White Paper

Markets Served
Data center & IT

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Understanding high-efficiency mode UPS return on investment

Best practices for estimating how quickly high-efficiency UPSs pay for themselves

Executive summary

Maintaining reliability is a data center operator's highest priority. Containing costs, however, is a close second. High-efficiency mode uninterruptible power systems (UPSs) help companies satisfy both requirements by dramatically improving power efficiency without compromising availability.

Drawing on concrete, real-world data, this white paper shows precisely how and why using high-efficiency mode UPSs can yield savings significant enough to produce a 100 percent return on investment in as little as two years. In addition, utility incentives that are commonly available can provide significant benefit. It also discusses key features to look for when evaluating high-efficiency mode UPSs and illustrates the difference between modern high-efficiency mode UPSs and older model "eco mode" operations. Not all high-efficiency modes are created equal, and you have to be certain you aren't sacrificing reliability for efficiency.

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Powering Business Worldwide

Issues driving increased demand for power efficiency

Power efficiency is hardly a new concern among data center operators, but trends like the following have made minimizing energy usage an even more critical goal in recent years:

- Tight budgets: Global competition and weak economic growth have combined to make reducing operational expenses more important than ever.
- Sustainability initiatives: More and more businesses are publicly committed to operating in an environmentally responsible manner. Reducing data center power consumption is typically an important part of such efforts.

Cloud computing vendors, colocation service providers and other operators of multi-tenant data centers, whose data centers represent their product costs, have yet another incentive to decrease energy use: low margins and intense pricing pressures that make cutting costs a competitive necessity. In fact, any mission-critical application (financial services, healthcare, e-commerce, etc.) has the responsibility to control power costs to be cost conscious and socially responsible.

Understanding high-efficiency mode UPSs

Companies looking to save money and shrink their environmental impact can dramatically improve power efficiency by deploying high-efficiency mode UPSs. Under normal conditions, a high-efficiency mode UPS operates in a highly efficient energy-saver mode. If power conditions fall outside pre-determined limits, however, the UPS automatically and immediately switches to double-conversion mode. Later, when power quality returns to acceptable levels, the UPS automatically transitions back into energy saver mode.

In older high-efficiency mode UPSs, transition times between energy-saver and double-conversion mode were sometimes lengthy enough to jeopardize data center reliability. As illustrated in Figure 1, however, today's more sophisticated products can complete transfers in two milliseconds or less. As a result, deploying the latest high-efficiency mode UPSs empowers companies to decrease power consumption without weakening reliability.

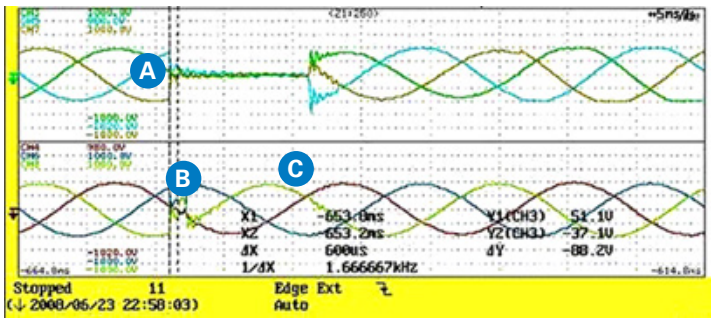

Figure 1. The latest high-efficiency mode UPSs transition between operating modes in two milliseconds or less, enabling companies to collect the benefits of energy-saver operation without sacrificing reliability.

A Input power is interrupted

B Transfer from eco-mode to double-conversion mode completes in less than two milliseconds

C Output power is virtually unaffected

Calculating high-efficiency mode UPS ROI

The newest double-conversion UPSs are often more than 93 percent efficient when fully loaded, and can deliver as little as 86 to 89 percent efficiency at the lighter loads commonly encountered in data centers. High-efficiency mode UPSs, by contrast, are up to 99 percent efficient when running in energy-saver mode, and maintain this high efficiency even at light loads. That seemingly small difference can quickly add up to significant savings.

Table 1 reveals the magnitude of those savings by comparing annual energy costs under identical conditions for both a legacy UPS and a modern high-efficiency mode UPS. As the figures in that table make clear, increasing efficiency from 93 percent to 99 percent reduces UPS power losses from 25.2 kW to just 3.6 kW, which in turn lowers energy spending by over $31,000 a year.

Base conditions	
Electricity rate:	$0.11 per kW / hr
Critical load:	360 kW
Cooling multiplier[1]:	0.50

Power calculations		
	Legacy UPS	**High-efficiency mode UPS**
Efficiency	93%	99%
Critical load	360 kW	360 kW
UPS losses	**25.2 kW**	**3.6 kW**
Cooling	192.6 kW	181.8 kW
Total power[2]	577.8 kW	545.4 kW
Annual energy costs[3]	$556,768	$525,547
Annual energy savings		**$31,221**

[1] kW of cooling required per kW of power used or lost
[2] (Critical load) + (UPS losses) + (Cooling)
[3] (Total power) x (electricity rate) x (24 hours) x (365 days)

Table 1. Comparative energy cost for a legacy double-conversion UPS and a modern high-efficiency mode UPS under identical conditions.

While prices on high-efficiency mode UPSs vary widely, savings that substantial should deliver 100 percent return on investment within two to three years in most cases. Possible utility incentives for energy-efficient power systems in the data center would reduce the capital cost of the UPS, and improve the ROI payback period. Furthermore, the high-efficiency mode UPS's greater efficiency produces significant environmental benefits too, as shown in Table 2, which employs the same base conditions as Table 1.

Environmental impact		
Metric	**Total**	**Notes**
Annual energy savings	284 MW-hr	(Legacy UPS total power – high-efficiency mode UPS total power) x (24 hours) x (365-days)
Annual CO2 savings	204 metric tons	Based on U.S. Environmental Protect Agency estimates of CO_2 per MW-hr
Cars off the road	39	Based on U.S. Environmental Protection Agency estimates of cars per metric ton of CO_2

Table 2. Environmental impact of replacing a legacy UPS with a high-efficiency mode UPS, based on figures from Table 1.

In short, using modern high-efficiency mode UPSs instead of constant double-conversion devices both lowers operating costs and strengthens environmental sustainability.

Capabilities to look for in a high-efficiency mode UPS

Many early high-efficiency mode UPSs forced companies to accept tradeoffs between energy-efficiency and reliability. Newer, more advanced models don't, however, provided they have the following critical capabilities:

1. Rapid transition time

Any high-efficiency mode UPS worth purchasing must transition between energy-saver mode and double-conversion mode in no more than four milliseconds, and ideally in less than two milliseconds. Beware of manufacturers that need to caution their end users of the inherent risk of any transition time greater than eight milliseconds. Such statements may read:

The transition from high-efficiency mode to double-conversation mode may result in a load loss if an interruption occurs.

2. High-energy efficiency

The best high-efficiency mode UPSs are more than 99 percent efficient when running in energy-saver mode, and over 98 percent efficient even under loads as low as 20 percent.

3. Robust surge suppression

Some data center managers question the ability of high-efficiency mode UPSs to suppress the kind of extreme power surges produced by lightning strikes. In truth, however, well-designed high-efficiency mode UPSs feature the same input and output capacitors that double-conversion models use to suppress surges, and are therefore every bit as effective at limiting the impact of voltage spikes. Figure 2 illustrates this fact under realistic test conditions.

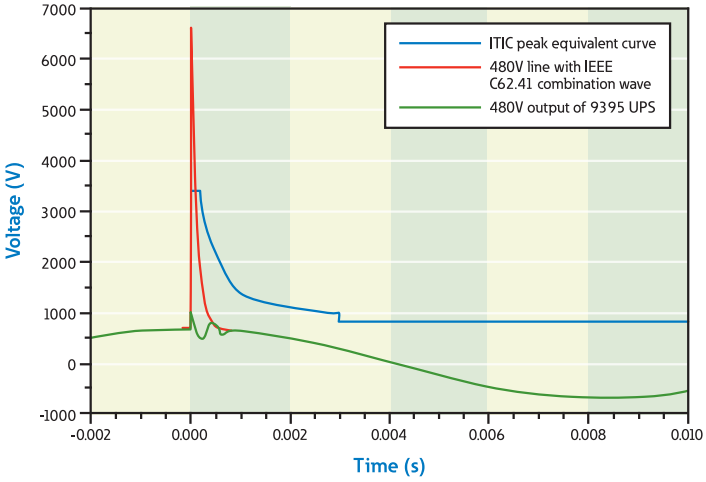

Figure 2. The latest high-efficiency mode UPSs successfully suppress even the kind of extreme power surges associated with lightning strikes.

4. Efficient electromechanical component utilization

Well-made high-efficiency mode UPSs utilize electromechanical components in a manner that increases their reliability. For example, the best high-efficiency mode UPSs extend the lifespan of their fans by switching them on only during heat-intensive processes such as charging batteries.

Similarly, when operating in energy-saver mode, the most advanced high- efficiency mode UPSs leave critical mechanical components like contactors in a closed state. This results in two important reliability advantages. First, contactors experience significantly less electrical and thermal stress when closed, so they're less likely to malfunction. Second, a contactor that's already closed is incapable of failing to close during abnormal power conditions, so it's guaranteed to perform as intended when needed most.

5. Ability to correct load harmonics when in high-efficiency mode

The UPS should be able to utilize its power conversion circuitry to cancel undesirable load harmonics that could appear on the UPS input. This harmonic mitigation prohibits voltage distortion being reflected onto the site electrical system.

6. Fault discrimination

The high-efficiency mode UPS should act to support the IT load if a fault occurs. Faults upstream of the UPS require a different reaction than downstream faults. If the UPS cannot discriminate between these, it may drop the load. Therefore, the UPS must detect the location of the fault and react appropriately to protect the IT load under any fault scenario.

7. Secure remote operation

High-quality high-efficiency mode UPSs switch between double-conversion mode and high-efficiency mode automatically, even when operators aren't present. If power conditions degrade overnight or during the weekend, for example, a well-designed high-efficiency mode UPS switches to double-conversion mode on its own, and switches back again unassisted as well when power quality improves.

8. Remote access capabilities

The most advanced high-efficiency mode UPSs come with remote access capabilities that let operators change modes manually over the Internet. The best such remote access features include security functionality that locks out unauthorized users by requiring both an IP address and password.

Conclusion

Before buying new UPS hardware, today's data center operators need to know that the funds they're investing will result in a quick and significant payback, one that can be improved further if their electrical utility provides energy-efficiency incentive programs for data centers. They also need to know that this rapid ROI won't come at the expense of lower reliability. As the calculations in this white paper demonstrate, a properly equipped high-efficiency mode UPS pays for itself in as little as two years without reducing availability, and also produces substantial environmental benefits. As a result, organizations eager to cut costs while preserving uptime and supporting sustainability initiatives should carefully consider replacing legacy double-conversion UPS hardware with more modern and efficient high-efficiency mode devices.

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Eaton is a power management company with 2013 sales of $22.0 billion. Eaton provides energy-efficient solutions that help our customers effectively manage electrical, hydraulic and mechanical power more efficiently, safely and sustainably. Eaton has approximately 103,000 employees and sells products to customers in more than 175 countries. For more information, visit www.eaton.com.

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