Hospitals Benefit by Improving Inefficient Chiller Systems

Many hospital chiller systems are working far below peak efficiency, often due to flawed system design or poor operations and maintenance practices. This inefficiency results in high energy costs, limited reliability, and short equipment life.

Building chillers are the largest energy users in most commercial facilities, sometimes accounting for as much as 50 percent of electricity used.[1] As such, chillers present hospitals with one of their best opportunities for improving energy efficiency—and for realizing the major cost savings and environmental benefits that come with it.

A chiller's inefficiency becomes apparent in its Delta-T (ΔT), which measures the temperature difference between the return and supply chilled water. A low ΔT indicates a problem. Some hospitals may seek to improve their chiller systems through major renovations and upgrades. Others accomplish much through operations and maintenance approaches alone. This fact sheet has been developed by the U.S. Department of Energy's Hospital Energy Alliance to assist facilities managers and operators in using effective, energy-efficient technologies and practices to reduce the energy costs associated with chillers.

Operations and Maintenance Fixes

Below are a few simple operations and maintenance solutions.

- ***Cleaning the coils***—Chiller performance is related directly to heat-transfer efficiency. Dirty evaporator and condenser tubes decrease a chiller's ability to transfer heat, thereby increasing a compressor's energy consumption by as much as 30 percent or more. When condensing temperatures rise from 95°F to 105°F, cooling capacity is cut by 7 percent. For a 10-ton unit, this wastes about $250 per year. Cleaning the coils typically costs about $50, so it would pay for itself in just over two months and would save $200.[2]
- ***Implementing a chilled water reset control algorithm***—In some cases, raising the chilled water temperature reset by 1°F can reduce the chiller's energy usage by about 2 percent.[3] Relative humidity levels should be regulated to meet requirements as chilled water temperatures rise.

Lowering the temperature of the condenser water can also reduce the chiller's energy usage.[4] It should be noted that adjusting temperature resets could cause additional energy use elsewhere and could reduce the equipment's ability to meet demand. Maintaining the manufacturer's set points often is the safest course. Manufacturers should be contacted for specific information about chilled-water and condenser-water temperatures.

Additionally, since chiller performance is affected by outdoor air temperature, it is useful to purchase outdoor air sensors, which easily can be integrated into the chiller control panel. Manufacturers can provide a good source of guidance.

Chillers typically are designed to have a ΔT of about 10°F to 12°F, but this tends to degrade as a chiller system is expanded or modified over time. Chiller systems with low ΔT use more energy than necessary and deliver below their rated capacity.

Whether this can be addressed with an operations measure, rather than a retrofit, depends on the pumps in the existing system. For example, if the pumps are variable-speed, a simple solution would be to change the control strategy to maintain a higher ΔT across the chilled water loop.

Try These O&M Solutions

- Clean the coils.
- Implement a chilled-water reset control algorithm.
- Eliminate three-way and bypass valves.
- Adjust improper set-point calibration.
- Adjust improperly piped coils.
- Ensure proper sizing of control valves.

1. http://www.facilitiesnet.com/hvac/article/5-Threats-to-Chiller-Efficiency—1893.
2. http://www.reliant.com/en_US/Page/Shop/Public/esc_oma_cleaning_condenser_coils_bus_shp.jsp.
3. http://www.betterbricks.com/DetailPage.aspx?Id=584.
4. http://www.betterbricks.com/DetailPage.aspx?Id=539.

Major Renovations and Upgrades

There are times, of course, when operations and maintenance approaches will not result in enough chiller system improvement. In such cases, major renovations and upgrades may be required. The following options should be considered:

- Sites with multiple air-cooled chillers may want to transition to a primary-only pumping chilled-water system. Water-cooled chillers typically have a higher coefficient of performance (COP) than their air counterparts, which results in increased energy savings. Manufacturers should be consulted for additional information.
- Variable-speed drives could be installed in place of fixed-speed systems. These can reduce cooling delivery system energy use by 30 to 50 percent, depending on the load profile.[5]

Variable-Speed Drives Save Energy[6]

Chiller (kW/ton) Percentage Savings per Degree (˚F) of Reset		
	Fixed-Speed Drives	Variable-Speed Drives
Chilled Water Reset	0.5% to 0.75%	2.0% to 3.0%
Condenser Water Reset	0.75% to 1.25%	1.5% to 2.0%

5. http://sciencestage.com/d/3808842/power-quality-and-line-considerations-for-variable-speed-ac-drives.html.
6. Lawrence Berkeley National Laboratory, "Chiller Controls-related Energy Saving Opportunities," January 2003.

Case Study

Memorial Sloan-Kettering Cancer Center

New York, New York • Occurred from 2006 through 2009

Overview

Memorial Sloan-Kettering Cancer Center (MSK) comprises seven interconnected Main Campus buildings, the Rockefeller Research Laboratory, and the Mortimer B. Zuckerman Research Center. Realizing a need to improve its chiller system, MSK worked with the New York State Energy Research and Development Authority (NYSERDA) to study the system and make changes.

NYSERDA's Existing Facility Program consultants developed both a baseline and a measurement and verification plan at no cost. MSK also took advantage of NYSERDA's FlexTech Program to document opportunities to improve operations, sequencing, and measurement of chiller system processes. The FlexTech Program pays half the cost of energy-efficiency studies, limiting MSK's share to $48,500. Energy cost savings were projected to total $486,500 annually over baseline. MSK then used a $598,000 NYSERDA grant to help implement the recommended upgrades in two phases.

Phase I

Key Actions (2006–2007)

- Installed 13 flow meters and micro-gateways in the Memorial plant (on the Main Campus) to collect data for computer analysis.
- Installed a data-collection panel connected to an FTP site and set up a Web site for real-time monitoring of the Memorial plant.
- Corrected flow issues in the Memorial plant to achieve the optimal approach temperature of 2°F.

Results (2006–2007)

- Gained ability to monitor and measure usage.
- Corrected flow through the chillers to within design parameters instantly.
- Improved chiller efficiency by approximately 24 percent over baseline.
- Captured an additional 1.8 million ton-hours of free cooling.
- Saved $793,000 annually over baseline.

Phase II

Key Actions (2008–2009)

- Expanded program to Rockefeller plant and Infill plant (on the Main Campus).
- Removed tertiary pumps and converted secondary pumps to primary pumps.
- Connected Rockefeller plant to the Main Campus loop.
- Connected Zuckerman plant to the Main Campus loop.
- Bypassed 20 pumps, which will be demolished.

Results (2008–2009)

- Improved Infill chillers by 27 percent over baseline.
- Improved Rockefeller chillers by 20 percent over baseline.
- Reduced peak demand by 1,000 kW combined across the Main Campus and Rockefeller plants.
- Reduced projected pumping horsepower by 1,600.
- Saved $625,000 annually over baseline.
- Realized simple payback in 0.6 years.

Hospital Energy Alliance

HEA is a forum in which healthcare leaders work together with DOE, its national laboratories, and national building organizations to accelerate market adoption of advanced energy strategies and technologies.

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

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August 2011
Printed with a renewable-source ink on paper containing at least 50% wastepaper, including 10% post-consumer waste.