Enterprise Data Center: A Look At Power Efficiencies

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March 2009

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Executive Summary

Purchasing servers, storage and network devices are not the only costs associated with operating today's high density IT infrastructure. Power consumption is playing a major role when it comes to the total cost of ownership. This paper categorizes and presents a collection of methods and technologies that could help lower total cost of ownership.

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Power Infrastructure

The Key Components

When evaluating an enterprise data center for efficiency improvements, it can be divided into three key components:

- **Power Distribution** – The infrastructure used to deliver reliable power to critical IT equipment.
- **Cooling Infrastructure** – The infrastructure used to remove heat generated by the IT equipment.
- **IT Infrastructure** – This consists of the servers, storage and network equipment.

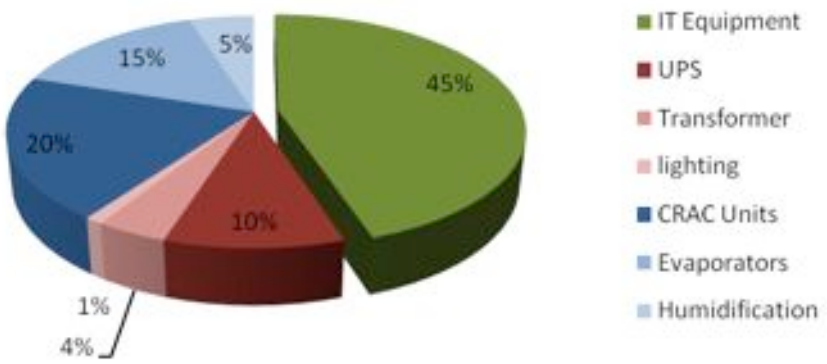
Each of these components have several elements that can be evaluated for either efficiency improvements through retrofits, or to ensure the appropriate equipment is purchased up front during the design and purchasing phases of a project.

The total cost of ownership for IT systems is not limited to the cost of the equipment and its power consumption. The transistors in modern processors are inefficient, and a lot of the energy that gets consumed by those processors yields a byproduct of heat. That heat must be removed from the equipment and either cooled or disposed of. The process of rejecting heat also comes with a price tag of power consumption.

Power Distribution

Major improvements in power and cooling technologies and strategies have been made in the past few years, however with legacy data centers still in operation, these technologies and strategies are still in use. Approximately 40% - 60% of the power delivered to a data center will get delivered to IT equipment, while the other 40% - 60% goes towards the electrical and cooling systems that supports IT infrastructure. An average data center may look something like the following diagram.

Figure 1 – Typical Power Consumption



When analyzing a data center facility for methods to reduce overall power usage, it would be wise to further divide the above categories into specific equipment to get a better idea of what areas may need more attention than others.

Power Infrastructure Improvements

When evaluating power delivery systems, there are typically two components that require attention to detail. The big energy saver is the Uninterruptible Power Supply (UPS), while the other important components to assess are transformers where required.

Uninterruptible Power Supply

The UPS is one of the most important components in a power delivery system for an enterprise data center. This device stores and delivers power to critical components within the data center while utility and backup generators are not available. Like servers, these devices come in a variety of sizes and configurations.

The components within a UPS that have the largest impact on UPS efficiency are called rectifiers and inverters. Rectifiers and inverters are the devices responsible for converting AC

(Alternating Current) power to DC (Direct Current) power and vice versa and they come in a variety of configurations. The typical double-conversion online UPS will have 6-Pulse, 12-Pulse or IGBT (Insulated-gate bipolar transistor) components. Choosing a UPS with a 95%+ efficient IGBT inverter and rectifier will help save money with the electric company and with standby generators. Choosing a lower quality 6-Pulse UPS will likely require you to purchase larger standby generators to compensate for the inefficiencies of these older technologies.

When operating a data center facility that has a $100,000/year electrical bill, choosing an IGBT UPS that is 95% efficient over a 6-Pulse UPS that may only be 80% efficient, could result in over $5,000/year in electrical savings.

Transformers

If the data center has step-down or step-up transformers in order to adjust voltages before delivering power to IT equipment, it's important to note that transformers vary in quality as well. Transformer efficiencies vary from 85% to 98%.

AC Power vs. DC Power

It is very common to see a telecommunication environment operating on DC power instead of AC power. The advantages of utilizing DC over AC power is you don't have energy loss converting DC power back into AC power, just to have it converted back into DC at the IT equipments' power supplies. This could result in energy savings as two power conversions are removed from the equation. The disadvantages of using DC power supplies in most servers and storage systems can be the added upfront expense.

AC power supplies have a much higher demand; therefore typically carry a much lower price point. With high efficiency power supplies reaching 98% efficiency, it's not likely that most environments will see a positive return on investment when opting for the more expensive DC power supplies. This is especially true if investments have been made on quality UPS's and transformers.

Think Modular

When growing into data center space, it is important to think modularly. UPS and transformer equipment vary on efficiency based on the percentage of load placed on the devices. A 300 kVA UPS may only be 30% efficient at 10% load, but 90% efficient at 50% load. If the data center space is not fully occupied, it may be wiser to purchase a smaller 100 kVA UPS to start with, then add additional 100 kVA units as IT requirements increase. This will help maintain a higher utilization on smaller UPS's, and spend more time operating at a higher efficiency level. Figures 2 and 3 depict the two different approaches.

Figure 2 – Single Larger UPS

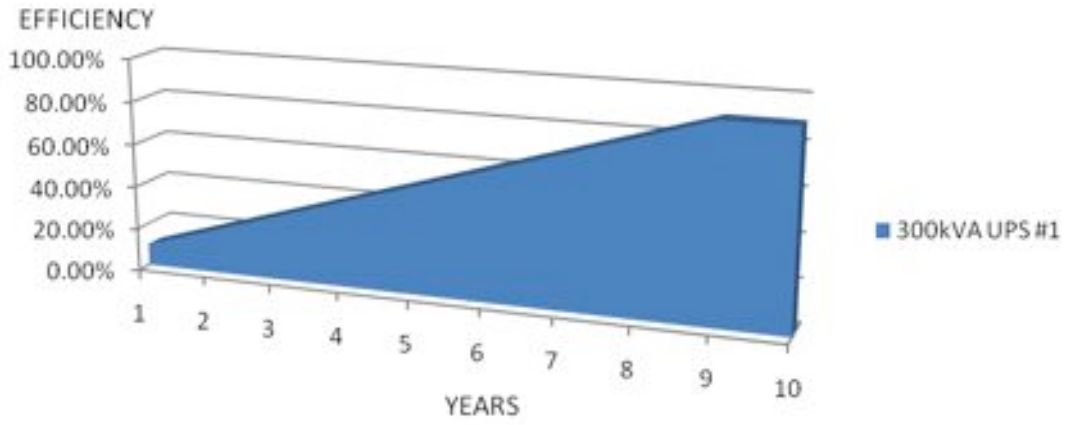
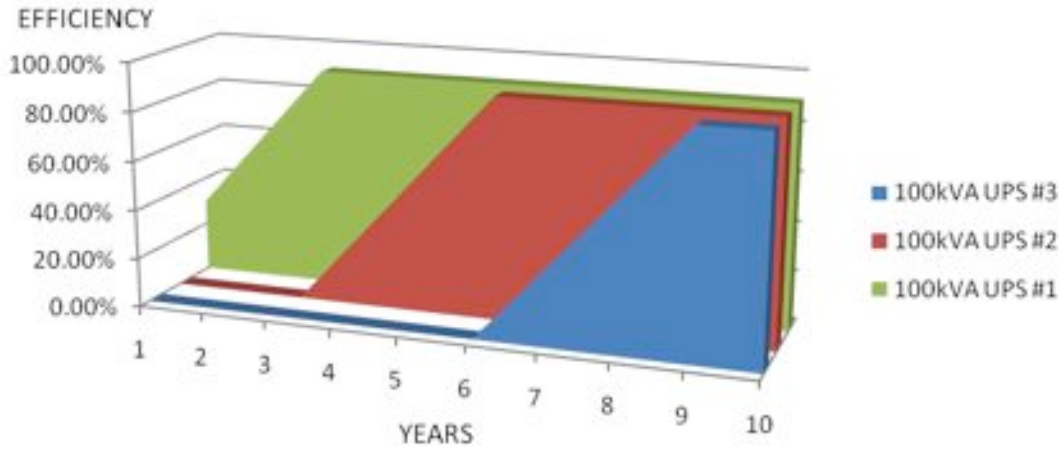


Figure 3 – Modular Installation



Operating three smaller UPS's opposed to a single larger UPS could save a company a substantial amount of upfront capital required for electrical equipment. A larger number of smaller investments can be made over time, as IT demands increase. The ability to place a higher load on each UPS after installation also helps to ensure that each UPS is also running as efficiently as possible.

Cooling Infrastructure

Cooling Infrastructure Improvements

Aside from the IT equipment, a large portion of power in a data center environment is devoted to the cooling infrastructure, therefore it is very important to ensure you have a well thought out cooling design. With proper cooling design, the heat extraction process from IT equipment becomes more efficient. When less energy is required to remove heat from the IT equipment, the end result is a lower utility bill.

The purpose of this white paper is to focus on the electrical infrastructure; however a few key points will be made on the cooling side of the data center. For more information on efficient cooling design, please reference the TEAM Companies white paper on Cooling Efficiencies.

- Ensure that cabinets are oriented to prevent the mixture of hot and cold air. This is typically accomplished by arranging cabinets to create hot and cold isles.
- If possible, use containment measures to prevent hot air from mixing with cold air. This can be done with hot isle containment, cold isle containment and hot air return duct.
- Keep air handlers as close to the IT equipment as possible. Moving air long distances requires additional energy.

IT Infrastructure

Choosing IT Equipment Wisely

Many organizations have legacy servers running applications and services that require little compute power. Often times these servers are left to run idle and process requests as required. Many of these services could be consolidated into fewer numbers of servers. By removing servers from the environment, the overall IT power requirements would decrease. Decreasing power requirements for IT load should have a similar impact on the power requirements to cool the remaining IT equipment.

When consolidating, it may be wise to consider new equipment. Processor manufacturers have made major strides in improving the power to performance ratio in enterprise processors. When purchasing new server equipment, ensure that the servers are equipped with the latest low voltage processors. Fewer multi-core processors can save energy over more single-core processors.

Hard disk manufacturers have been working hard to reduce energy usage as well. With high density disk platters available, hard disks have been migrating from 3.5” drives to 2.5” drives. The smaller drives require less energy to operate. If servers are connected to a centralized

NAS (Network Attached Storage) or SAN (Storage Area Network), equip your servers with the 2.5", higher efficiency drives.

Two other key components to evaluate when purchasing new server equipment, is that they are equipped with high efficiency power supplies, and the fans are variable speed. When the servers are idle, the fans should be allowed to spin down, requiring less energy to maintain and acceptable server temperature.

Server Consolidation

Consider migrating to a blade server environment. Blade environments use larger common power supplies resulting in lower overall power consumption. Blade environments also use a lower number of larger fans capable of moving higher volumes of air while utilizing less energy.

Virtualization

Virtualization may be the answer if compatibility or security issues prevent service consolidation. Virtualization can dramatically reduce the total number of physical servers. There are many virtualization technologies available to assist an organization to cost effectively consolidate many platforms on a single server. Consolidating platforms to a fewer number of physical servers reduces the total power consumption required to operate your IT infrastructure. As a result of the reduced number of servers, there should also be a comparable reduction in cooling requirements.

Conclusion

Careful consideration should be placed on key components within power systems, cooling systems and IT infrastructure early on during the design and development phases. Taking proper steps, an organization can easily lower both upfront capital and operating costs associated with an IT environment.