**Putting the Heat on Data Center Cooling Costs**
**Exclusive to Cleantech Group**

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Data centers are becoming the single largest industrial energy users consuming 61.4 billion kWh annually in the U.S. alone, while producing more than 43 million tons of $C0_2$ each year. What is not universally understood is that 40-60 percent of this annual energy spend is consumed by cooling systems for data center IT equipment. Consequently, there is an enormous market opportunity to deliver power and cooling solutions that can reduce costs dramatically and improve IT availability.

And as data centers get larger they are getting thirstier as well. The enormous volume of water required to cool high-density cloud computing server farms is making water management a growing priority for data center operators. For example, a 15-megawatt data center can use up to 360,000 gallons of water daily.

Given this gluttony for natural resources, the requirement for next-generation data center cooling solutions capable of setting new industry precedents for reduced energy consumption and aggregate water usage is more vital than ever. On a directly related note, there are broader sustainability issues associated with reducing energy and water in data center cooling to minimize increasingly harmful E-waste caused by unnecessary "server churn."

Like death and taxes, the absolute certainty surrounding data centers is that they will continue to expand to support more users, more compute-intensive equipment and applications and increasing demand for higher availability. Simply put, that demand calls for even greater energy consumption. This leaves data center managers with two vexing choices: either invest in upgrading the power and cooling infrastructure of existing data centers via a major retrofit, or build out entirely new facilities, both of which can be significantly capital-intensive alternatives. In the case of new data center construction, costs can run as high as $2,000-3,000 per square foot.

Let's step back and examine some of these issues in greater detail. First, there is a general trend toward consolidating many smaller data centers into one or a few large data centers. The theory behind these centralized data centers is that they can support higher equipment densities and more effectively use available floor space than a number of smaller centers can. That's why computing hardware is increasingly moving to space-efficient form factors such as 1U rack servers and blade servers, which allow higher computing density in a given floor space.

However, this trend toward increasing server density is resulting in higher power densities in many data centers. The impact of these dramatically higher power densities is that, in many cases, power and cooling capacity are the primary constraints to expansion of computational capacity within a data center. As a result, data center managers must either invest in upgrading the power and cooling infrastructure of existing data centers or build new facilities; either choice requires significant capital investment.

Another impact of higher energy densities is that server hardware is no longer the primary cost component of a data center. The purchase price of a new (1U) server has been exceeded by the capital cost of power and cooling infrastructure to support that server. And this will soon be exceeded by the lifetime energy costs alone for that server. This represents a significant shift in data center economics that seriously challenges conventional cooling strategies.

The other side of the data center resource problem is excessive water consumption. According to the USGS, 39 percent of the water used in the United States is for power production followed by the public sector that taps into 13 percent of the available supply, which includes water used at data centers. What this tells us is that the energy used at data centers has a bigger effect on the national water tables than most every other industry.

According to the Energy Information Administration (EIA) only the Chemical industries 153B kWh's and Metal Industries 144B kWh use more water due to their power usage requirements. Data centers are not far behind, using more water than the paper, food, auto, wood, petroleum, and plastics industries.

As data centers are forecast by the EPA to double their cumulative power and water consumption levels by 2011 and every five years thereafter, the industry faces a legitimate and daunting question: is there enough water supply to support the energy needed for power hungry data centers? Historically, water use has been seriously overlooked when designing and permitting a data center. Given the total sustainability footprint that data centers leave behind, the industry is now at a tipping point with respect to implementing new solutions that reduce energy and can reduce water consumption significantly.

In view of this sobering data, data center designers and facility managers must reevaluate how to go about reducing power and cooling requirements. This is going to involve a much more stringent evaluation of next-generation computer room air-conditioning (CRAC), air-handling units (AHU) and chiller systems that have demonstrable efficiency advantages over legacy systems.

A good metric that the industry is relying on more and more is a Power Utilization Efficiency (PUE) rating. Currently, data centers deploying cooling infrastructures based on legacy systems are averaging a PUE of 2.25 according to the Uptime Institute. With the introduction of next-generation CRACs, AHUs and chiller systems, PUE's can now be reduced to levels reaching 1.25 without sacrificing temperature or humidity control. To put that in a financial context, lowering a PUE from 2.25 to 1.25 can slash spending from $.44 per ton hour for cooling to less than $.05 per hour.

Facility managers should be very careful to avoid being seduced by various technologies vying for dominance in the data center cooling market. This is especially true with airside economizing (ASE) solutions that have been the rage in the industry of late. In point of fact, ASE uses more energy, requires additional consumable expenditures for filters, and does not provide consistent temperatures and humidity levels. Refrigerant side economizing (RSE), on the other hand, can reduce refrigeration compressor energy by up to 100 percent. By deploying RSE solutions directly in the return air based on the outside wet-bulb temperature rather than dry bulb temperature relied upon by ASE, economizing hours can be increased by as much as 50 percent, as compared to airside economizing and typical waterside economizing.

Next-generation cooling solutions also play a vital role in reducing water usage onsite at data center facilities and at regional power plants. A typical 100-ton water-cooled data center consumes 1.2 million gallons of water per year at the onsite facility. This can double or triple depending on cycle concentration rates in cooling towers. Consequently, a 100-ton data center consuming 1.7 million kWh per year for cooling on average requires 3.2 million gallons of water for the cooling load at the power plant. With a next-generation data center-cooling infrastructure, water consumption can be drastically reduced to 900,000 gallons at the power plant per year due to the total energy savings.

Clearly, the table stakes for breakthrough cooling solutions in the $6 billion retrofit and new construction data center market is huge. While this data center "plumbing" may not be as glamorous as the more visible computing side of these multi-million dollar glass houses, it will constitute a major piece of the new energy efficiency infrastructure of the 21st century. The next "Cisco of cooling" will emerge from this wholesale change in data center economics.

**About the Author**

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