is enrolled in a regional Demand Response program to reduce electricity consumption on short notice to support the New England grid. These measures and others have helped Dartmouth achieve its campus energy reduction goals and will continue to further those efforts in the future.

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