

# Green Networking Equipment: Who Leads and Who Lags

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## Introduction

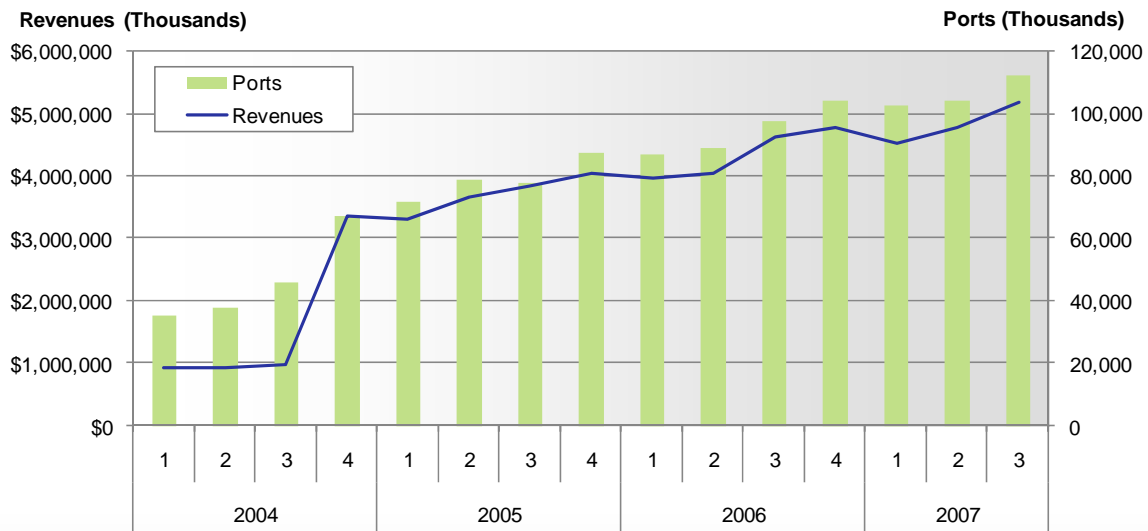
In the data center, the advent of high-density computing equipment has sent power usage soaring. For instance, servers and their supporting infrastructure consumed an estimated 1.5% of US electricity in 2006, according to the Environmental Protection Agency. As a result, power consumption and other “green” issues are fast becoming the information technology (IT) industry’s biggest challenge. Inevitably, as these concerns grow, focus will broaden to all types of IT equipment, settling on one of the thirstiest devices; the local area network (LAN) switch, which can consume several thousand watts.

As many businesses develop “green” initiatives using best practices published by organizations like the Green Grid, IT managers will be forced to absorb some degree of responsibility for their organization’s power usage. With the same department responsible for equipment purchases and the power bill, the role of energy efficiency will grow considerably in importance for future equipment purchases. Furthermore, by reducing power consumption, equipment capacity is freed, enabling switch vendors to add more advanced technologies and software features to their product lines. For these reasons, In-Stat believes switch vendors who address energy efficiency earliest have significant opportunities in the growing Ethernet switch market, as shown below.

### HIGHLIGHTS

- In-Stat found significant differences in the energy efficiency of similarly equipped switch equipment.
- Shipments of power over Ethernet ports, which can consume more than 10 times the energy of standard ports, have tripled since 2005.
- Power metric comparisons show that equipment from top vendor Cisco currently lags in energy efficiency.

**Figure 1. Total Quarterly Ethernet Market Revenues and Port Shipments**



Source: In-Stat, 12/07

## What Makes Networking Equipment “Green”?

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There is no formal definition of “green” in the networking equipment industry because of the number of factors that help equipment vendors develop more environmentally friendly products. Still in their early stages, green practices can best be described as the integration of technologies that significantly improve energy efficiency, as well as manufacturing processes and materials that significantly reduce waste and the use of toxic chemicals.

To understand a vendor’s development of a green product strategy, it is important to briefly examine emerging “green” regulations and the components of networking equipment that drive energy efficiency.

### Manufacturing and Recycling Regulations

In reaction to the increasing amount of electronic and electrical waste, the European Union (EU) began requiring all manufacturers of electrical and electronic equipment to reduce the use of toxic substances and flame-retardants to specified levels and fund recycling programs for their equipment. China and South Korea have followed with similar regulations. Also several states in the US, including California, Connecticut, Florida, Illinois, Maine, Maryland, New York, Rhode Island, Vermont, and Washington have initiatives as well. While there are obviously costs for manufacturers and vendors, such as the purchase of specialized equipment and product redesign, there are benefits too. These benefits include more environmentally friendly manufacturing equipment and an opportunity to update product lines.

### Energy Efficient Components

Improvements in the energy efficiency of networking equipment components have been slow, due to the high costs of designing equipment with energy-saving technologies and the increasing number of functions that switches perform in the network that require more power.

Progress depends on the increase of research and development budgets, use of more expensive components, and other measures whose strategic importance can be difficult for vendors to justify from a short-term revenue perspective.

### Processors

High performance, enterprise-level switching equipment provides similar functionality and capacity. However, when comparing competing solutions, there can be significant differences in energy consumption. Some of these differences can be attributed to the processor technology used in the equipment. Different processor manufacturers employ different strategies and technologies to conserve energy. Generally, designs with smaller transistors can lead to significant increases in energy efficiency and performance.

### Power Adaptors

Inefficient power adaptors can waste significant amounts of energy. For example, a power adaptor with an efficiency rating of 70% will lose 30 Watts during conversion for every 100 Watts consumed. However, some switch vendors are beginning to ship higher efficiency adaptors with 80% to 90% efficiency ratings, saving significant amounts of energy in environments requiring redundant power supplies.

## Cooling

Fans that cool switches also drive up energy consumption. As a result, some manufacturers design switches that can dissipate heat more quickly, sometimes eliminating the need for a fan, and also increasing reliability. In higher performance switches, powering fans with high efficiency power adaptors and using fans that can adjust speed based on cooling needs can help conserve energy.

## Software

In effort to maximize the efficiency of network equipment, vendors are working to intelligently control hardware components through specialized software. In the small/medium business (SMB) market, vendors are developing technologies to hibernate unused ports, and ultimately an entire device, when not in use. In the high-end market, the focus includes improving operating efficiency by controlling individual hardware components, and optimizing the efficiency of network-attached devices by using technologies such as virtualization. Looking forward, vendors in all markets hope to eventually incorporate technologies that can enable a switch to intelligently adjust its wire-speed based on network capacity needs, saving tremendous amounts of electricity.

## Challenges for Vendors

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There are two major challenges vendors will face over the next couple of years. Adapting equipment to support the growing popularity of Power over Ethernet (PoE) is a crucial initiative. Furthermore, the capacity of equipment must also grow in order to support advanced features and network applications.

Together, both will cause energy consumption to skyrocket beyond the closet or data center's capacity limitations. Undoubtedly, this will put considerable strain on IT managers responsible for the power bill. Vendors can expect the total cost of ownership to become increasingly a top priority in purchase decisions. Although security, voice, and wireless applications will drive an increasing portion of upgrade cycles, the desire for manageability, growth capacity, and cost reduction will be factored in just as strongly.

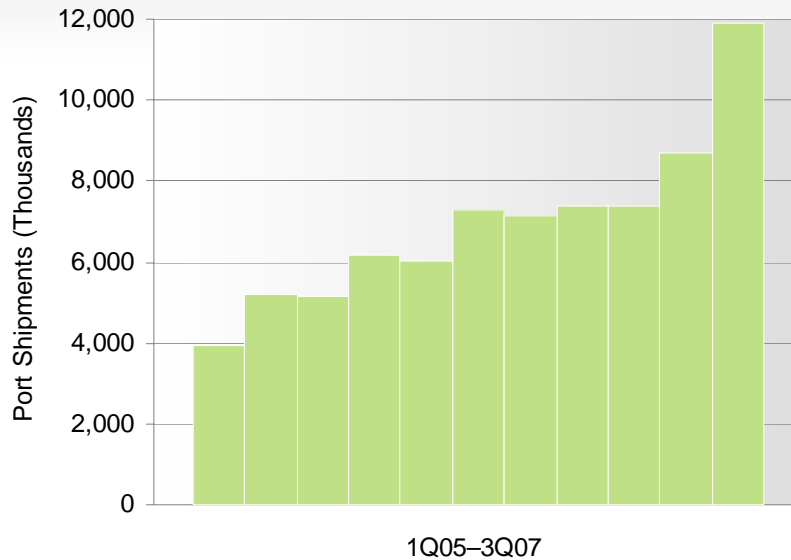
## Power over Ethernet

PoE technology transmits electrical power, along with data, to remote devices over standard twisted-pair cable in an Ethernet network. PoE is useful for powering IP telephones, wireless LAN access points, and other network-attached equipment where it would be inconvenient, expensive, or infeasible to supply power separately.

The benefits of network-attached equipment have led to a rapid increase in the number of PoE port shipments. This causes major concerns for IT personnel, as PoE equipment typically consumes about ten times the energy of a standard switch. Furthermore, PoE equipment is usually mission critical, which requires redundant power supplies and battery backup equipment that increase energy consumption and heat dissipation even further.

PoE port shipments have increased steadily since 2005, as shown below.

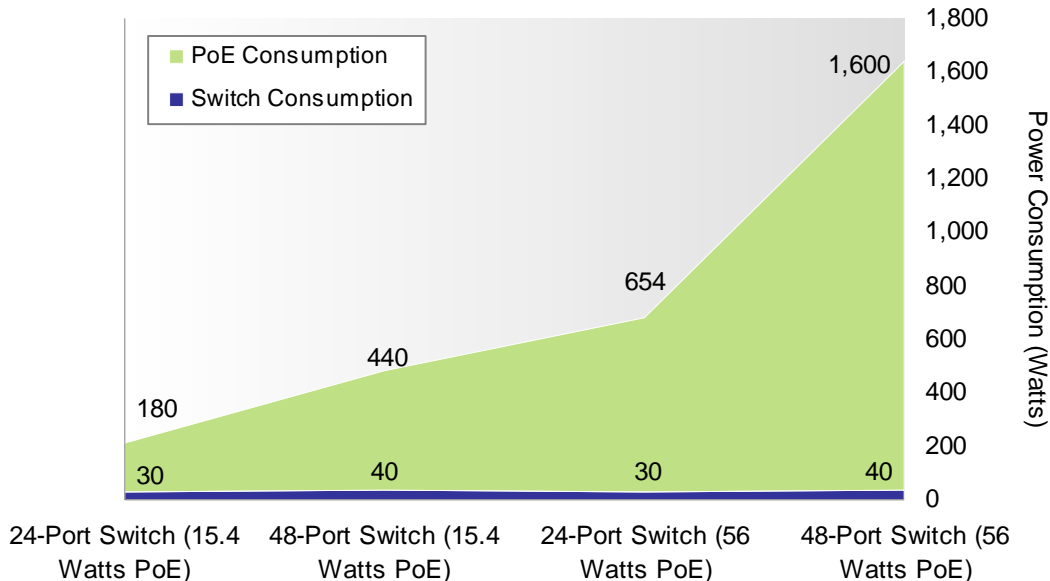
Figure 2. Total PoE Port Shipments—2005 to 2007



Source: In-Stat, 12/07

As a further complication, future PoE standards will require more power to enable networking equipment to power videophones, surveillance equipment, WiMAX transmitters, and thin clients. Standards under consideration could provide up to 56 watts of power per port, sending the power consumption in watts of fixed switches into the thousands and sending chassis solutions into the tens of thousands. The estimated increase in energy consumption is shown in the following figure.

Figure 3. Estimated Effect of Proposed PoE Standards on the Energy Consumption of a Fast Ethernet Switch



Source: In-Stat, 12/07

## Component Strategy: Standard vs. Proprietary

Historically, leading switch vendors have maintained high margins and differentiated products by using proprietary elements such as specialized software, operating systems, and custom application-specific integrated circuits (ASICs). For many reasons, this strategy may be difficult to maintain in the future.

It is becoming increasingly difficult for switch vendors who use proprietary silicon solutions to maintain competitive price/performance ratios. The prices of standard silicon will continue to fall, making high performance, energy efficient chips available to low-cost domestic and foreign producers. A sampling of key switch vendors' and chip suppliers' relationships is shown below.

**Table 1. Switch Vendor Chip Sourcing**

Source	Market	Switch Vendor
Broadcom	Consumer, SMB	Alcatel, D-Link, HP ProCurve, Linksys, Netgear, Nortel
Custom ASICs	SMB, Enterprise	Cisco, HP ProCurve, Force10
PowerPC	Enterprise, Data Center	Alcatel, Cisco, Extreme, Force10, Huawei, Nortel
Freescale	Various	Foundry

Source: In-Stat, 12/07

In the consumer and SMB markets, where margins are low, solutions from Broadcom are popular. For vendors competing with products intended for the core of the data center, where raw speed and network availability are highly demanded, PowerPC chips dominate. However, in the more general enterprise and data center markets, which are estimated to account for 72% of total port shipments, ASICs are commonly used. Custom ASICs, utilized heavily by market leader Cisco, keep products difficult to imitate and help vendors hold on to higher margins.

While custom ASICs have their strategic advantages, switch vendors are still struggling to integrate 130nm silicon designs and make the move to 90nm before the end of 2009. Meanwhile, Broadcom is offering 65nm chips that are highly efficient and can handle more complex tasks such as deep packet inspection, quality of service (QoS), and Layer 2–3 forwarding. In fact, Google, dissatisfied with the energy consumption and heat issues associated with high-end-switch products currently available to the market, turned to Broadcom for 10GE chips to build their own solutions internally.

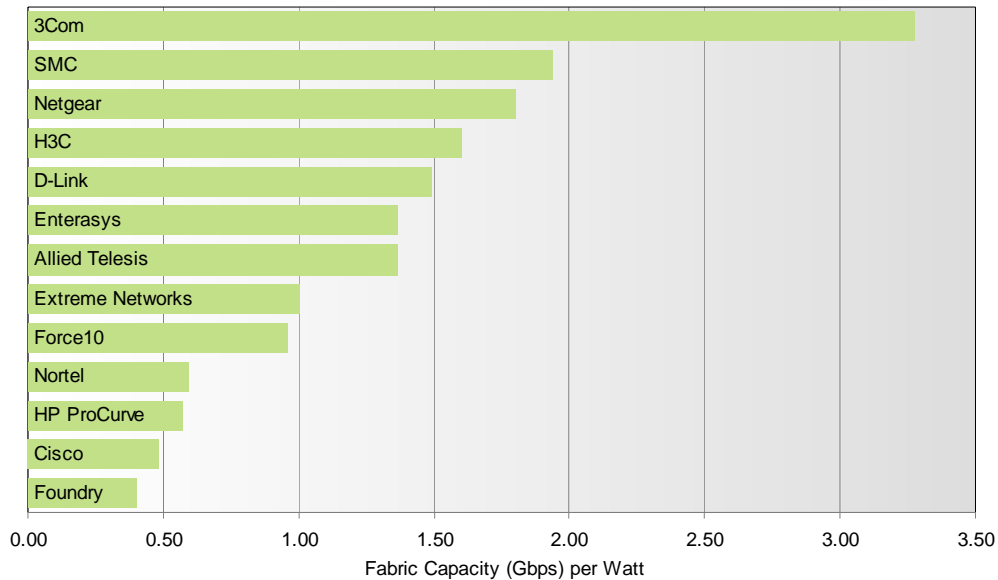
## Energy Efficiency Snapshot

In an effort to measure the “greenness” of high-end switch vendors, In-Stat compared similarly equipped fixed switching solutions in both the 24-port and 48-port categories from each switch vendor’s product portfolio, using a simple, server-like metric for calculating energy efficiency. In both the 24-port and 48-port categories, an entry-level and high-end solution was selected. The 24-port configurations had throughput capacities near 50Gbps for low-end configurations and 100Gbps for high-end configurations. The 48-port configurations had throughput capacities near 100Gbps for low-end configurations and 200Gbps for high-end configurations.

In-Stat found that energy efficiency did not vary materially when comparing a manufacturer’s entry-level and high-end switches. Rather, energy efficiency within a manufacturer’s product line fell only as the

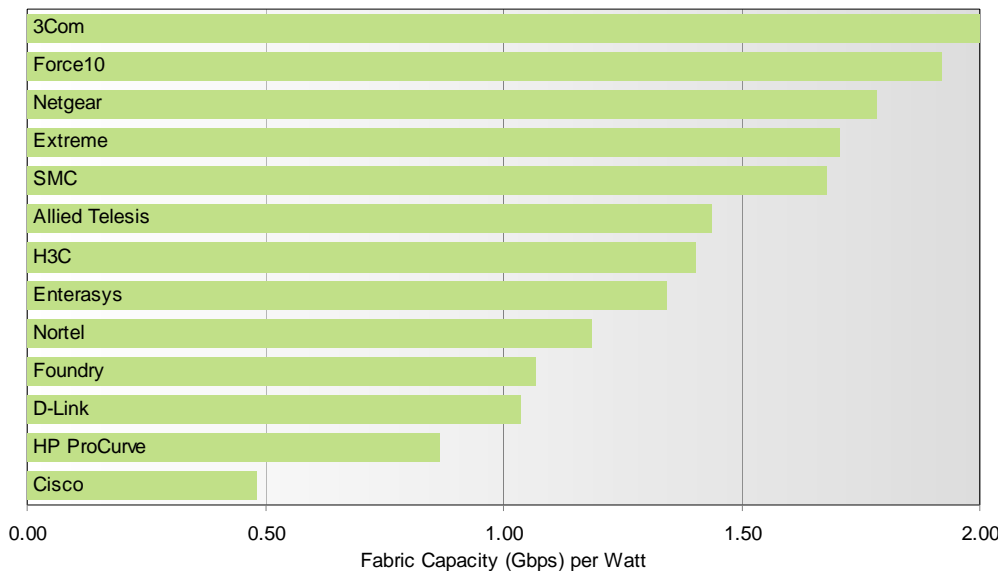
number of ports increased, as expected. Under these conditions, In-Stat determined that even among similarly equipped switches, capable of performing identical tasks, there are significant vendor-specific differences in energy efficiency. Consequently, shown in the following figures, are In-Stat's comparisons of energy efficiency for each vendor's enterprise fixed switching solutions.

**Figure 4. Fabric Capacity (Gbps) per Watt (24-Port GE, Fixed, Managed, L2-3)**



Note: IT managers commonly use a combination of both equipment-level and network-level metrics to measure power efficiency and each may yield different results. Some of these metrics include power per port, power per unit of bandwidth, power per user, power per server, and power per unit of work. For more information on calculations, see the *Methodology* section.  
Source: In-Stat, 12/07

**Figure 5. Fabric Capacity (Gbps) Per Watt (48-Port GE, Fixed, Managed, L2-3)**



Note: IT managers commonly use a combination of both equipment-level and network-level metrics to measure power efficiency and each may yield different results. Some of these metrics include power per port, power per unit of bandwidth, power per user, power per server, and power per unit of work. For more information on calculations, see the *Methodology* section.  
Source: In-Stat, 12/07

## Improving Energy Efficiency: Strategic Directions

To improve energy efficiency, there are two strategic directions being pursued by vendors within the industry. Some vendors are working from the bottom up, by using the most efficient components available for their equipment. Other vendors are working from the top-down, by seeking to first optimize network traffic across the network to reduce the stress on equipment.

### Cisco

Probably the most notable proponent of improving energy efficiency by optimizing network traffic is Cisco, although these efforts are common for vendors competing in high-density environments. Cisco envisions enabling its networking equipment to intelligently control the power consumption of all IT equipment, although it could be several years before such a solution is available and widely deployed.

### Everyone Else

Alternatively, some switch vendors are taking a proactive approach, designing their equipment from the ground up with the most efficient hardware components available. Using rapid heat-dissipating raw materials, highly efficient power supplies, intelligent cooling systems, and advanced silicon solutions, there are significant equipment-level improvements in energy efficiency that are both easily measured and visible to the consumer. Aside from just immediate energy efficiency improvements, this strategy allows for scalability, giving IT managers the excess capacity to enable equipment with more advanced networking technologies and applications. Two vendors using a bottom-up, approach are 3Com and D-Link.

3Com has forged an early partnership with startup Tileria. Tileria is a fabless semiconductor company producing highly scalable, multi-core embedded processors. If 3Com is to add Tileria's 64-core, Tile64 microprocessor, 3Com's switches will be capable of performing L4-7 deep packet inspection, advanced quality of service (QoS), network monitoring, and unified threat management. According to Tileria, adding the processor would only increase maximum power consumption by 20 watts.

D-Link's line of gigabit Ethernet switches for small and home offices are able to reduce power usage by both hibernating unused ports and adjusting signal strength based on cable length. D-Link claims that the DSG-2208 desktop switch can achieve up to 80% power savings, compared to conventional D-Link switches. Further, D-Link plans to integrate these technologies into its Web smart switches in early 2008 and their managed switches near the end of 2008. D-Link is on track to be the first major vendor offering an entire portfolio of backward compatible, "green" switches by the end of 2008.

## Conclusion

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“Green” is a competitive dynamic that is increasing in importance for the networking equipment industry, given the impact of power consumption on the company’s bottom line. Vendors who are best able to adapt as concerns over energy efficiency grow for network equipment, will have significant opportunities, including the chance to impact market share among the top vendors.

In-Stat believes that “green” initiatives and product lines will begin eliciting responses from competitors, expediting a broader market shift toward more environmentally friendly products over the next few years. Furthermore, as vendors experiment with new software and hardware configurations, there are likely to be many new innovations throughout 2008 and 2009.

## Methodology

Primary and secondary sources of information were used in the development of this report. Research for manufacturer shipment data was collected by contacting the manufacturers in question directly via email surveys and correspondence, in addition to telephone-based briefings and interviews. With publicly-traded manufacturers, financial cross-checking was used. With non-publicly traded manufacturers, cross-checking was performed by looking at historical data and applying knowledge of the total market and trends. All sales are calculated as manufacturer’s revenue, as opposed to end-use sales. Manufacturer’s revenue is the revenue received by the manufacturer before channel markups.

In-Stat has followed industry convention in segmenting the market for Ethernet LAN switches by speed (Fast Ethernet, Gigabit Ethernet, 10-Gigabit Ethernet), OSI layer (Layer 2, Layer 3, Layer 4–7), as well as by form factor (Fixed vs. Modular).

Fundamentally, Layer 2 (L2) switches forward packets based on media access control (MAC) address information. Layer 3 (L3) switches forward packets based on Internet protocol (IP) address information. Layer 4–7 (L4–7) switches forward packets based on content- and application-specific address information. Please note that recent generations of switches commonly perform L3 or L4–7 “services,” such as quality-of-service (QoS), by looking at higher layer address information, even if they do not forward packets at these higher layers. However, In-Stat only classifies switches by the layer at which they forward packets, not that at which they can perform services.

Fixed configuration switches are comprised of self-contained equipment that may stand alone on a desk, be stacked with other fixed switches, or be rack-mounted in a “wiring-closet environment.” Modular configuration switches are chassis-based equipment, in which switch modules, containing set numbers of differing port types, can be inserted to configure the switch for differing functionality. In this instance, “module” does NOT refer to optical modules, such as small form factor pluggable (SFP) modules, which are small devices that are inserted into empty port slots to allow for optical connectivity in the switch. Generally, fixed configuration switches are less expensive, lower in port density, and are used at the edge of the enterprise network or in smaller network deployments. Modular configuration switches are typically more expensive, offer higher port density, and are used more toward the core of enterprise networks, in large network deployments.

Fixed GE switches account for 36.5% of total worldwide revenues, holding the single largest market share of any switch configuration.

**Table 2. Most Common Switch Configurations by Market**

Market	Wirespeed	Form Factor	Management	Technology	Estimated Market Share
Consumer	FE, GE	Fixed	Unmanaged		9%
SMB	FE, GE	Fixed	Unmanaged, Managed	Layers 2–3	19%
Enterprise	FE, GE, 10GE	Fixed, Modular	Managed	Layers 2–4	31%
Data Center	GE, 10GE	Fixed, Modular	Managed	Layers 2–7	41%

Source: In-Stat, 12/07

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