Powering Business Worldwide

Technology Brief

Eaton Energy Saver System for highest-efficiency power protection

With 99 percent efficiency, your UPS can pay for itself—many times over—by dramatically reducing facility power and cooling costs.

Utility costs now account for 20 to 30 percent of data center operating costs. For many IT organizations, energy costs represent the largest single component of total cost of ownership—and the most stifling influence on IT expansion. According to IDC, for every dollar spent on new IT hardware, an additional 50 cents is spent on power and cooling, more than double the ratio of five years ago. The cost of electricity is already outpacing the cost of hardware. $1 million worth of servers purchased in 2009 will consume $1.2 million in electricity over a three-year operating life—a figure that will only increase with rising utility rates.[1]

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 supporting these growing loads, without bringing unwanted governmental scrutiny or surcharges for excessive power consumption.

The good news is that advances in UPS technology have dramatically improved the efficiency of these systems—reducing the costs and environmental impact of delivering continuous, computer-grade power to your data center.

UPSs have been getting steadily more efficient

In the 1980s, most UPSs were 75 to 80 percent efficient at best. For every dollar of utility power purchased, only 75 to 80 cents of it made it through the UPS and into the facility as useful energy. Those energy losses are dissipated as heat, so that meant more expensive cooling as well.

By the 1990s, UPS efficiency had risen to 85 to 90 percent efficiency—and then up to 94 percent. The 2000s have brought some UPSs that operate at 97 percent efficiency or better and are optimized for today's IT equipment power supplies. Still, a typical one-megawatt data center could be forfeiting about $28,000 of its utility power each year to UPS energy losses.

Eaton is changing the game with the revolutionary Energy Saver System. UPSs equipped with this technology deliver *99 percent efficiency* or better without sacrificing reliability.

With this approach, the UPS operates at extremely high efficiency unless utility power conditions force the UPS to work harder to maintain clean power to the load. The intelligent power core continuously monitors incoming power conditions and balances the need for efficiency with the need for premium protection, to match the conditions of the moment.

Key advantages of the Energy Saver System

Until recently, specifying engineers had to choose a UPS based on mutually exclusive merits. One type of UPS offered highest efficiency but without comprehensive power protection. Another offered highest protection, but at lower efficiency. Energy Saver System delivers it all in a single UPS:

- Premium power quality
- Highest efficiency across all load ranges
- User-configurable modes for maximum control
- Advancement of corporate sustainability initiatives

Consistent power quality ensures protection for IT systems

The Energy Saver System uses an intelligent “power core” to adapt to incoming power conditions and first deliver clean power to the load and, second, to maximize efficiency. Whenever the high-speed line-detection circuitry in the UPS senses a change in condition, the system automatically changes modes accordingly:

— **Normal utility conditions**: When power conditions are within acceptable limits, the UPS operates as a high-efficiency, energy-saving system—providing surge protection for IT equipment and ensuring clean power is delivered to the facility.

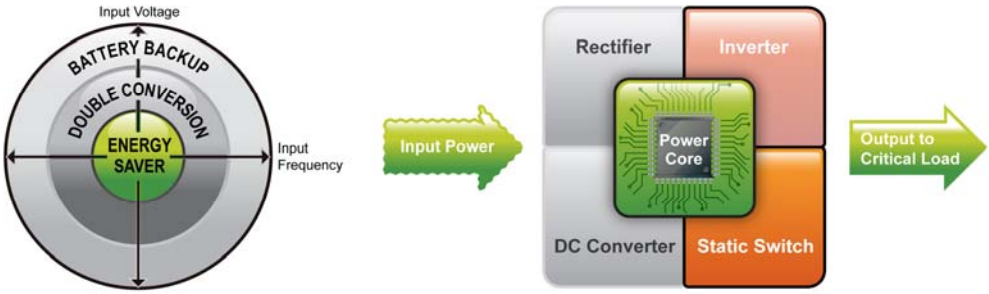

Figure 1. Active components engaged during Energy Saver System.

— **Erratic power or fleeting disturbances**: If input power falls outside of preset tolerances, the UPS continuously provides power to the load, while conditioning the power to eliminate any disturbances. In this mode, the UPS processes incoming power through a rectifier and inverter, completely isolating IT equipment from the incoming AC source.

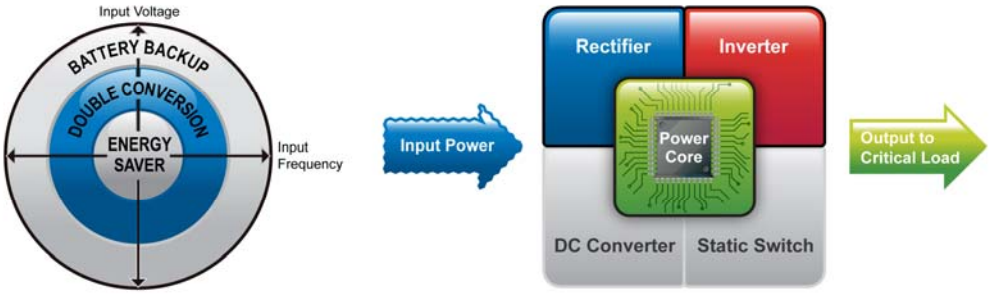

Figure 2. Active components engaged during double-conversion operation.

— **Power outage or sustained power anomalies**: If input power is outside the tolerances of the system (or the power is lost altogether), the UPS draws power from available battery modules or other standby sources (generators, etc.). In configurations with a generator, the UPS ensures that generator power has stabilized before engaging the Energy Saver System.

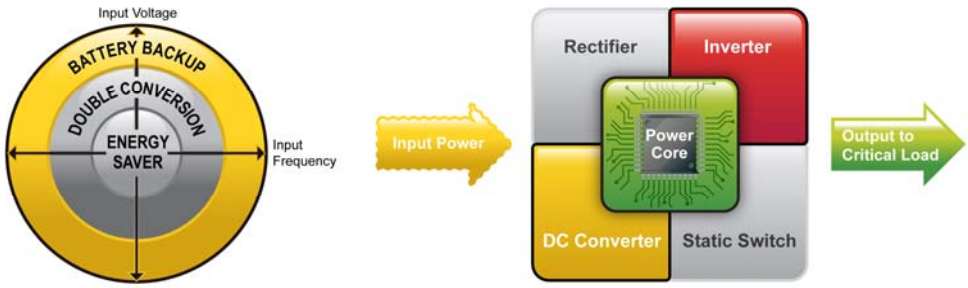

Figure 3. Active components engaged during battery backup.

This intelligent, multi-mode technology provides exactly the level of power protection needed under the conditions of the moment—optimizing for both protection and efficiency.

High efficiency—up to 99 percent—reduces energy consumption and costs

A key benefit of Energy Saver System is a significant improvement in UPS efficiency, compared to traditional UPS designs. At higher loads, the difference can be as much as five percentage points (99 percent efficiency compared to 94 percent for a typical UPS). At lower loads, the differences are dramatic.

Manufacturers usually state UPS efficiency ratings at full load, but most of today's UPSs are markedly less efficient under lighter loads, which is how they are likely to be used. Since so many IT systems use dual bus architecture for redundancy, the typical data center loads each bus (and UPS) at less than 50 percent capacity, often as little as 20 to 40 percent.

As a result, it is important to understand UPS efficiency across the entire load range, not just under theoretical ideal UPS operating conditions. While other UPSs drop off markedly in their efficiency, UPSs with the Energy Saver System sustain 99 percent efficiency even when lightly loaded—as much as 15 percentage points better than a traditional UPS.

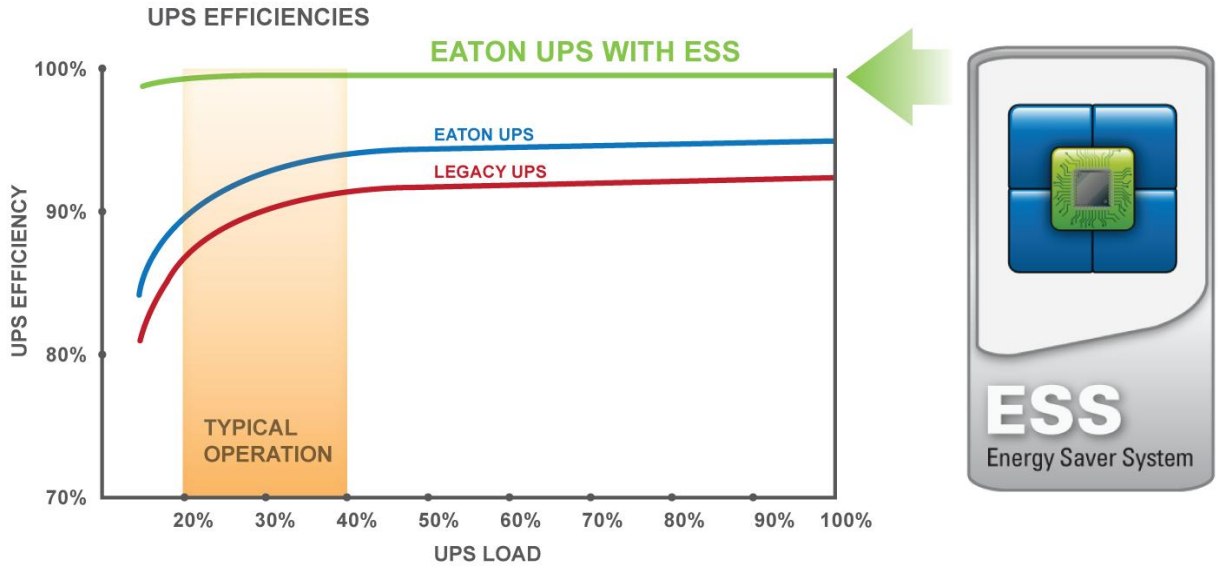

Figure 4. ESS UPSs maintain 99 percent efficiency no matter how big or small the load—as much as 15 percentage points better than traditional UPSs in the typical operating load range.

Even small increases in UPS efficiency can quickly translate into thousands of dollars, realized in more real power and lower cooling costs. In a one megawatt data center, a 10-year-old UPS is probably wasting about 150 kW of power and dissipating a lot of heat. Replacing that vintage equipment with new, high-efficiency UPSs can free up about 120 kW of that power to support new IT equipment and reduce the burden on cooling systems.

Table 1 shows an example for a single UPS supporting a 250 kW load. In this example, the Energy Saver System saves about $4000 per percentage point of efficiency gain, enough to recover 100 percent of the UPS cost within three to five years. The reduced carbon footprint is equivalent to pulling 29 cars off the road.

Critical Load	50 kW	125 kW	250 kW	500 kW	700 kW
Electric Costs (energy + demand)	$0.11 per kWhr				
Legacy UPS efficiency	92.5 percent		93 percent		
Eaton Energy Saver System UPS efficiency	99 percent				
Three-year energy savings (MWhrs)	145	363	670	1340	1876
Three-year CO_2 savings (metric tons)	104	261	481	962	1347
Equivalent number of cars off the road	6	16	29	59	82
Three-year utility cost savings	**$15,972**	**$39,929**	**$73,715**	**$147,431**	**$206,403**

Table 1. ESS savings are significant across all load ranges and compound based on data center size.

User configurable modes provide flexible, on-demand functionality

Energy Saver System UPSs can operate in any of four modes, depending on the conditions:

- **Standard mode**—The UPS operates in high-efficiency Energy Saver System with the inverter charged and ready to take over whenever necessary.
- **Double-conversion mode**—The UPS has sensed a short-term power problem and now converts incoming power from AC to DC and back to AC again to isolate IT equipment from input power.
- **High-alert mode**—The UPS has sensed power conditions outside of user-defined thresholds—either due to frequency or severity—and stays in double-conversion mode for a pre-defined period, then automatically reverts to standard mode.
- **Storm detection mode**—The UPS senses a significant number of disturbances during a short period of time and automatically switches to double-conversion mode for eight hours, then reverts to high-efficiency mode.

All modes are user-selectable from the UPS front panel, from signal inputs or remotely through serial communications.

Not just another "eco mode"

Conventional "high-efficiency mode" and "eco-mode" capabilities have been available on UPS products for years. Energy Saver System achieves its industry-leading efficiency quite differently from those legacy systems, with far better performance results.

With conventional eco-modes…	With Eaton Energy Saver System…
For many vendors' models… The load is powered from a bypass power source; UPS internal components are off. When conditions require a switch to double-conversion mode, the UPS must start, synchronize the waveform and then transfer. Transfers can take seconds or minutes, enough time for IT systems to lock up. **For other UPS models…** The UPS operates in line-interactive mode with the inverter running all the time. Transitions to double-conversion mode are faster, but efficiency is no better than 96-98 percent.	Energy Saver System provides power to the critical load and maintains the inverter input. Because the inverter input is always charged (but not running), and the output is always synchronized, transition time is two milliseconds or less (two thousandths of a second). **The Energy Saver System can detect and transition faster and more reliably than traditional high efficiency schemes.**
The UPS has a transformer, so the maximum possible efficiency is 98 percent, and in reality may be much lower depending on variables such as load and the quality of the utility feed.	A transformerless topology enables the Energy Saver System to reach and maintain 99 percent efficiency regardless of variables such as load and the quality of the utility feed.

Table 2. ESS compared to other energy saving technologies.

A life cycle assessment: The environmental impact of Energy Saver System

In 2008, Eaton engaged the consulting firm, Sylvatica, to conduct a life cycle assessment study comparing the environmental benefits of energy-efficient UPSs versus traditional double-conversion UPSs.

A life cycle assessment looks far beyond utility costs, cooling requirements, and the other usual components of total cost of ownership. It evaluates the potential environmental impacts of a product or service throughout its life cycle—from manufacture to delivery to day-to-day operation and ultimately, disposal. It asks: What processes are involved in creating, using and discarding this product? What earth resources do these processes consume? What negative outputs do these processes discharge?

Resource extractions and emissions to air, water and soil are investigated across 15 categories, such as carcinogens, ozone layer depletion, aquatic toxicity and global warming. These midpoint categories are then combined into four higher categories, showing the impact on human health, ecosystem quality, climate change and resources.

The Sylvatica study compared the overall environmental impact of three UPS configurations:

- A two-module, 550 kVA Eaton 9395 with Energy Saver System
- A two-module, 550 kVA Eaton 9395 *without* Energy Saver System
- A legacy UPS configured with three 300 kVA modules and a system bypass module

The results from the Sylvatica study verified the significance of energy efficiency in environmental impact. The manufacture, delivery and disposal of a UPS represent but tiny fractions of the unit's environmental footprint in all four categories. Operating the UPS over the course of its service life represents more than

97 percent of the UPS's total environmental impact. That means improvements in UPS efficiency play a huge role in reducing the overall environment impact of the product.
Figure 5 shows how profoundly UPS efficiency affects the normalized environmental impact in each category. The most energy-efficient UPS has approximately 11 percent of the impacts of the legacy system and about 14 percent of the impacts of the pure, double-conversion mode UPS.

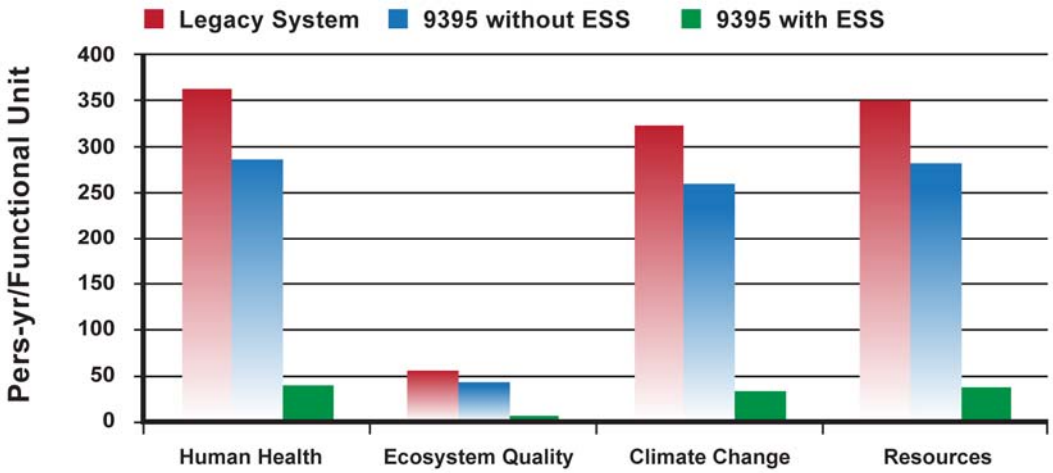

Figure 5. Energy efficiency has a dramatic effect on environmental impact across all categories.

Similar results were recorded when looking at the 15 important subsidiary categories as well. The environmental impact of the Eaton 9395 with Energy Saver System was only a small fraction of that of its legacy counterparts in every category.

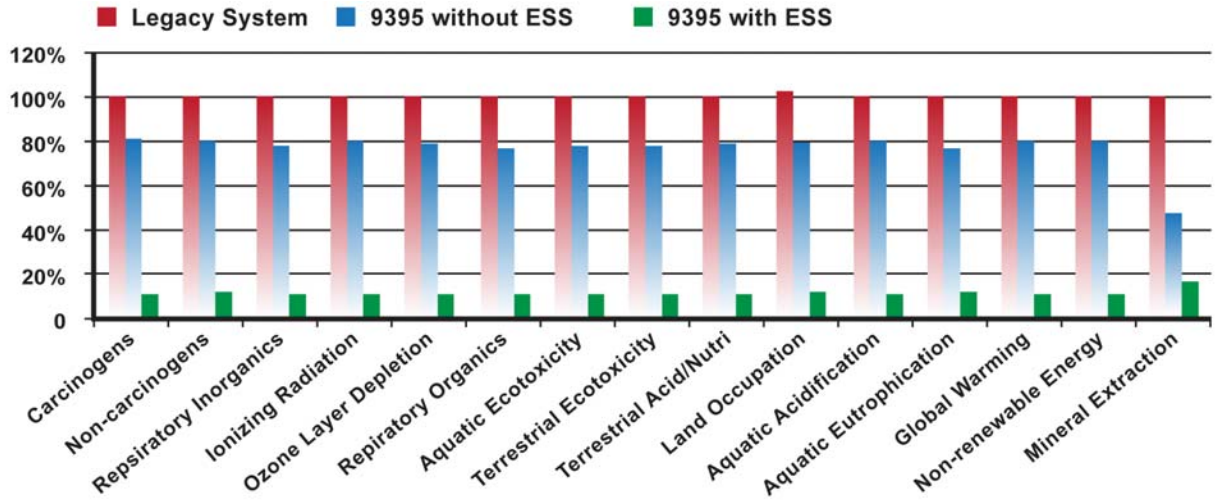

Figure 6. Looking closer at resource consumption and discharge of emissions, the energy-efficient UPS far outperforms traditional counterparts in all categories.

Closing thoughts

When selecting new data center hardware, including UPSs, purchasers still tend to look more closely at initial purchase price than at long-term operating cost and environmental impact. That trend is changing.

With a more efficient allocation of power, you not only reduce utility bills and total operating cost, but also achieve more with available backup power and cooling systems—delaying the point where those systems would have to be upgraded to accommodate data center expansion.

The last three decades have brought notable improvements in the energy efficiency of UPSs, but a UPS even a few years old might not be operating as efficiently as it could. For data centers looking to expand or upgrade their power protection and backup power, Energy Saver System from Eaton provides a win-win proposition:

- **Assured computer-grade power**—The UPS intelligently adapts to utility power conditions to achieve 99 percent efficiency—the highest available—while still providing clean power to the load.
- **Significant energy savings even at real world loads**—Operating at the industry's highest efficiency across all load ranges, the UPS delivers tens of thousands of dollars in annual savings and quickly pays for itself.
- **Seamless transition among modes**—The UPS transitions seamlessly among modes, so IT equipment doesn't sense any disturbance in quality power.
- **User-configurable modes**—The UPS can operate in any of four modes: standard, double-conversion, high-alert and storm modes to optimize for both power protection and efficiency.

If you already have an Eaton 9390 or 9395 UPS, you may be able to upgrade to Energy Saver System quickly and easily with a visit from an Eaton field technician. If you are in the market for a new UPS, check out the industry's most effective, efficient and environmentally responsible choice.

Sources

1. Underlying figures from *The Invisible Crisis in the Data Center: The Economic Meltdown of Moore's Law,* Uptime Institute, 2007