Most data center equipment uses internal or rack mounted AC-DC power supplies. Using higher efficiency power supplies will directly lower a data center’s power bills, and indirectly reduce cooling system cost and rack overheating issues. Savings of $2,700 to $6,500 per year per rack are possible just from the use of more efficient power supplies. Efficient power supplies usually have a minimal incremental cost at the server level, however, management intervention may be required to encourage equipment purchasers to select efficient models. The purchasers need to be given a stake in reducing operating cost and the first cost of the electrical and conditioning infrastructure, or at least be made aware of these costs, in order to make a rational selection. Power supplies that meet the recommended efficiency guidelines of the Server System Infrastructure (SSI) Initiative should be selected. The impact of real operating loads should also be considered to select power supplies that offer the best efficiency at the load level at which they are expected to most frequently operate.

Principles

• Specify and utilize high efficiency power supplies in Information Technology computing (IT) equipment. High efficiency supplies are commercially available and will pay for themselves in very short timeframes when the total cost of ownership is evaluated.

• For a modern, heavily loaded installation with 100 racks, use of high efficiency power supplies alone could save $270,000-$570,000 per year and decrease the square-footage required for the IT equipment by allowing more servers to be packed into a single rack footprint before encountering heat dissipation limits.

• Cooling load and redundant power requirements related to IT equipment can be reduced by over 10 – 20%, allowing more computing equipment density without additional support equipment (UPSs, cooling, generators, etc.).

• In new construction, downsizing of the mechanical cooling equipment and/or electrical supply can significantly reduce first cost and lower the mechanical and electrical footprint.

• When ordering servers, power supplies that meet at least the minimum efficiency recommended by the SSI Initiative (SSI members include Dell, Intel, and IBM).

• When appropriate, limit power supply oversizing to ensure higher – and more efficient – load factors.
The individuals specifying data center equipment should consider the efficiency of the power supply. Frequently, there is little connection between the group selecting data center equipment and the group that is aware of (and responsible for paying) the equipment’s energy costs. To encourage the use of more efficient power supplies, an organization must illustrate the clear connection between equipment energy usage and operating cost to the people who make the equipment purchasing decisions. With many types of equipment becoming commodity items and with small difference in price heavily impacting the selection, it is essential that the total cost of ownership of a low efficiency power supply be recognized in the selection process.

One approach to doing this might be to offer an internal budget incentive to be applied to the purchases of IT equipment that meet or exceed the minimum efficiency recommendations set forth by the Server System Infrastructure (SSI) initiative.

Equipment selection should include an evaluation of the power supply efficiency. For servers with integrated power supplies, a high efficiency option should be considered if available. The table below shows the impact of increasing the power supply efficiency from 72% (SSI Minimum) to 83% (SSI Recommended Minimum) on annual operating cost. This level of efficiency improvement is the difference between the SSI Required Minimum efficiency to allow proper cooling and the Recommended Minimum for reasonable energy performance. Only direct electrical savings are shown at an average (including peak charges) energy cost of $0.10 per kWh. Significant additional savings would accrue from the lower cooling requirement of a more efficient supply. When looking at the table, note that the typical server power supply costs about $20 to $40 to manufacture in most cases, a more efficient power supply would pay for itself in a single year even if its manufacturing costs were doubled.

When a data center is housed and operated by the equipment owners, encouraging more efficient power supplies is usually just a matter of basic management to coordinate the actions (and budgets) of the data center equipment specifiers and those responsible for the infrastructure including those paying the electrical and cooling bills. Often, the department that selects and procures the data center equipment deals with hardware and software deployment issues
and has little if any interaction with the department responsible for paying operating costs. With no feedback regarding operating cost, energy efficiency is naturally overlooked by the selectors – unless, perhaps, they have had negative, usually expensive, experience with overheating racks and the associated risk of equipment failure.

A simple management approach to address the disconnect between equipment purchases and the resulting energy bills and extra first-cost for facility infrastructure would be to offer an internal budget incentive equal to one to three years of energy savings for the purchase of equipment meeting the high efficiency performance level. For example, when purchasing servers that consume 200 watts, the purchaser’s budget would be increased by $70-$150 per server if the server met the SSI Initiative’s recommended efficiency levels. The ‘incentive’ money would be recovered from the reduced operating cost. Such a system provides much needed feedback between the equipment purchases (and by extension, manufacturers) and the total cost of ownership by allowing equipment purchases to be quickly and rationally evaluated on their true cost. The opportunity for energy savings from using high efficiency power supplies in a data center can be investigated using the simplified calculation tools developed as part of the LBNL project on data centers (see http://hightech.lbl.gov/server-ps-tool.html).

Recognizing the fiscal benefits of high-efficiency power supplies and considering them when selecting data center equipment is vital if high-efficiency power supplies are to make an impact in the market and on data center energy use. Higher efficiency power supplies are transparent to the user – they look the same and operate the same, the only noticeable difference is the lower heat and lower power bills. Without a deliberate effort to evaluate the efficiencies, the market has responded by providing minimum efficiency power supplies, sacrificing even very low cost, high return efficiency features to compete in a commodity market.

Current recommended efficiency levels of server power supplies are outlined in the power supply design guidelines developed by the SSI Initiative. The SSI Initiative’s goal is to deliver a set of specifications covering two primary server elements: power supplies and electronics bays. Members of SSI are Intel, Dell, HP, Silicon Graphics, and IBM. The current efficiency levels for power supplies used in servers based on the SSI design guidelines are shown in the
following figure. Note that the lower line is the minimum performance required for cooling. The upper line is the efficiency recommended as the best balance between efficiency and first cost for entry level servers. Considerable work is being done to encourage the production of high efficiency power supplies so the availability of equipment that meets the higher, recommended efficiency performance is expected to increase rapidly.

As much as possible, power supplies should be matched to meet the system load. In recent studies, measured data of various manufacturers' power supplies showed that most were 70-75% efficient at full load. Typically, however, power supplies operate at between 15 and 40% of the full load; in this range, the efficiency drops off to roughly 50-65%.

It is technically and economically feasible today to design an 85% efficient power supply with an output voltage of 3.3V or less. Higher voltage, higher wattage designs are already achieving peak efficiencies of 90-92%. As seen in the consumer PC market, the technology to make more efficient power supplies exists in a form that could be economically brought to the commercial market. Blade server manufacturers have investigated offering more economical systems in the past, but a lack of market demand stalled the technology. Currently, the efforts of the SSI initiative and various governmental agencies ranging from the California Energy Commission to the EPA are actively encouraging the power supply market to focus design effort on improving efficiency. Taking advantage of the efficiency advances as they become available is both an efficiency and business best practice.

**Benchmarking Findings/Case Studies**

A good example of a server that illustrated many of the principals discussed here was the original RLX “ServerBlade 633” blade server that came on the market in 2000. It was a low-power server designed to meet specific requirements of the web-server market only. Based on a Transmeta chip, it was up to 10 times more power-efficient than servers based on processors from Intel. Because they generated less heat, RLX’s servers could be stacked closer with less danger of overheating. Incredibly, RLX demonstrated that they could run a rack containing 336 of their servers safely. The rack consumed only about 3.3 kilowatts at average load, 2.4 kilowatts at idle, and 4.5 kilowatts at absolute peak, even though that was highly unlikely to happen. That’s just over 13 watts per server at peak, fully loaded with everything spinning. By comparison, typical server racks today—containing far fewer servers—operate at 7.5 to 14 kilowatts, with talk of reaching 20 kilowatts by the end of 2004. RLX no longer offers the Transmeta based product, and current RLX blade servers consume 180 to 190 watts apiece.
Related Chapters
Uninterrupted Power Supply Systems

References
1) Industry group, see http://www.ssiforum.org

2) Depending on cooling system efficiency and rack loading. Top end assumes a rack load of 16.8 kw of server power and a cooling power use equal to rack power use (lower quartile of cooling performance measured in recent benchmarking).

3) Energy Design Resources, RMI Design Brief, Data center Best Practices


Resources
• http://www.ssiforum.org

• http://www.efficientpowersupplies.org

• http://www.80plus.org

• http://www.hightech.lbl.gov

• Data Processing and Electronic Areas, Chapter 17, ASHRAE HVAC Applications, 2003.
Energy Design Resources provides information and design tools to architects, engineers, lighting designers, and building owners and developers. Energy Design Resources is funded by California utility customers and administered by Pacific gas and Electric Company, San Diego Gas and Electric, Southern California Edison, and Southern California Gas Company, under the auspices of the California Public Utilities Commission. To learn more about Energy Design Resources, visit www.energydesignresources.com.

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