Introduction

Data centers can consume 25 to 50 times as much electricity as standard office spaces. With such large power consumption, they are prime targets for energy efficient design measures that can save money and reduce electricity use. But the critical nature of data center loads elevates many design criteria -- chiefly reliability and high power density capacity – far above efficiency. Short design cycles often leave little time to fully assess efficient design opportunities or consider first cost versus life cycle cost issues. This can lead to designs that are simply scaled up versions of standard office space approaches or that re-use strategies and specifications that worked "good enough" in the past without regard for energy performance. The Data Center Design Guidelines have been created to provide viable alternatives to inefficient building practices.

Air Management

Concerned about your data center's cooling capacity? Use of best-practice air management, such as strict hot aisle/cold aisle configuration can double data center cooling capacity. Proper air management is critical to running an energy efficient data center. When designed correctly, an air management system can lower operating costs, reduce first cost equipment investment, increase the data center's density (W/sf) capacity, and reduce heat processing interruptions or failures. .

Airside Economizer

Instead of running air conditioning on chilly days, why not using free outside air and cut data center cooling costs by over 60% annually? The steady cooling load of a data center is well-suited to take advantage of seasonal and nighttime temperature variations to cool the space. An air handling system equipped with an airside economizer takes advantage of cool outside air temperatures, and draws this air into the data center when it is at a lower temperature than the return air coming off of the computing equipment. The heated return air is then exhausted from the building instead of re-cooled, which leads to obvious energy savings.

Centralized Air Handling

If your facility has a rooftop, then it can have a centralized air handling system which reduces cooling system maintenance costs and frees up space in your actual data center for more servers. A centralized air handling system can improve efficiency by taking advantage of surplus and redundant capacity. Centralized systems use larger motors and fans, thus they have the capability for increased efficiency. These systems, when equipped with variable air volume fans, tend to have better efficiency when underloaded, matching nicely with the typical data center system operation profile.

Cooling Plant Optimization

Phantom dehumidification loads are wasting you money, so eliminate them through the use of an energy efficient medium-temperature (55°F) water loop design. For large data center facilities, a chilled water system served by a central plant is the most efficient approach to providing mechanical cooling. While the chiller is not the only important element in an efficient plant design, it is the single largest source of energy consumption. Data centers offer a number of opportunities in cooling plant design and operation optimization, including: thermal energy storage, load monitoring sensors, a primary-only variable volume pumping system, and a medium-temperature chilled water loop design.

Direct Liquid Cooling

You may have heard about direct liquid cooling, but did you know that water flow carries approximately 3,500 times as much heat by volume as air. Liquid cooling can service higher heat densities, and with much greater efficiency than traditional air cooling. Under an ideal scenario, waste heat is transferred as close to the server racks (the heat source) as possible. Direct liquid cooling allows this near-immediate transfer to occur, and takes advantage of the fact that water is a more efficient heat transfer agent than air. As chip power continues to rise and equipment loads continue to increase in density, liquid cooling becomes increasingly inevitable as a strategy for cooling the rapidly increasing equipment load density (measured in W/sf). While a typical data center boasts the ability to cool loads of up to approximately 5kW per rack, integrated water cooled systems have demonstrated the ability to efficiently cool loads up to four times that size.

Free Cooling via Waterside Economizer

Reducing cooling costs is simple with the implementation of free cooling, which can cut chilled water plant energy consumption costs by up to 70%. Waterside economizers use the evaporative cooling capacity of a cooling tower to indirectly produce chilled water to cool the data center during mild outdoor conditions, bypassing the energy intensive chiller. Cooling towers produces low temperature water, and a heat exchanger is used to cool the building loop while keeping it clean and isolated from the relatively dirty cooling tower water. Free cooling can provide a backup to the compressor chillers during cooler nighttime hours when plant staffing may be lower. When the weather allows, free cooling replaces the complex mechanism of a chiller with a simple, non-mechanical heat exchanger.

Humidification Controls

Servers do not require tight humidity control, and can be placed in rooms with 30-70% relative humidity without adverse effects. Using this rather broad band of humidity generates immediate savings, as humidification is very energy intensive, and dehumidification can result in even higher energy costs. One of the main reasons energy use is high with decentralized humidity control is that the humidity is typically over-controlled, often with inadequate systems. Decentralized humidity may result in adjacent CRAC units simultaneously humidifying and dehumidifying a space, and humidity sensor drift as well as sensors that are not calibrated, become an issue when attempts are made to restrict humidity to a very narrow band.

Power Supplies

Did you know that savings of $2,700 to $6,500 per year per rack are possible just from the use of more efficient power supplies? Using higher efficiency power supplies directly lowers a data center's power bills and indirectly reduces cooling system cost and rack overheating issues. When power supplies are selected, the impact of real operating loads should be considered, and the optimal supplies are those that offer the best efficiency at the load level at which they are expected to most frequently operate. Oversizing power supplies is inefficient, and supply should be matched to system load.

Self Generation

Generating on-site power and utilizing the waste heat can reduce chilled water plant energy costs by well over 50% and help stop global warming. Self-generation provides both an alternative to grid power and waste heat that can be used to meet nearby heating needs or harvested to cool the data center through absorption or adsorption chiller technologies. Self-generation is not only more efficient due to the capture and use of waste heat, but when generators are run at full-load and selling surplus power back to the grid they are globally more fossil fuel efficient.

Uninterruptible Power Supply (UPS) Systems

Simply selecting a 5% higher efficiency model of UPS can save over $38,000 per year in a 15,000 square foot data center. UPS inefficiencies can total hundreds of thousands of wasted kilowatt hours per year, but the inefficiencies can be lowered by making changes to the electrical design and/or the system configuration. Increasing UPS system efficiency offers round-the-clock energy savings, both within the UPS itself and indirectly through lower heat loads and reduced building transformer losses.