HEALTHCARE CASE STUDY

Penn Medicine

Optimization unearths savings in state-of-the-art chiller plant

Overview

Kathleen Morlang, energy manager of the Hospital for the University of Pennsylvania in Philadelphia, has one goal: reduce the energy used by the University of Pennsylvania's research hospital while ensuring a stable, comfortable environment for patients. To that end, she worked with Johnson Controls and Optimum Energy to turn Penn Medicine's modern chiller systems into an ultra-efficient, ultra-reliable cooling plant. The solution—Optimum Energy's OptimumLOOP® for central plant optimization and OptiCx® platform for operational reliability—led to a rarely seen level of efficiency that's saving Penn Medicine more energy and lowering operational costs more than anticipated.

Prior to optimization, the lead chiller plant, which consisted of new variable-speed water chillers with variable-speed pumps, fans and cooling towers, was already operating at peak efficiency. However, Morlang found it possible to realize significant savings even in fully controlled, automated plants with industry-standard high-efficiency equipment. After Johnson Controls and Optimum Energy completed commissioning, the plant was running at an efficiency of 0.511 kW/ton—an improvement of about 27%, and an unheard-of level for systems without the use of water-side free cooling. The plant has seen annual energy savings of 4.4 GWh/year and carbon emission cuts of 7.8 million pounds.

"In 20 years of experience, I've never seen chiller optimization like this," said Morlang. "It has more depth, it analyzes the system as a whole, and it uses advanced algorithms to adjust for the system you have in a holistic way. We're exceeding our predicted savings, and I expect that to continue year after year."

"After we had the optimization solution in place, we could make better decisions about expanding the plant. I was able to justify spending more to buy better, more efficient equipment than I could have if I didn't have the optimization software," the engineering director said.

Challenge: Optimizing an efficient, state-of-the-art plant

On paper, Penn Medicine's state-of-the-art central facility appeared to be operating at peak efficiency prior to the project. Two cooling plants serve the hospital: The lead chiller plant is a 4,500-ton all-variable-speed plant. The lag chiller plant is an older 6,000-ton plant with constant-speed auxiliary equipment.

The most challenging aspects of the optimization project were the constraints of the hospital environment and its location. Penn Medicine is one of the biggest hospitals in Pennsylvania, with 749 beds and 1,843,828 square feet of cooled space, and it must maintain specific temperatures around the clock for patient comfort and safety. That puts an immense load on the chiller plant all year—even in the middle of a Northeastern winter, the base load is more than 2,000 tons.

Nevertheless, Morlang suspected she could wring more energy-saving efficiencies from the cooling system. But because her department competes for funding with lifesaving medical equipment, she needed a solution that could provide quantifiable savings and a quick payback.

Solution: OptimumLOOP plus OptiCx

Morlang chose to increase energy savings through optimization, deploying the solution in partnership with Johnson Controls, which integrates with the facility's existing JCI Metasys building automation system to monitor plant conditions continuously and automatically calculate the most efficient operations in real time. She also leverages Optimum Energy's OptiCx platform—which includes the company's engineering support as well as cloud-based analytics—to monitor operations and to collect and analyze data, ensuring that the plant is running at maximum efficiency and reliability.

Now Penn Medicine's chiller plant is ultra-efficient and continuously fine-tunes performance in real time while performing operational data analytics. The solution is also more reliable than ever before: It monitors the chillers for conditions that could indicate system failure, alerting Morlang's team to deficiencies before they become real problems that lead to downtime.

"The chiller plant is 10 to 15 percent of our overall electricity bill, so when something goes down and we have to run an inefficient backup plant, it's really expensive," said Morlang. "But with [the optimization solution's] alerts and the second set of eyes on it daily with OptiCx and the Optimum Energy team, we can work together to find out what's going on. It's an amazing benefit."

Result: Extreme efficiency, operational reliability

At the outset of the optimization project, Penn Medicine's chiller plant was running at an average 0.699 kW/ton, meeting today's standards of high efficiency for a chiller plant. After full optimization, the plant runs at 0.511 kW/ton.

Since deploying the optimization solution, Penn Medicine is seeing annual savings of over 4.4 million kWh of energy, 7.8 million pounds of CO_2 emissions and $288,250. Because the lead plant required no mechanical changes prior to deploying OptimumLOOP, the entire savings result from applying the optimization software to the existing equipment. The project is providing ROI in under two years, easily justifying the expenditure. The hospital also received a one-time $221,731 rebate from its utility as a result of the project.

"It's a unique system. With its meters in place, we can collect hard numbers. If we turn the system off, we can watch energy usage increase. Then we turn it back on and we can make it go back down again," said Morlang. "We can see the immediate, quantifiable impact. The savings are verifiable—we know that our money is being quickly recovered and that the investment is helping patients."

DETAILS

Penn Medicine, University of Pennsylvania Health System

Two cooling plants primarily serve the Penn Medicine facility. The lead chiller plant consists of three 1,500-ton variable-speed chillers, three variable-speed chilled water pumps, three variable-speed condenser water pumps, and six variable-speed cooling towers. The lag chiller plant consists of four 1,500-ton constant-speed chillers, three variable-speed chilled water pumps, three constant-speed condenser water pumps, and four variable-speed cooling towers. A Johnson Controls building automation system controls all the equipment.

Penn Medicine facility

1,843,828 square feet of conditioned space

8,760 hours of cooling per year

Chiller plant specifications

Lead plant cooling capacity: 4,500 tons

Lead plant chilled water production: 25,326,853 ton-hours

Project benefits

- Energy savings
- Cost savings
- Water savings
- CO_2 emissions reductions
- Increased reliability

Plant efficiency improvements

Annual average plantwide efficiency, pre-optimization: 0.699 kW/ton

Annual average plantwide efficiency, post-optimization: 0.511 kW/ton

Utility savings (annual)

Electrical energy savings: 4,434,618 kWh/year

CO_2 emissions reductions: 7.84 million pounds/year

Water use savings: Over 1.8 million gallons/year

Financial savings (annual)

Annual electricity cost savings: $288,250 ($0.065/kWh)

Estimated ROI: 1.6 years (simple payback)

ABOUT OPTIMUM ENERGY

Since 2005, Optimum Energy has helped customers in higher education, healthcare and other industries reduce energy use in buildings, delivering typical energy savings of 30 percent, improved operating efficiency and reduced carbon emissions. To-date, Optimum Energy has helped their customers save over 1.6 billion kilowatt-hours of electricity, reduce carbon emissions by over 1 million metric tons and save over 337 million gallons of water.