



Energy Advantage Architecture



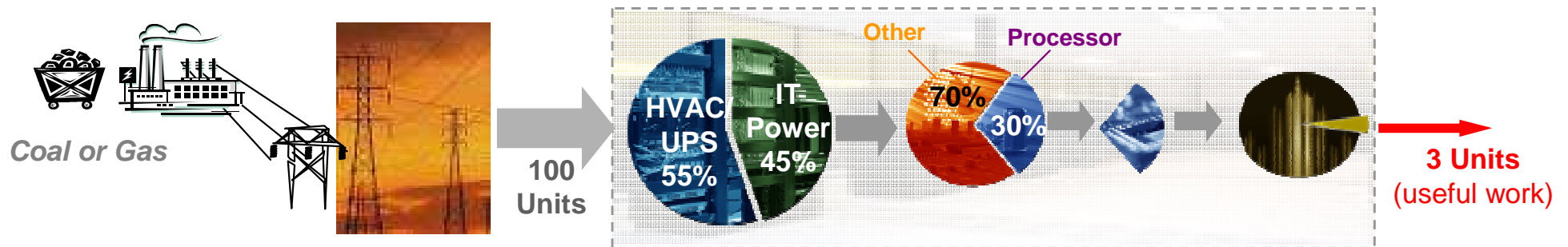
Powering Business Worldwide

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Data Centers – A Global Perspective

- Wasted energy burdens the environment and increases operational expenses
 - Carbon Footprint in IT Computing
 - Only 3% of the energy entering a data center is used for net computing creating opportunities for efficiency improvements

(Source: IBM, 2009)



Item	Generation	The Grid	Data Center	Server	Processor	Server Load
Units Delivered	65 Steam 35 Electric	35	33 (45% DCiE, 2.2 PUE)	15	5	0.1- 4***

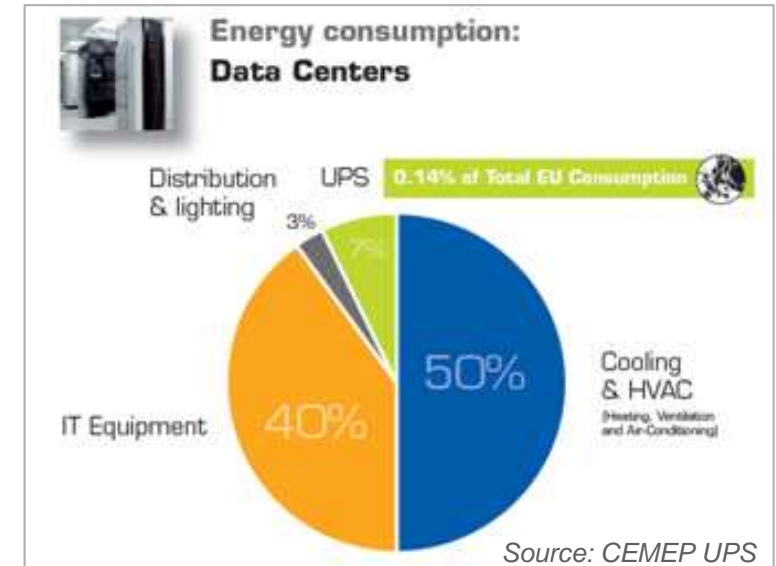
Challenges For Customers

- Energy costs and regulatory compliance will continue to place organizations at risk
 - Social, economic and regulatory pressures to reduce carbon emissions and energy costs globally
 - **Increasing Energy Costs**
 - Through 2009, Energy costs will emerge as the second highest operating cost (behind labor) in 70% of the Data Center facilities worldwide (source: Gartner)
 - **Sustainability**
 - 80% of CEO's view sustainability as impacting brand value (source: 2008, McKinsey)
 - 31% say they want to reduce their environmental impact (source: 2008, McKinsey)
 - IT accounts for 2% of the global CO2 emissions, as much as the airline industry (source: 2008, IBM, UK)
 - **Regulations**
 - 82% of executives expect some form of climate change regulation within 5 years (source: 2008, McKinsey)
 - European Union Code of Conduct for Data Centers
 - UK Carbon Reduction Commitment (2010)

The Quest For Energy Efficiencies

- The Key Challenge For Our Customers

- Energy Efficiency
 - Reduced OpEx
 - Sustainability
 - Regulations



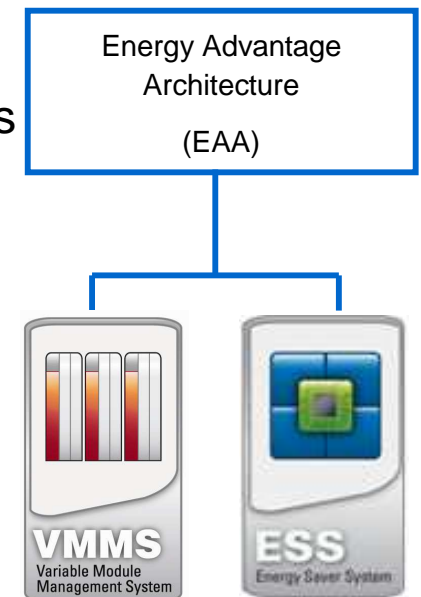
- The Solution

- Eaton 9395 UPS
 - Industry-leading efficiency in double conversion mode
- Energy Advantage Architecture
 - Innovative proprietary technologies bringing new ways to maximize UPS energy efficiencies without compromising on reliability



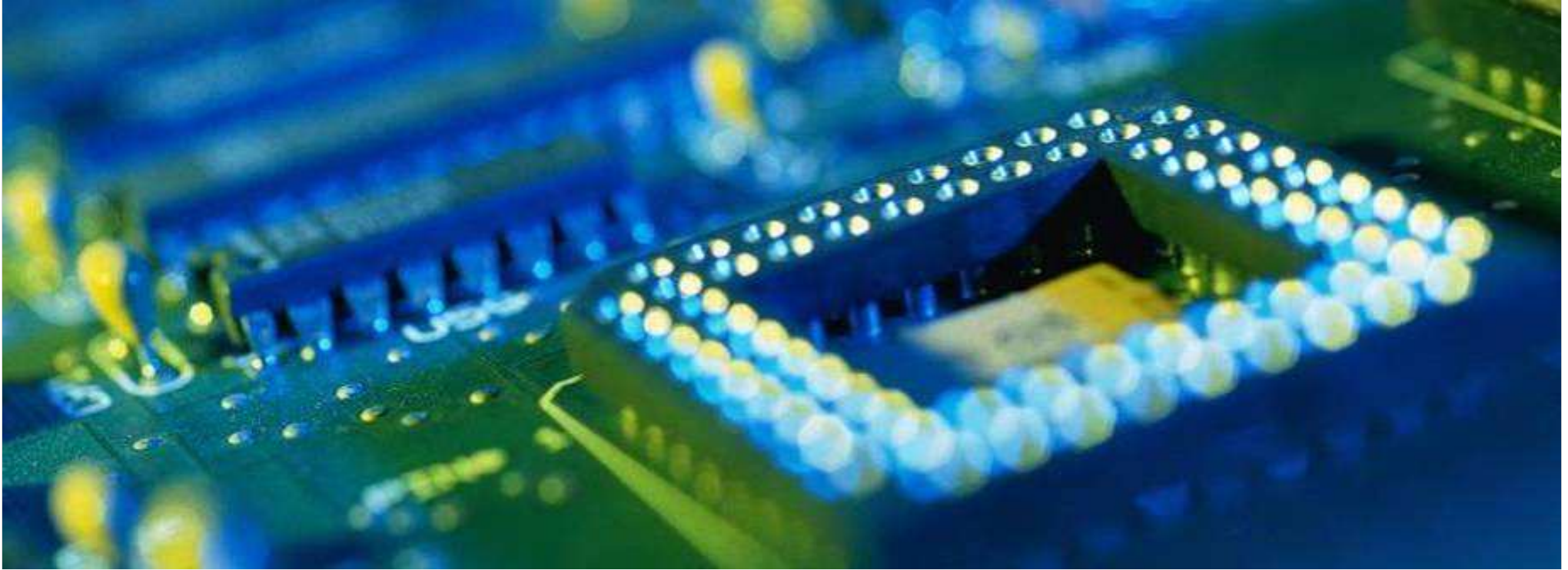
Energy Advantage Architecture

- Two complementary Eaton-proprietary technologies to maximize UPS performance & efficiency
 - **Variable Module Management System (VMMS)**
 - Maximized efficiency in double conversion mode
 - Both in single- and multi-UPS systems applications
 - **Energy Saver Systems (ESS)**
 - The ultimate savings: 99% efficiency
 - Automatic fast transfer to double conversion mode when needed (in less than 2 ms)



Energy Advantage Architecture

- ✓ Higher System Efficiency
- ✓ No Compromise On Reliability



Energy Advantage Architecture

Variable Module Management System (VMMS)



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The Challenge For UPS's

FACTS

In double conversion mode, the efficiency of any UPS varies depending on the % of load

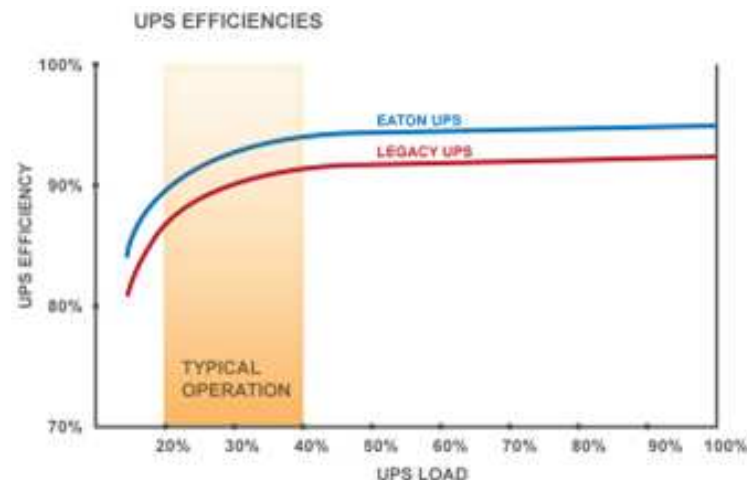
- Highest efficiency when close to full capacity

UPS systems rarely loaded at full capacity

- This is fact in redundant systems

CHALLENGE

How to maximize efficiency potential of UPS systems with lighter loads



The Solution:
Eaton 9395 UPS
and VMMS



An Eaton Green Solution

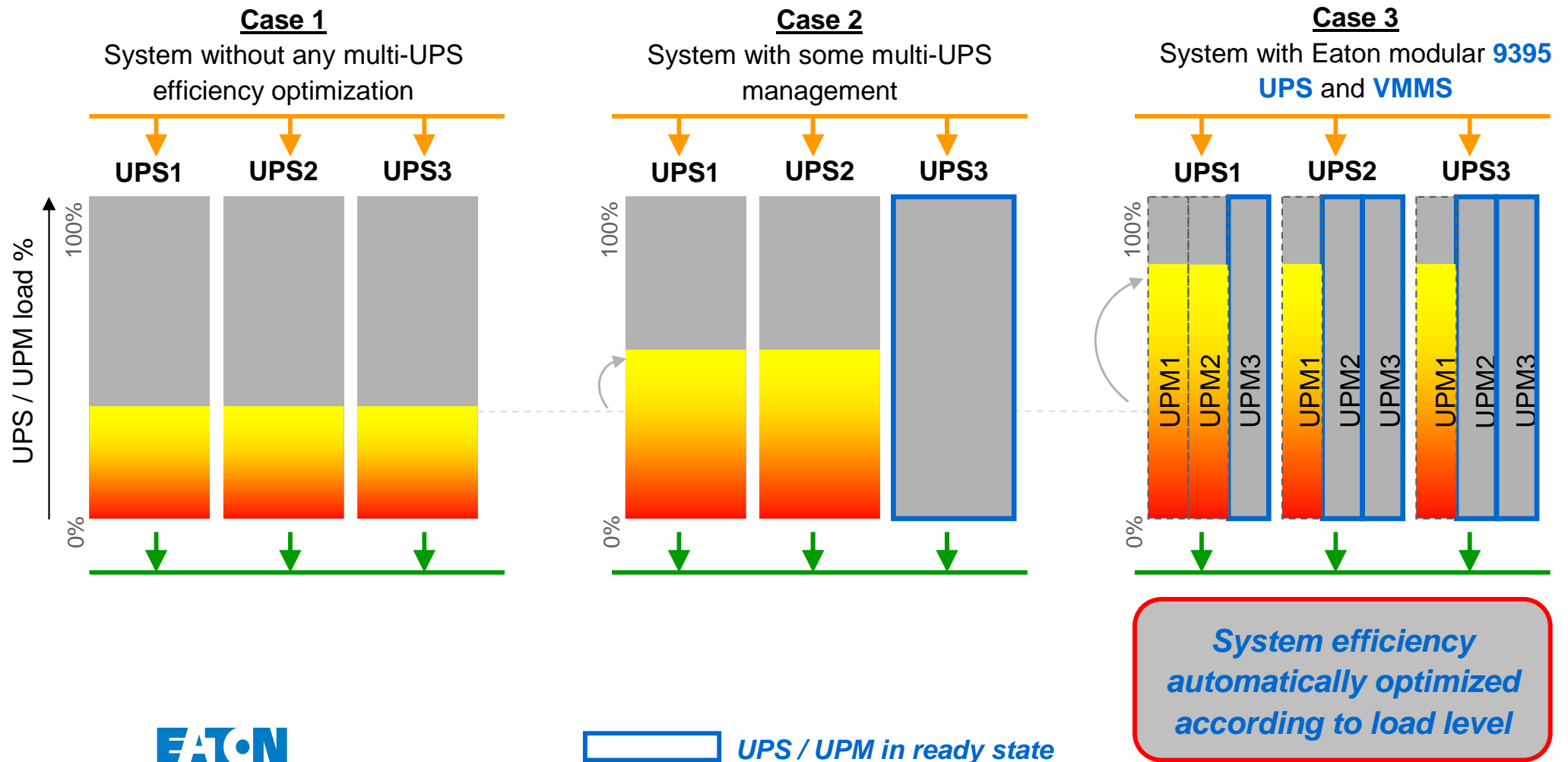
The Solution: Eaton VMMS

- How to maximize efficiency with lighter loads in double conversion mode
 - Especially in multi-UPS and redundant system configurations
- Solution #1 (+)
 - Concentrate load on certain UPS's to maximize UPS load level and overall system efficiency
 - Some energy savings
 - Limited to multiple-UPS systems (with several UPS in parallel)
 - Still not optimal
- Solution #2 (+++)
 - Eaton 9395 and its Variable Module Management System
 - Automatically optimize efficiency at UPM level
 - Concentrate the load on certain UPM's to maximize overall system efficiency
 - *Only possible thanks to modularity of Eaton 9395 UPS*
 - Not limited to multiple-UPS systems
 - Achieve even higher optimization thanks to UPM's modularity



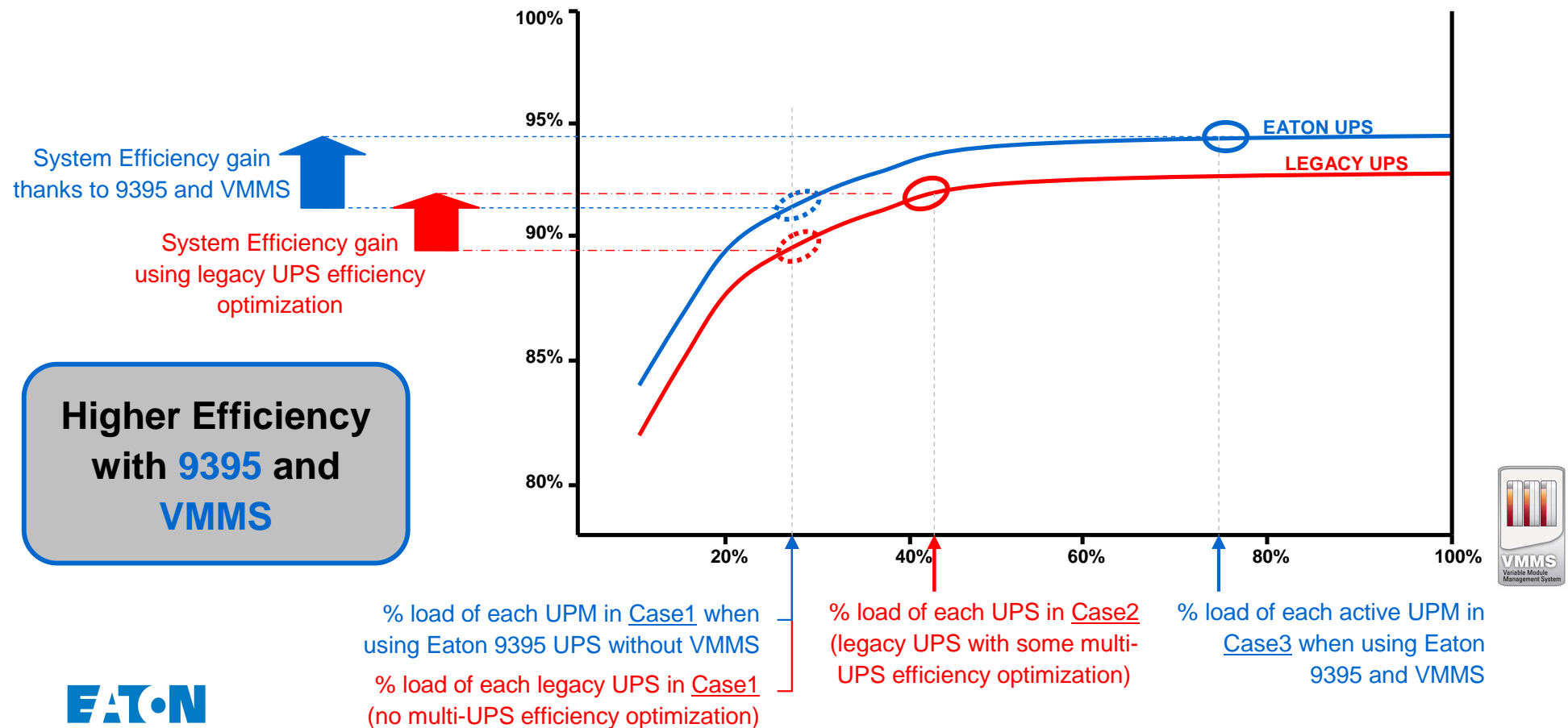
VMMS Principle

- Example With Same Load Applied To Different Multi-UPS Configurations



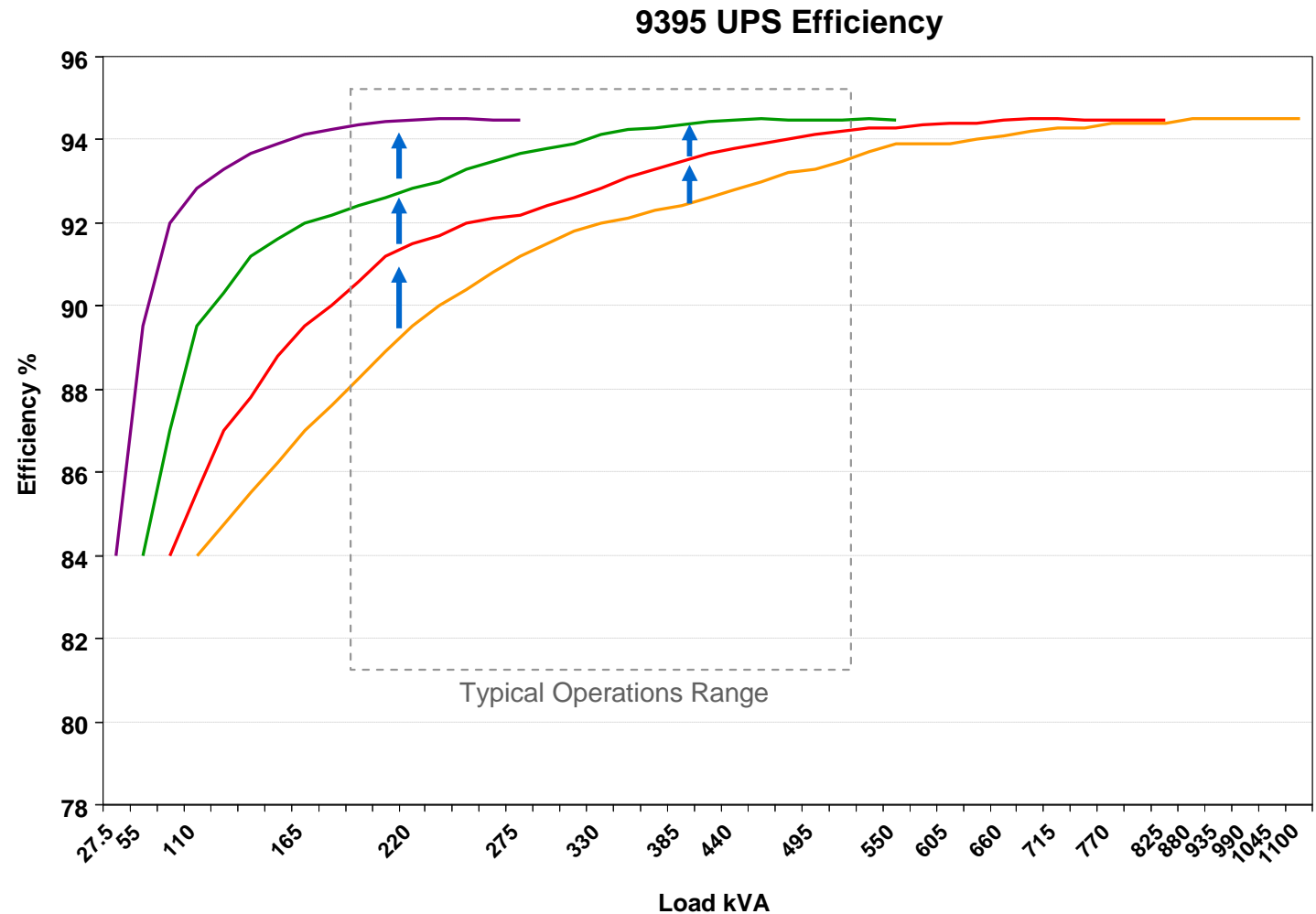
VMMS Principle

- VMMS maximizes % load of each UPM
 - Optimizing overall system efficiency



VMMS In A Nutshell

VMMS allows to shift to higher efficiency curves (according to system's redundancy requirements)



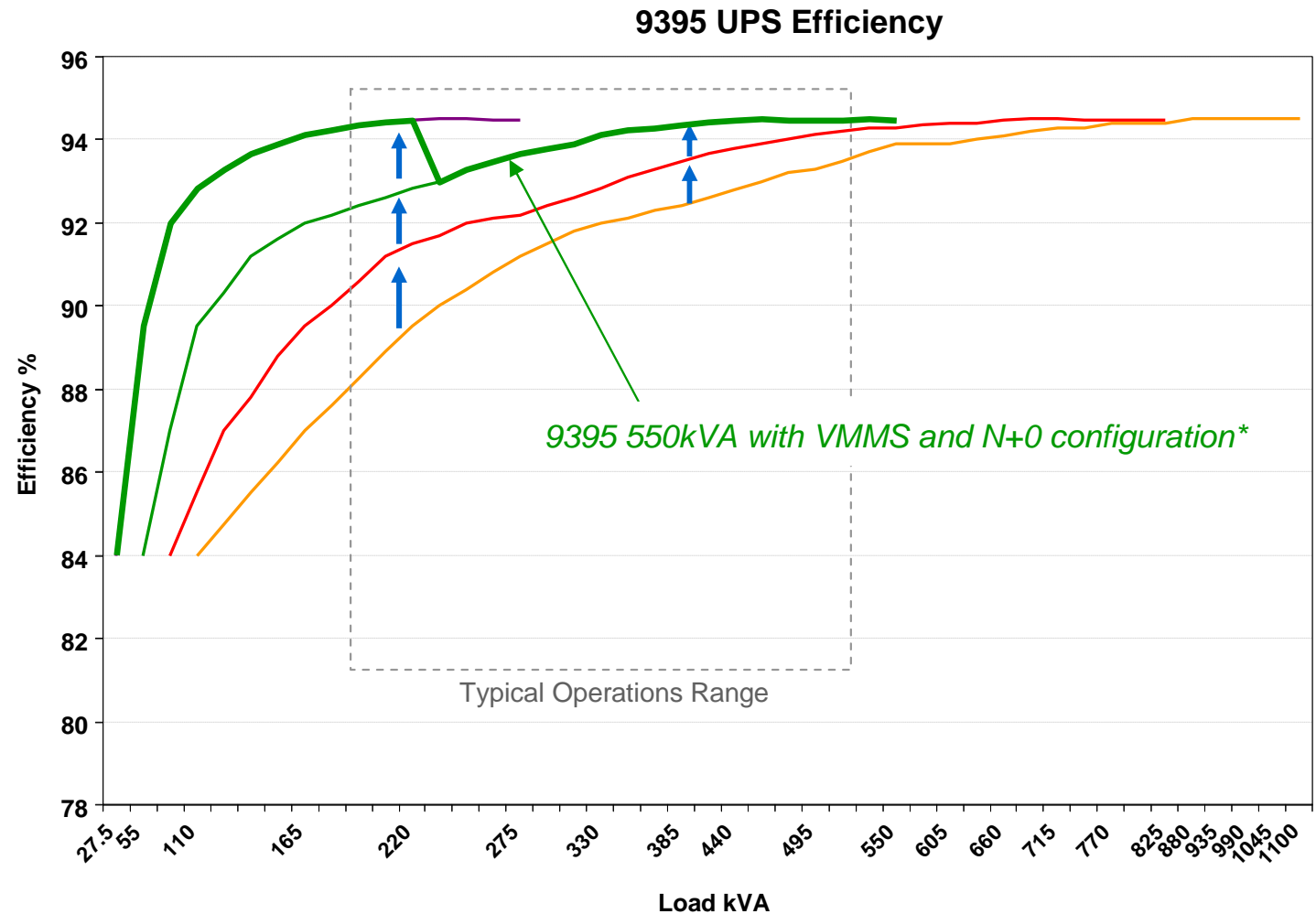
- 9395 275kVA
- 9395 550kVA
- 9395 825kVA
- 9395 1100kVA
- 9395 VMMS N+0

Notes:

- Scaled drawing
- VMMS and N+0 curves using VMMS default max UPM
- % load level @ 80% (*)

VMMS In A Nutshell

VMMS allows to shift to higher efficiency curves (according to system's redundancy requirements)
up to **N+0 VMMS** efficiency curve



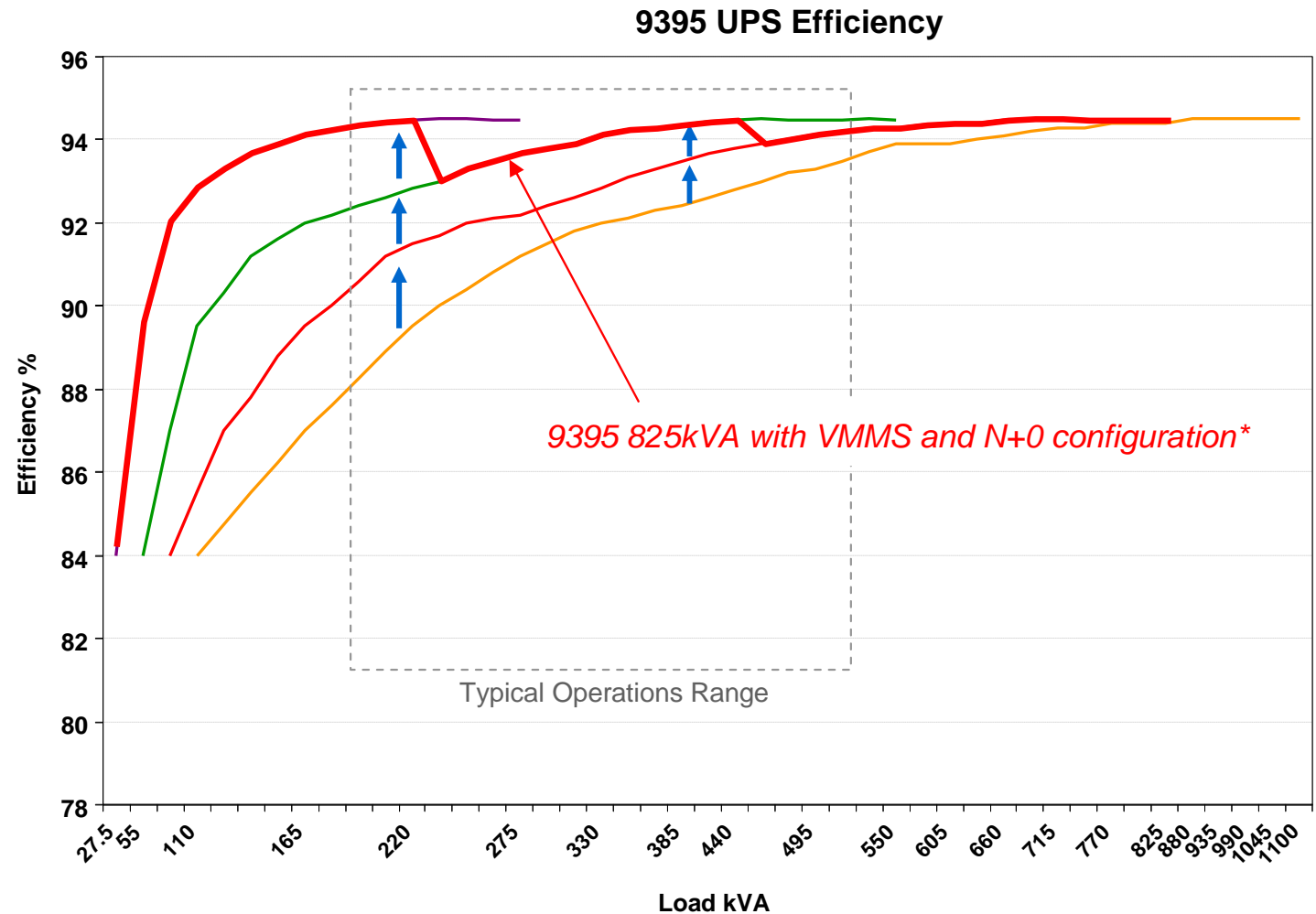
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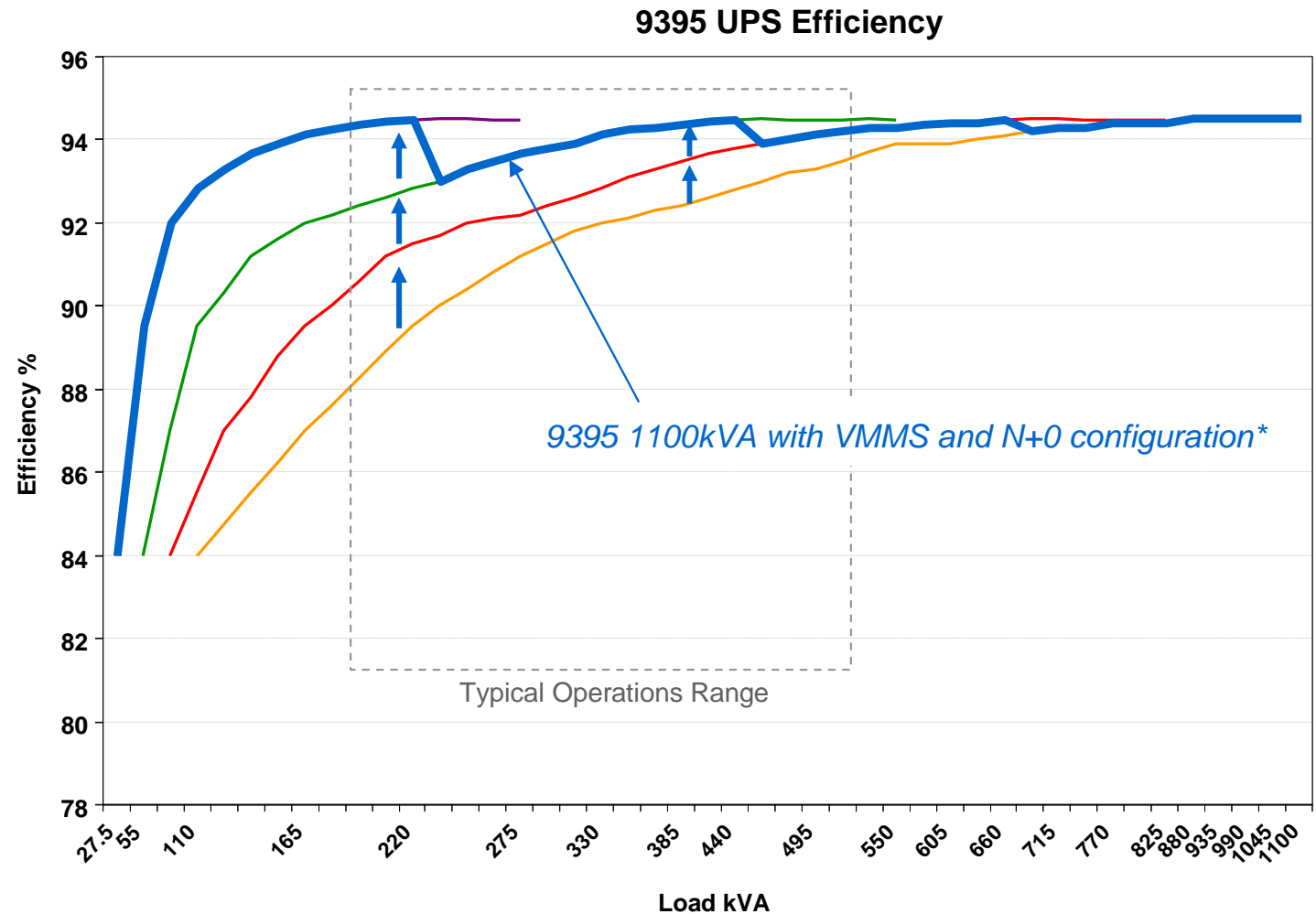
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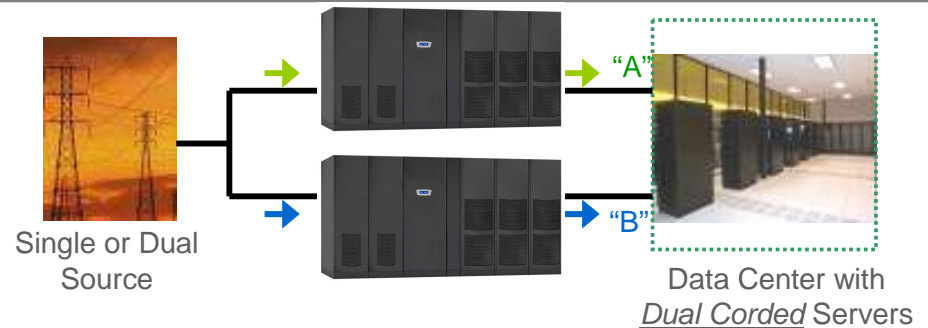
VMMS Applications

- VMMS can be used in all multi-module (multiple-UPM) 9395 systems
 - Single 9395 units from 550kVA to 1100kVA
 - Distributed parallel systems SBM Systems
- Typical Applications Where VMMS Particularly Efficient
 - Redundant N+1 and 2N systems UPS's
 - Lightly loaded: typically operate at loads < 45% load level where efficiency is not optimal
 - Data Centers, especially when UPS system feeds dual corded servers
 - Any applications when load is not constant

VMMS Example:

9395 / 825kVA Units in Dual Corded Load with A and B feeds

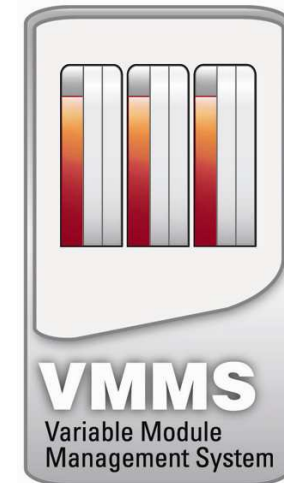
Example with 440kVA load
(A 220kVA + B 220kVA)



UPS Configuration	Without VMMS	VMMS on N+1 Redundancy	VMMS on N+0 Redundancy
Efficiency @ 440kVA load	91.2%	92.8%	94.3%
UPS Energy Savings	Used as reference for savings calculation	56 MWh / year	108 MWh / year
Additional benefits & comments	<ul style="list-style-type: none"> ✓ Industry-leading UPS efficiency in double conversion 	<ul style="list-style-type: none"> ✓ Additional energy savings from reduced cooling in VMMS (typically +30-40% to UPS energy savings) ✓ UPM's in VMMS ready state available for redundancy 	

VMMS – How Can I Get It?

- Variable Module Management System is available
 - on Eaton 9395 UPS
 - Earlier installations can also be upgraded with VMMS capability



The top of the slide features a graphic with a light gray background on the left and a blue background on the right. On the gray background, the text 'ESS' is written in large, bold, white letters, with 'Energy Saver System' in smaller black text below it. On the blue background, there is a green microchip with a black square in the center and green circuit lines radiating from it.

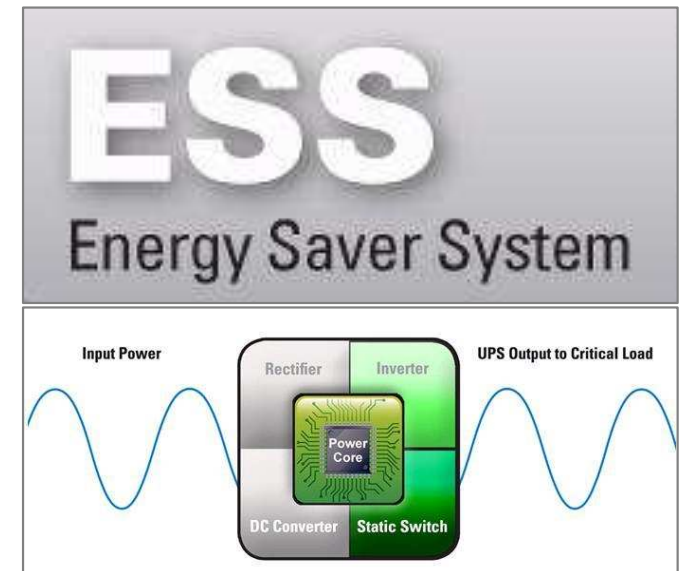
ESS

Energy Saver System

Energy Saver System (ESS)

Energy Saver System

- ✓ **Efficient**
99% efficiency across entire operating range
- ✓ **Intelligent**
Detects incoming power quality and engages modules as needed in $< 2\text{ms}$
- ✓ **Reliable**
Proven Eaton technology ensures reliability and continuous load availability

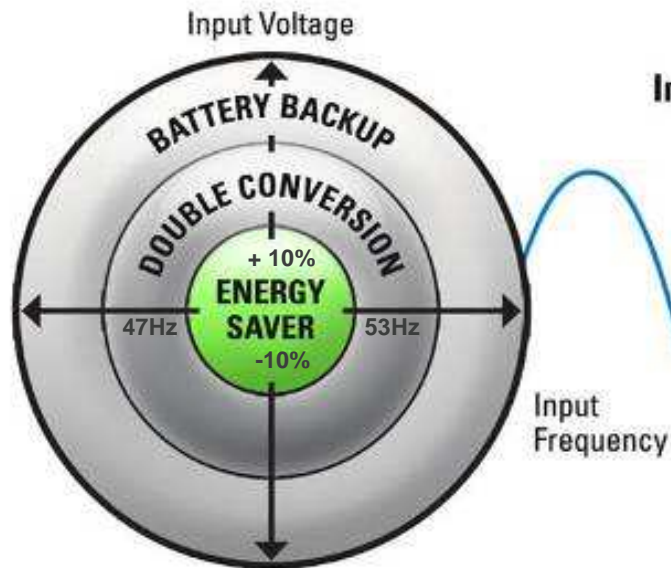


Energy Saver System (ESS) allows the UPS user to achieve the ultimate power efficiency without compromising the protection of the supported equipment.

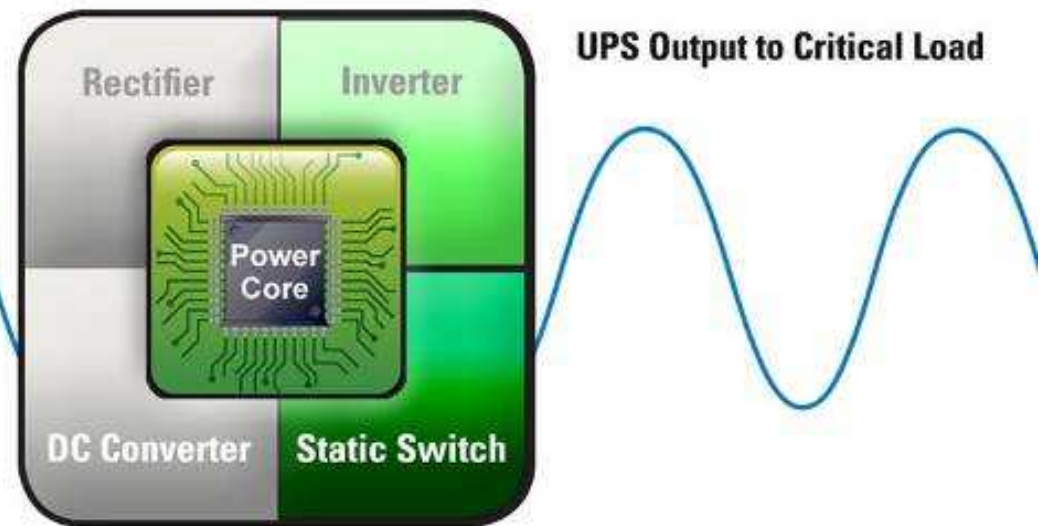
Energy Saver System

- Energy Saver System engages modules according to input power

**Input Power Quality
within load tolerance**



Active Modules

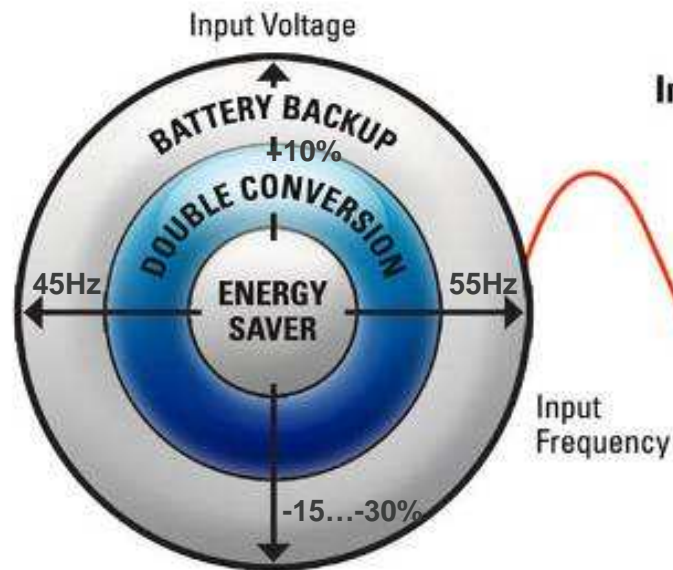


at nominal voltage 400V/50Hz

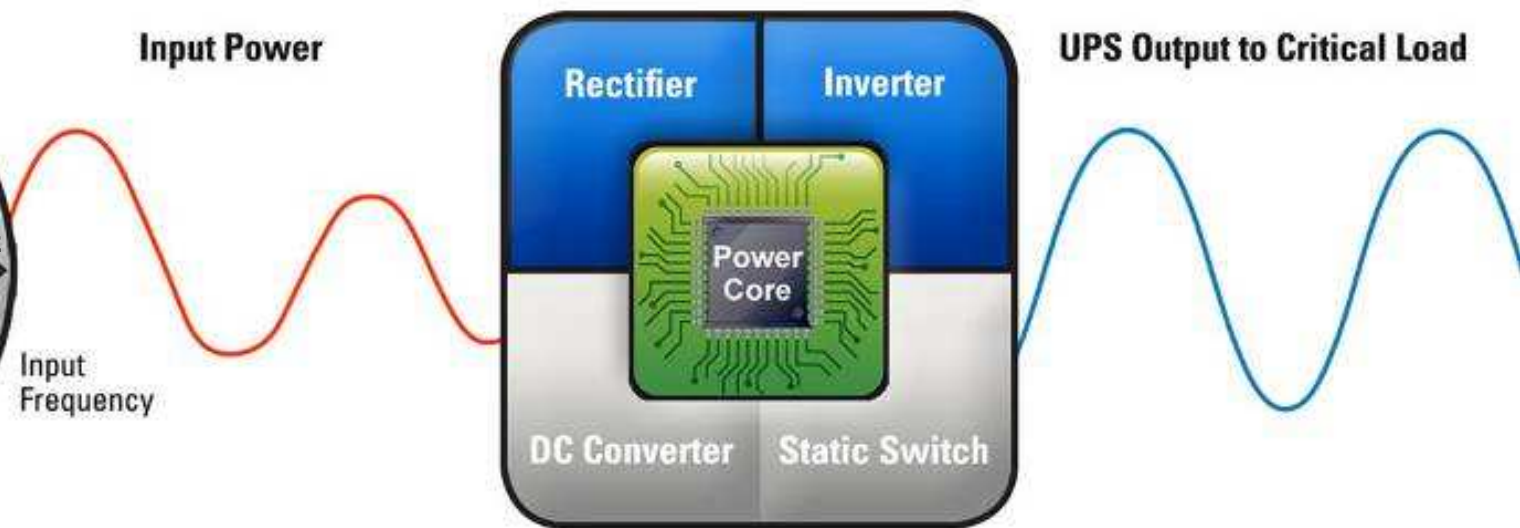
Energy Saver System

- Energy Saver System engages modules according to input power

**Input Power Quality
within rectifier tolerance**



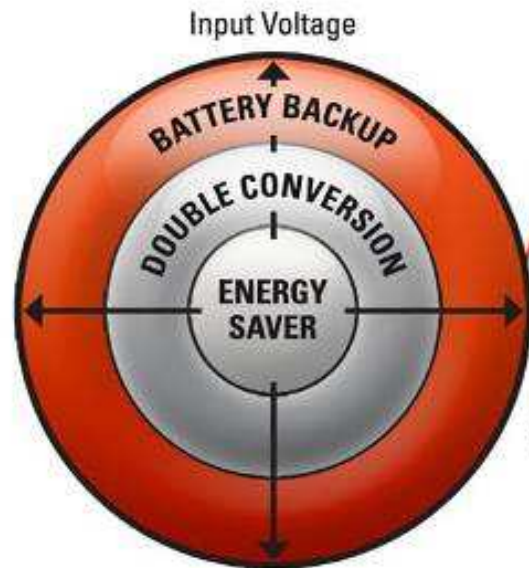
Active Modules



Energy Saver System

- Energy Saver System engages modules according to input power

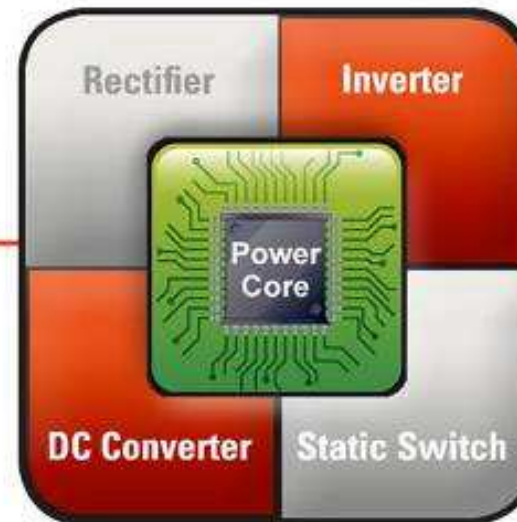
**Input Power Quality
out of rectifier tolerance**



Active Modules

Input Power

Input
Frequency

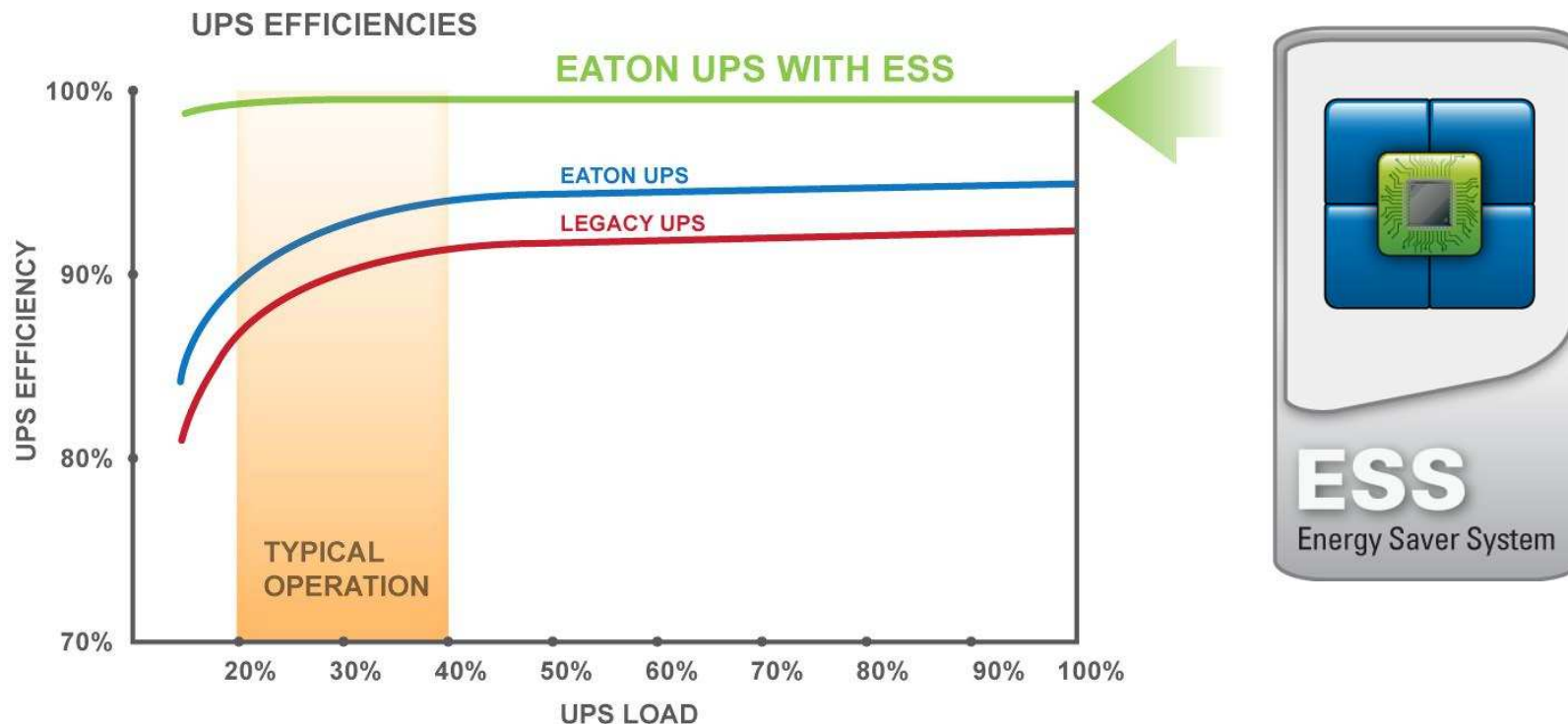


UPS Output to Critical Load

→ **Superior detection and transition technology**

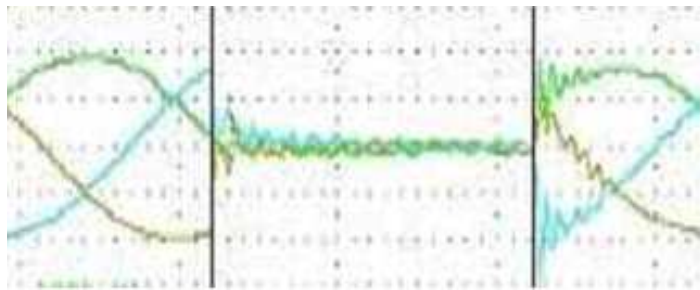
Energy Saver System saves even more at lower loadings

Maximum Efficiency Tracking

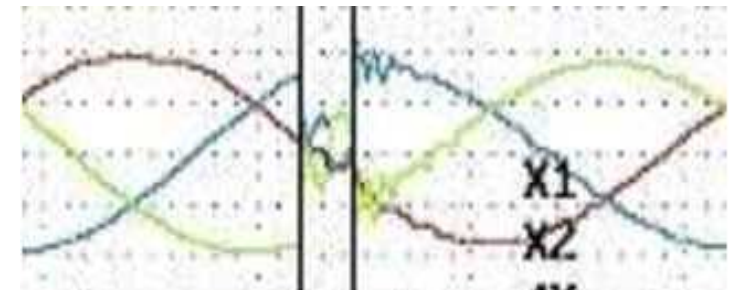


- **ESS Efficiency - 99%** across the complete operating range
- **85% reduction in losses** compared to legacy transformer-based UPS
- **Continuous power tracking** and proprietary DSP algorithms combined with transformer free design topology ensures **critical loads are always protected**

Utility Fault Transitions - Three Phase Outage



Source Outage



ESS Output Response 1.2 ms

Energy Saver System – How do we do it?

- Eaton's Energy Saver System is the latest innovation in the area of UPS providing [The Highest Reliability with The Highest Efficiency](#).
 - With advanced DSP controls, power conversion stages are “shifted into gear” only when needed
 - Energy Saver Mode (ESS) allows the UPS power converter stages to adapt its operation to provide [optimum load availability and energy efficiency](#)
 - [99% efficiency](#) over wide load range - above 20% load
 - Maximizes efficiency when the input is within the acceptable voltage and frequency window
 - Maximizes performance when the input is outside the window
 - [UPS seamlessly transitions through different operating modes](#) as needed
 - only possible with transformer-free topologies
- **Full voltage and frequency independency available in just 2ms**

What differentiates ESS from traditional “ECO-Mode”

EATON Energy Saver System

highest efficiency in the industry (99%)

Superior detection and transition technology

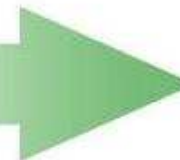
- Power system **fault detection technology** allows for a warp speed detection and correction of disturbances well **below 2 ms**
- **Adaptive algorithm** turns off the static switch before the inverter and **avoids back-feeding** the input

ESS can detect and transition faster and more reliably than traditional high efficiency schemes.



Energy Saver System– The Bottom Line

CRITICAL LOAD	250 kW
ELECTRIC COSTS	0,10 €
LEGACY UPS EFFICIENCY	93 %
EATON ESS UPS EFFICIENCY	99 %
ANNUAL EFFICIENCY SAVINGS	220 MW hr
ANNUAL CO ₂ SAVINGS	88 METRIC TONS
ANNUAL ELECTRIC COSTS SAVINGS	21 900 €



- ESS drives the UPS losses close to zero
- The energy savings from ESS typically recovers 100% of the UPS cost over a 3 - 5 year period
- At 250kW of critical load, the savings is equivalent to 3 600 € per year per point of efficiency gain.

DVT Testing - Three Phase Outages

Test Setup

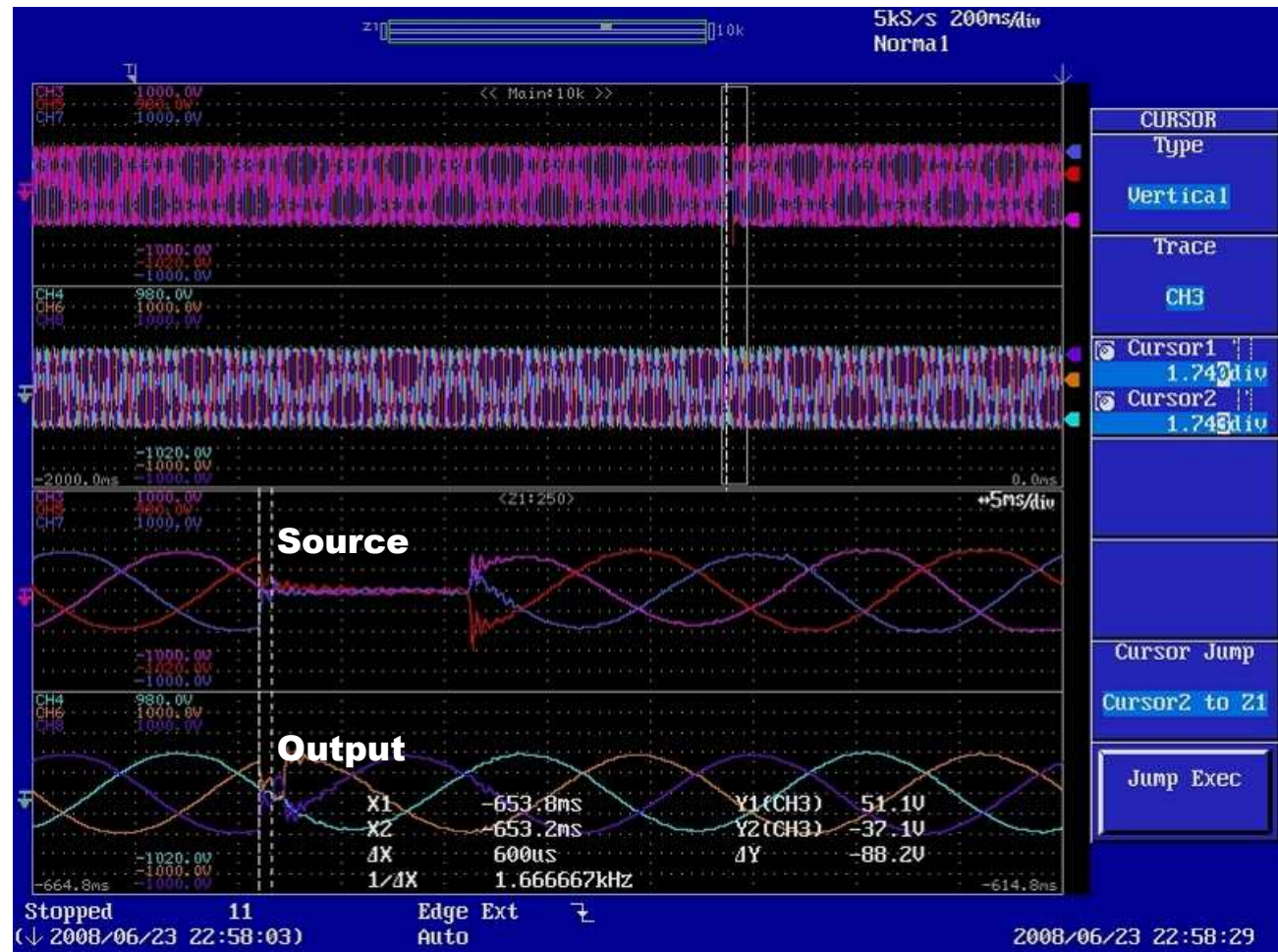
- » Source Channels -> 3, 5 & 7
- » Output/Load Channels -> 4, 6 & 8

Test Description

- » 1/2 cycle 0% dropout sequence (All Phases)
- » (0% is a low impedance (short) source fault)

Test Result

- » 1.2ms Transfer Time (600us detection time plus 600us SCR clearing time).



ESS – How Can I Get It?

- *Energy Saver System* is available to all *EATON 9390 and 9395 UPS*
 - stand alone single UPS
 - parallel systems
- Also all earlier installations can be upgraded with the ESS capability





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