



EBAY DATA CENTER RETROFITS: THE COSTS AND BENEFITS OF ULTRASONIC HUMIDIFICATION AND VARIABLE SPEED DRIVES

eBay, with more than 90 million active users globally, serves as the world’s largest online marketplace, where practically anyone can buy and sell almost anything. They are committed to continually improving the efficiency and environmental sustainability of their business. Data centers are the core engine of so much of what they do, and it’s essential that they continue to innovate to get the maximum amount of work out of them, while consuming the minimum amount of resources.

A major portion of this commitment can be seen in eBay’s effort to reduce its data centers’ energy use. The design and construction of eBay’s new flagship \$287 million data center facility¹ has incorporated a myriad of energy-efficiency measures. In addition, eBay considers retrofitting existing data center facilities a top priority. eBay’s 139,000 square foot data center (65,000 square feet of white space) in Phoenix houses² all of eBay’s business units. This facility, built in 2004, has been the target of numerous energy-efficiency upgrades.

“eBay is to be commended for their efforts to save energy through these data center retrofit measures and sharing their data with EPA so that others can learn from their efforts”

—Steve Ryan of EPA
ENERGY STAR program manager.

This case study describes the costs and benefits deriving from two retrofit measures eBay employed in its Phoenix facility: ultrasonic humidification; and variable speed drives (VSDs).

Table 1. Retrofit Measure Paybacks

Measure	Payback without APS Incentive (years)	Payback with APS Incentive (years)
Ultrasonic Humidification	1.9	0.5
Variable Speed Drives	2.6	1.6

If implemented effectively, both measures can yield cost-effective energy savings. Table 1 presents these measures’ simple paybacks (costs divided by annual energy savings), with and without incentives from Arizona Public Service (APS) Company. Ultrasonic humidification pays for itself in half a year with incentives, and in less than 2.0 years without incentives. VSDs pay for themselves in 1.6 years with incentives and 2.6 years without incentives.

ULTRASONIC HUMIDIFICATION

Computer room air handlers (CRAHs) and computer room air conditioners (CRACs) rely on humidification units to maintain data center humidity at specific levels. When data center humidity becomes too low, it can result in electrostatic discharge (ESD) failures. Where humidity becomes too high, water can condense inside servers, causing electrical shorts that trip circuit breakers, damage equipment, or harm electrical circuits within the data center.

Typically, isothermal humidification methods (infrared and steam canister) are used to maintain humidity levels. Ultrasonic humidification works by vibrating water molecules³ (rather than heating them), producing a fine mist (1 to 2 microns) of discharge. They use 90% less energy than isothermal methods.

The amount of humidification required with an ultrasonic system differs from the steam generator units replaced. Proper sizing should be reviewed with equipment suppliers and engineers. In general, steam humidifiers are oversized, as their use leads to a higher heat load, resulting in more cooling that reduces relative humidity. On the other hand, ultrasonic humidification reduces cooling loads, leading to less cooling, which increases relative humidity. At eBay, steam humidifiers supplied 533 lbs/hour of water vapor, while ultrasonic humidification supplied 141 lbs/hour.

¹ eBay’s flagship facility hosts the eBay.com and Paypal.com Websites. The facility came online May 4, 2010, and is 30% more efficient than the most efficient data center in the eBay portfolio, with a designed power usage effectiveness (PUE) of 1.4. <http://www.datacenterknowledge.com/archives/2010/05/23/eBay-unveils-new-flagship-data-center/>

² This includes server applications for the eBay services, analytical databases and storage devices for internal analysis, and routers/switches to direct traffic to the applicable system arrays. In addition, telecom gear will be required to interconnect to a fiber optic backbone.

³ In ultrasonic humidification, a small disc (often metal) transducer is vibrated through piezoelectric application of voltage under a thin layer of water. The vibration’s frequency is high enough to prevent water molecules from conforming to the waveform induced by the transducer. The water cavitates on the negative portion of the wave cycle, forming a micro pocket of negative pressure. Water in this micro region is released from the surface tension of the thin film of water. Thus, small water droplets are released into a discharge device, often a tube or fan assembly. <http://www.datacenterfix.com/expert-article/ultrasonic-humidification-data-center>

⁴ These rooms house UPS equipment, electrical switchgear, and chiller equipment.

Ultrasonic humidification must use mineral-free, deionized water or water treated with reverse osmosis. A reverse osmosis/deionized water system was already in place at eBay. When considering ultrasonic humidification, project managers must consider the costs of installing these systems.

At eBay, the electrical and mechanical equipment rooms⁴ were served by six, ducted Air Handling Units, equipped with steam-generating humidifiers to maintain the proper humidity in those spaces. The duct-mounted steam generating units were removed, and

room-mounted ultrasonic humidifiers were installed. Eight ultrasonic humidifiers were required to serve all areas adequately. The newly installed ultrasonic humidifiers maintain equipment rooms at a relative humidity between 30% to 40%.

Table 2 shows energy use, savings, costs, and paybacks for eBay's purchase and installation of the ultrasonic humidifiers, with and without the APS incentive. At the time of the retrofit, the incentive offered was 11 cents per kWh, capped at 75% of costs. Payback for the costs was less than 2.0 years without the incentive and half a year with the incentive.

Table 2. Ultrasonic Humidification Payback

	Power Draw (kW)	Hours of Use ⁵	Number of Units	Energy Use (kWh)
Steam Humidifier	30.3	4380	6	796,284
Ultrasonic Humidifier	0.67	4380	8	23,477
Energy Savings (kWh)				772,807
Energy Savings (\$)				\$50,232
Costs (labor and ultrasonic humidifier purchases)				\$ 94,270
Payback (years)				1.9
Potential incentive at 11 cents per kWh				\$ 85,009
Actual incentive limited to 75% of costs				\$ 70,703
Payback (years) with Incentive				0.5

VARIABLE SPEED DRIVES

In the eBay facility, white space raised floor areas were cooled by 83 chilled water CRAHs, each equipped with constant velocity fans. Each CRAH's chilled water valve was controlled by a return air sensor, installed in the unit's return plenum. For this retrofit, new high-efficiency motors (95% efficient) and new VSDs for the fans were installed at each CRAH. VSD retrofit kits were supplied by the CRAH manufacturer.

In addition to these new installations, control system changes enabled more precise use of the CRAH. Control changes included relocating the chilled water valve control feedback sensor from the return air plenum to the supply air plenum, leading to much better room temperature controls, and more consistent supply air temperatures, maintained at 65 degrees Fahrenheit.

Due to the amount of harmonics created with VSD operations, 16 225-KVA harmonic mitigating transformers had to be installed. This caused project costs to increase, and, more importantly, proved to be one of the greatest challenges during installation, primarily due to locations of existing units in electrical rooms, and many installed in the overhead, complicating their replacement.

Table 3. VSD Payback

	Power (HP)	Efficiency	Hours of Use	Number of Units	Energy Use (kWh)
Constant Speed	10	90%	8760	83	6,026,685
Variable Speed	10	95%	8760	83	1,663,675
Energy Savings (kWh)					4,363,010
Energy Savings (\$) at 6.5 cents per kWh					\$ 283,596
VSD Equipment Costs					\$341,960
Harmonic Transformer Costs					\$338,984
VSD Installation Costs					\$69,056
Payback (years)					2.6
Potential incentive at 11 cents per kWh					\$ 479,931
Actual incentive limited to 50% of costs or \$300,000					\$300,000
Payback (years) with Incentive					1.6

The fan speed is controlled through an array of wireless sensors installed in the cold aisles. The CRAHs are responsible for specific zones of control. Within these zones, in-row temperatures sensors control fan speeds to ensure sufficient cold air to maintain an average cold aisle temperature of 75 degrees Fahrenheit.

Table 3 shows energy use, savings, costs, and paybacks with and without the APS incentive. The incentive for VSDs was 11 cents per kWh, capped at 50% of costs or \$300,000. Fan flow rates were estimated at 65% of current rates with VSDs. Paybacks were less than 3.0 years without the incentive, and less than 2.0 years with the incentive.

⁵Humidifiers were estimated to run one-half the time. Other data centers may see much less frequent hours of use and should adjust their savings estimate accordingly.

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