Powering Business Worldwide

White Paper

The Green Imperative—
Power and cooling in the data center

An interview with Fred Miller, Product Line Manager, Eaton Data Center Solutions

Expanding power demands. Increasing energy costs. Excessive heat.

If you manage a data center—or engineer the architecture for clients who do—you know how critical these issues have become. It is a challenge to conserve energy while powering and cooling all those growing loads, without bringing unwanted governmental scrutiny or surcharges for being an energy hog.

In a candid interview, Eaton's Fred Miller discusses metrics and tools for power planning, and the promise and limitations of new cooling technologies and alternative fuel sources for data center applications.

To increase efficiency while reducing power consumption and cost, data centers must plan ahead for energy management. What tools are available to address this issue?

There are two key aspects to this issue. First, you must have reliable and meaningful data about present-day power consumption and quality—not just a snapshot, but a performance record. Second, you need the ability to analyze, troubleshoot and assess trends over time.

The good news is that even a small data center can afford the tools to address both these aspects, to proactively manage energy consumption, prevent overload conditions, improve capacity planning and optimize power distribution.

With new energy management systems, new or existing electrical infrastructures can easily be equipped for 24/7 monitoring, all the way to the branch circuit or receptacle level:

- New, high-speed power meters can accurately detect even the most fleeting anomalies in power quality on critical loads.
- Branch circuit monitoring systems enable users to keep tabs on current flow at a very granular level, even on power distribution systems that weren't designed to have this capability.
- Compact environmental monitors fit into unused side or rear channels in racks to monitor temperature and humidity.
- At a central vantage point, or from anywhere, software systems aggregate all this data, present it in easy-to-grasp terms (or visuals) and support in-depth analysis.

With these technologies, data center managers can get visibility into their power systems at multiple levels—down to the individual branch circuit or receptacle, or summarized across loads or for the whole data center.

Are more data centers using real-time automated monitoring systems to analyze power usage and help identify hot spots and cooling problems?

Absolutely, and this has been driven not only by rising energy costs but by recent technology advances. For example, back in the day, if you wanted high-speed sampling of power quality, you'd have to call in a consultant with a $20,000 portable power meter. In the more recent past, less expensive hand-held meters are used. Even then, you'd get a snapshot view of power consumption and quality. You could miss fleeting anomalies or seasonal variations.

Now this kind of high-end monitoring is affordable and practical for data centers to own and use all the time, and you don't have to be a power guru to understand the information it delivers. These technologies are now so readily available, and so easy to use, that we are definitely seeing an increase in interest from data center customers.

The first step in getting a grasp of power usage would be an energy assessment. What recommendations do you have for data center managers to begin this process?

Many data center managers don't know the efficiency of their IT equipment or site infrastructure—or have a clear path in mind for maintaining and improving that efficiency. There's a lot of low-hanging fruit being overlooked, easy opportunities to reduce energy costs and become "greener" in the process.

So a good first step is simply to determine how much of the data center power budget goes to IT systems, and how much to support systems, such as power distribution and cooling. For every kilowatt-hour of power being fed to IT systems, how much real IT output do you get, in terms of Web pages served, transactions processed or network traffic handled?

The Uptime Institute has a variant on this metric called the Power Usage Effectiveness (PUE) ratio— a ratio of total facility power to the power drawn by all IT equipment. After applying this calculation to several data centers, the Uptime Institute recommends an ideal PUE of 1.6 and a realistic goal PUE of 2 for a well-designed and operated data center. The Institute estimates that most U.S. data centers have a PUE of 3.0, with an average of 2.4.

If PUE is poor, data center managers can investigate operational changes, such as virtualization or consolidation; or configuration changes, such as alternating hot and cool aisles; and new technologies, such as high-efficiency UPSs and power supplies.

In this process, data center managers can reach out their facility counter parts and leverage outside consultants to conduct an energy audit and make recommendations. If time and manpower are in short supply, this is an attractive option. But with new monitoring and management tools available, data center managers can be more self-sufficient than ever in assessing their power systems.

Compared to diesel generators and lead acid batteries, fuel cells provide better efficiency, reliability, service life, maintenance cost and emissions, while running quietly. What research have you done on fuel cells, and do you foresee this technology playing a key role in the sector in the near future?

The biggest barrier for fuel cell adoption today is the very high initial cost, compared to traditional backup energy sources. Most organizations have a hard time making a business case for the premium price, especially when existing solutions are still satisfactory.

However, we will see changes in the next five years or so, due to several forces. Increasing concern about environmental issues puts a harsh light on the dark side of traditional technologies: dependence on fossil fuels, emissions from diesel generators and disposal of lead-based batteries. When we start to see greater tax benefits for green operations (and lower prices for maturing fuel cell technology), the technology will have to grow. Companies that seek the environmentally conscious path will drive adoption of fuel cells, more than the experimental level of today.

At Eaton, we believe fuel cells represent an exciting potential for our customers. We continue to track trends in the industry, and we are working with a number of technology providers with an eye toward offering a commercially viable fuel cell offering as soon as practicable.

Do you see data centers accelerating their technology refresh cycles to get the advantages of virtualization sooner? What is the best strategy to plan for this change?

There's no doubt that virtualization can be a good deal. Some analysts predict that virtualization will improve server utilization for a typical x86 machine from 10 to 20 percent to at least 50 to 60 percent in the next three to five years. One of our customers found the opportunity to reduce its portfolio of 1000 servers to about 200 servers. Even if we assumed a utility rate of only 10 cents a kilowatt-hour, this customer stands to save $700,000 in the first year alone.

The prospect of such savings will drive more data centers to adopt virtualization strategies to one degree or another—and that would translate into an accelerated pace of server replacement.

But virtualization will not be the salvation for everyone. Many data centers have to be designed to accommodate periodic peak loads far above daily loads, such as seasonal peak volumes for a retailer. In that case, having underutilized or idle hardware sitting around is just par for the course. Virtualization wouldn't buy this data center much, if anything.

The best strategy is therefore not a prescription but a process: stay abreast of new technology developments and regularly assess the ROI potential of replacing old technology. The business case will differ for every customer, geography and infrastructure.

With power and heat rising higher in blade server racks — from 1 kW in 2000 to 14kW and even 24kW today — what are your thoughts about refrigerant-based cooling systems that provide up to 30kW cooling per rack?

As much as 30 to 60 percent of the data center utility bill goes to support cooling systems. If that figure seems too high, it is. As data center managers struggle to reduce this burden, they have to weigh several variables. Are you better off paying the higher initial cost of refrigerant-based cooling modules (and enjoying lower energy costs over time), or spreading the IT load so average power level is less than 15kW per rack, which can be supported with conventional air cooling (no new investment necessary)?

As with so many issues in data center design, the answer is, “It depends.” Where existing air cooling seems to be ineffective, we’re often finding that the cooling system has been inefficiently deployed, or racks are set up in a way that produces hot spots. These issues can be minimized by best practices, such as distributing servers across more racks, alternating hot and cool racks or aisles, and carefully regulating air flow across the data center.

However, in areas of the country where energy and real estate costs are high —such as Manhattan or California—a data center could more easily cost-justify refrigerant-based cooling. The higher initial investment would be repaid in lower utility bills for cooling systems and lower real estate costs, thanks to the ability to deploy more IT equipment in the same square footage.

Power cost and energy usage can be reduced with simple solutions, such as only buying equipment with internal power supplies that are at least 80 percent efficient. How prevalent is this practice in the data center community?

Even a small data center can save tens of thousands of dollars simply by making wise choices in management practices, IT hardware, power and cooling infrastructure. For example, the three-year utility savings from an energy-efficient server can nearly equal the cost of the server itself. Couple this strategy with energy-efficient power and cooling systems, and a mid-sized data center with 1500 servers could save millions of dollars, while reducing carbon footprint.

Unfortunately, this issue isn’t getting serious attention yet. When selecting new hardware, buyers still tend to look more closely at initial purchase price than long-term operating cost. Now that high-profile organizations such as Google have announced energy-conscious choices in their data centers, we’re seeing more interest. Let’s hope power issues don’t have to reach crisis proportions before energy efficiency moves to the forefront of every planner’s agenda.

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