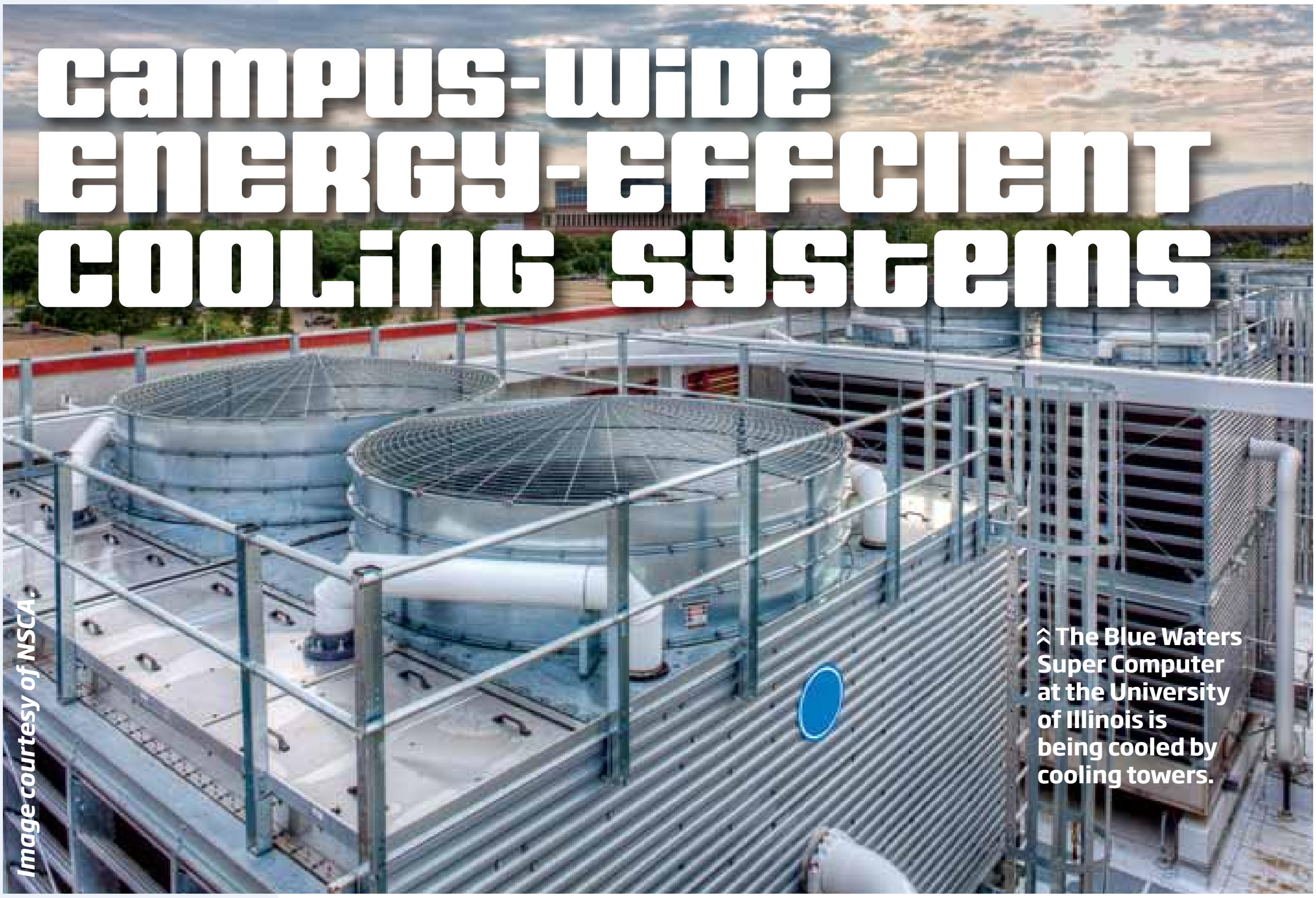

Campus-Wide Energy-Effcient Cooling Systems

The Blue Waters Super Computer at the University of Illinois is being cooled by cooling towers.

A look at evaporative cooling systems utilizing ice thermal storage at universities and schools.

BY JUNE GALLOWAY AND JOHN LAU

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Many universities and colleges are faced with unique challenges in today's complex marketplace. Enrollment has increased, and increased energy and operating expenses continue to pose a problem. One of the largest energy consumers at any university or college is the cooling system for the campus. Cold water from the chillers provides air-conditioning, lab processes, and/or can be combined with other equipment, such as ice thermal storage, to run a central campus power or cooling plants.

Evaporative cooling towers reject heat from chillers to the atmosphere, and can be used for individual buildings or on central campus cooling or power plants. In a cooling tower, hot water from the system enters and is distributed over the heat-transfer surface which is called "fill." Air is induced or forced through the fill, causing a small portion of the water to evaporate. This evaporation removes heat from the remaining water. The colder water (generally designed for 85°F) collects and is then returned to the system to absorb more heat.

Typical cooling systems utilize air, water or adiabatic heat-rejection methods. The use of a cooling tower enables building owners to take advantage of the operating cost savings inherent in water-cooled systems. Water-cooled methods are approximately 35% more efficient than their air-cooled counterparts. With greater efficiency and lower operating costs, water-cooled methods as a long-term investment help save money in the long run and provide a reasonable payback (1–3 years).

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Choosing a cooling tower

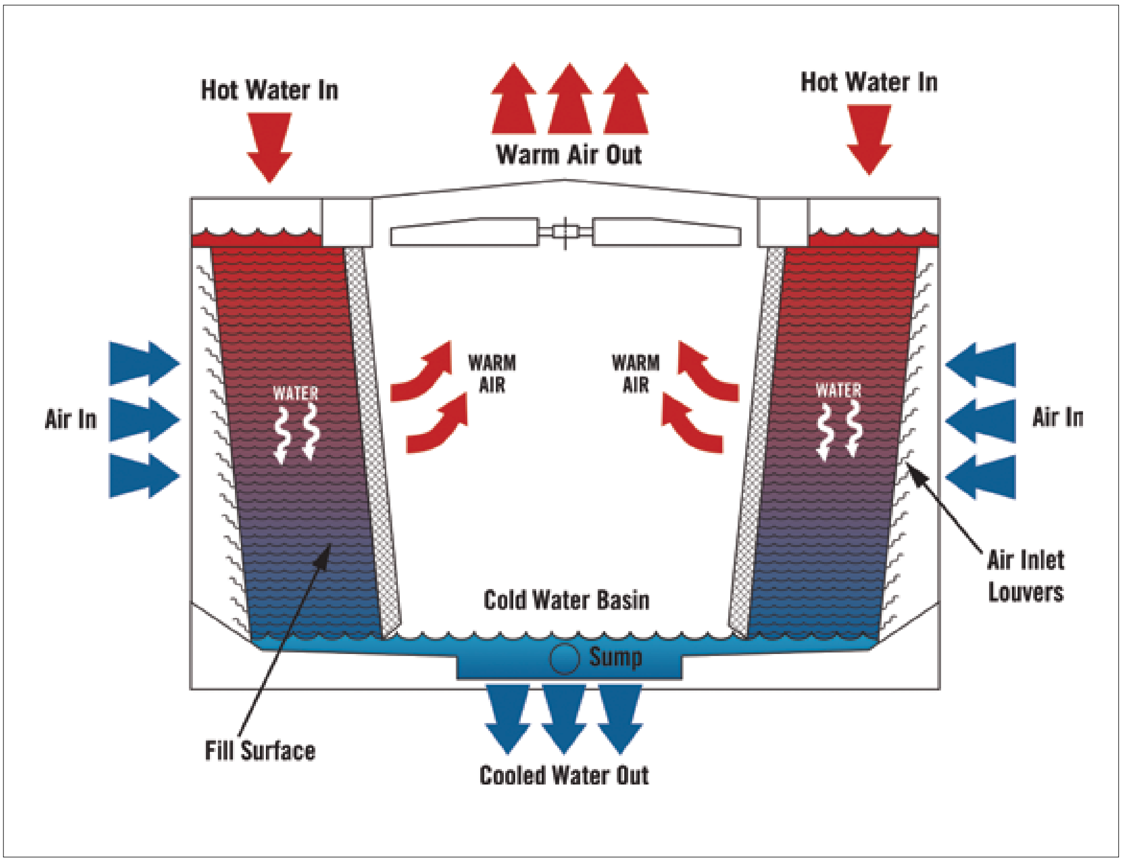
There are many factors that can influence the selection of a cooling tower. The size of the system, required design conditions, sound levels and efficiency are key selection criteria.

Energy efficiency—Cooling tower selection can be affected by many local and national codes, standards and rating systems that are becoming increasingly focused on green programs, energy savings and environmental responsibility. Energy-efficiency standards such as ASHRAE 90.1, local regulations such as California's Title 24, and voluntary certifications like the U.S. Green Building Council's LEED rating system can affect cooling tower selection. Campus facility managers should carefully analyze the lifespan of the cooling system in order to achieve the best value and energy savings.

Design considerations—The operational efficiency of an evaporative cooling tower depends on an adequate supply of fresh, ambient air to provide design capacity. Proximity to building air intakes or discharges must be taken into account when selecting the equipment site. As the size of the installation increases, the total amount of heat being rejected into the atmosphere and the volume of the discharge air increases. In some instances, a portion of the discharge air may recirculate back into the cooling system for installations in an enclosure. The recirculation should be minimized or design wet-bulb temperature must be adjusted to allow for the recirculation.

Sound—Another selection criterion to consider is sound. On applications using cooling towers, the source of sound is a combination of the cooling tower fan(s), the fan motor(s), water, etc. Sound ratings should be considered if the units are located in densely populated areas and can be obtained from the original equipment manufacturer.

Reliability and maintainability—Today's building owners are constantly challenged to reduce operating costs. Therefore, it is important that owners purchase a cooling tower that is reliable and maintenance friendly. An easy-to-access-and-maintain cooling system promotes routine mainte-



›› The principles of operation for a cross-flow evaporative cooling tower.

nance and smooth, reliable year-round operation. A cross-flow cooling tower typically meets these objectives and can provide an excellent method of campus cooling.

Ice thermal storage

While evaporative cooling towers can be used in the system on individual buildings or in power or cooling plants, another method that can be used to reduce the total cost of ownership and reduce environmental impact is to add ice thermal storage. This is a growing trend in the U.S. and can save energy and money, while conserving natural resources.

Lower total cost of ownership—Ice storage is the process of using a cooling tower and chiller to build ice on coils during off-peak hours. The ice is then melted to provide cooling during peak periods.

This use of electricity at night vs. peak hours can lead to large savings on energy bills. Ice thermal storage can lower peak electrical demand for the system by 50% or more. Since many campus electrical rates include demand charges during peak demand times and/or higher day vs. night kWh charges, savings can be substantial. In addition, some campuses with ice thermal storage are also eligible to receive demand-response rebates from local utility companies.

An example of this can be seen at the University of Maryland. UMD utilizes 8,900 ton-hours of ice storage to shave off 1 MW of electric demand. According to John Vucci, Associate Director of HVAC Systems, the university saves approximately $70,000 a year by participating in a demand-response program.

Reduced piping and pumping cost—Ice thermal storage tanks can provide supply water as low as 34°F (1.1°C) to the system. Flow-rate requirements are reduced by taking advantage of greater temperature ranges achieved when utilizing this colder supply water, providing substantial savings in the chilled-water distribution loop. A range of 20°F (10°C) instead of the more traditional 10°F (5.5°C) can reduce the required system flow to half of a traditional system, resulting in significantly reduced pipe sizes and pumping energy for the chilled-water system.

Environmentally friendly—Storing energy as ice during off-peak hours allows the system to take advantage of cleaner and more efficient energy sources. Ice thermal storage lowers peak demand, offsetting the need to build new power plants, and helping to lower greenhouse gas emissions. An operating example of this can be seen in Florida. According to John Nix, Senior Engineer for Florida Power and Light, ice ther-

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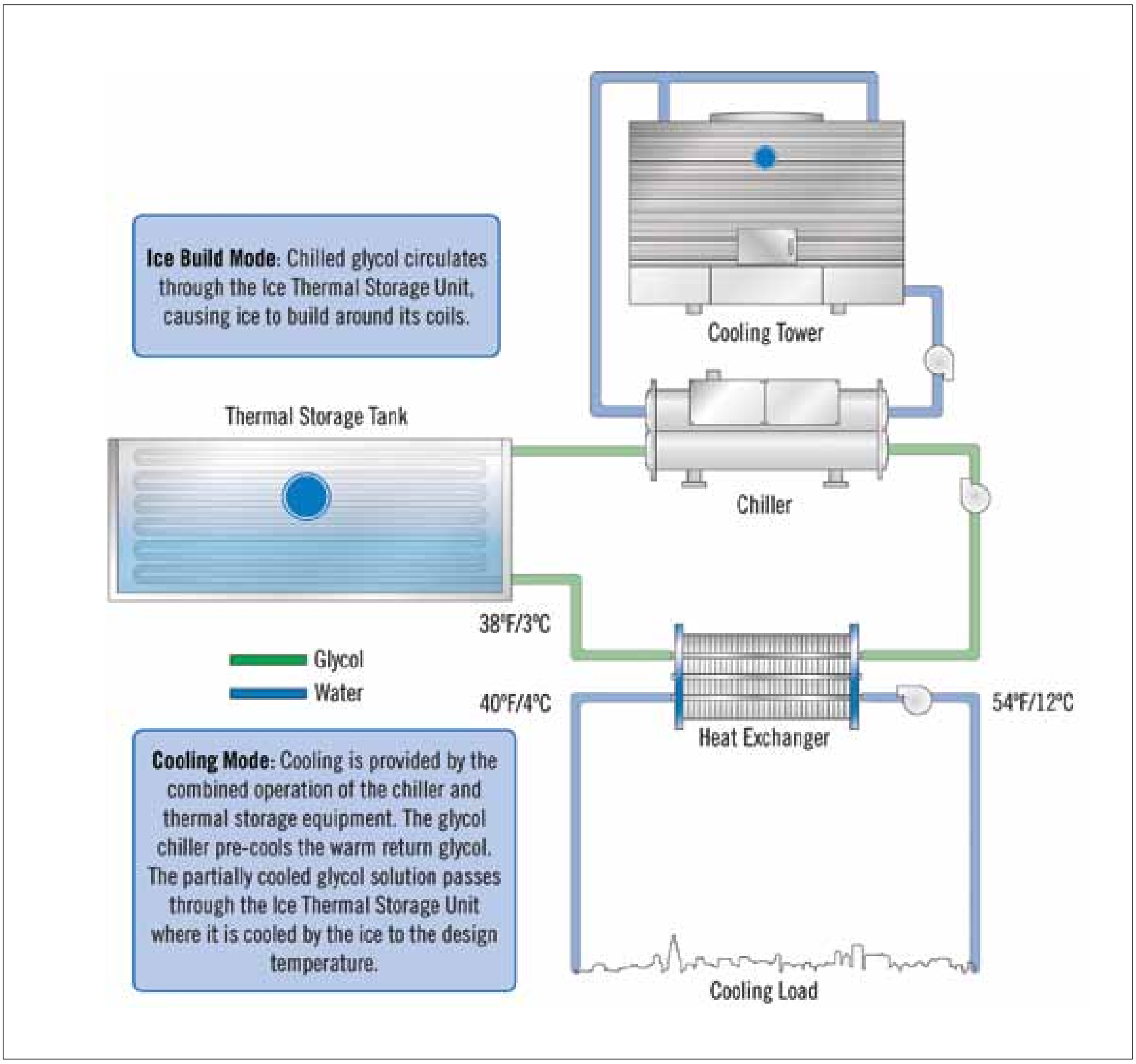
mal energy storage has helped FPL avoid building 13 power plants in the past 20 years. To encourage load shifting, FPL provides $480/ton rebate incentives to customers installing thermal storage on their facilities. FPL also offers time-of-usage rates to lower the cost of electricity during off-peak hours.

Another environmental benefit to ice thermal storage comes with reducing the size of other system components. Reduced peak load allows for the use of smaller chillers in the system. Smaller chillers require lower refrigerant charges, which reduces the use of ozone-depleting refrigerants and the overall impact on the environment.

As a green technology, ice thermal storage systems can also qualify for a number of LEED points specific to LEED for Schools as well as LEED for new buildings and renovations:

- → **Optimize Energy Performance Credits (19 points)—** Make ice during off-peak periods and optimize energy from the grid.

Ice thermal storage tanks at Catonsville Community College in Catonsville, MD, just outside of Baltimore.



›› **Details of how an ice thermal storage system operates.**

- **Enhanced Refrigerant Management Credits (2 points)**—Reduce the chiller size by up to 40% compared to conventional chilled-water plants. The chiller then holds a smaller refrigerant charge, minimizing the contribution of ozone-depleting compounds.
- **Enhanced Acoustical Performance Credit (1 point)**—Provide chilled water during peak hours without turning on chillers and cooling towers, significantly reducing the sound contribution of HVAC equipment.
- **Demand Response Credit (3 points)**—Planned to be introduced in 2012, ice thermal storage shifts energy demand to off-peak hours.

Campus projects that incorporate ice thermal storage to cut peak electric demand and reduce operating costs include Stanford University, University of Pennsylvania, Johns Hopkins University, University of Maryland College Park and George Mason University.

Conclusion

Evaporative water-cooled towers and ice thermal storage systems can be utilized for air-conditioning, lab processes, or for a central campus power plant. These units offer reliability, energy savings, conserve resources and are environmentally friendly.

“Evaporative water-cooled towers and ice thermal storage systems can be utilized for air-conditioning, lab processes, or for a central campus power plant.”

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