Power Supplies: A Hidden Opportunity for Energy Savings

Executive Summary

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for

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Introduction

Although nearly all home electronic products and office equipment plug directly into wall outlets and draw 120 volts of alternating current (AC), most of their circuitry is designed to operate at a much lower voltage of direct current (DC). The devices that perform that conversion are called power supplies. Power supplies are located inside of the product (internal) or outside of the product (external). Most external models, often referred to as "wall-packs" or "bricks," use a very energy inefficient design called the linear power supply. Our measurements of linear power supplies confirmed energy efficiencies of 20 to 75%. Most homes have 5 to 10 devices that use external power supplies, such as cordless phones and answering machines.

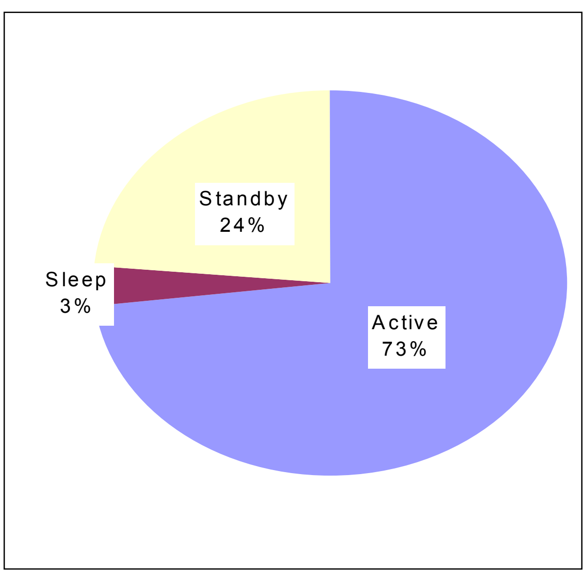
Internal power supplies are more prevalent in devices that have greater power requirements, typically more than 15 watts. Such devices include computers, televisions, office copiers, and stereo components. Most internal power supply models use somewhat more efficient designs called switching or switch-mode power supplies. Our measurements of internal power supplies confirmed energy efficiencies of 50 to 90%, yielding wide variations in power use among similar products. Power supply efficiency levels of 80 to 90% are readily achievable in most internal and external power supplies at modest incremental cost through improved integrated circuits and better designs.

Energy Saving Potential and Environmental Impacts of Improved Power Supplies

Nearly 2.5 billion electrical products containing power supplies are currently in use in the United States, and about 400 to 500 million new power supplies (linear and switching) are sold in the U.S. each year. The total amount of electricity that flows through these power supplies is more than 207 billion kwh/year, or about 6% of the national electric bill. More efficient designs could save an expected 15 to 20% of that energy. Savings of 32 billion kwh/year would cut the annual national energy bill by $2.5 billion, displace the power output of seven large nuclear or coal-fired power plants, and reduce carbon dioxide emissions by more than 24 million tons per year.

The Significance of Active Mode Energy Consumption

Figure 1 – Percentage of Total Energy Consumed in Each Operating Mode



Our research suggests that, on average, about 73% of the total energy passing through power supplies occurs when the products are in active use (Figure 1). Sleep and standby modes, though they account for most of the hours of operation in the majority of products, represent much smaller overall energy use.

Many products like televisions and computers only spend a few hours per day in active mode but consume far more energy during that time than they do in the longer periods spent in sleep and standby modes. This is easy to see in the following table, which summarizes typical energy use in each operating mode for televisions, computers, and monitors.

Product	Active kwh/year	Sleep kwh/year	Standby kwh/year	Total kwh/year
Analog Television	105.1	0.0	33.8	138.9
Office Computer	296.1	18.0	6.6	321.0
Office Monitor (CRT)	291.5	19.4	7.5	318.4

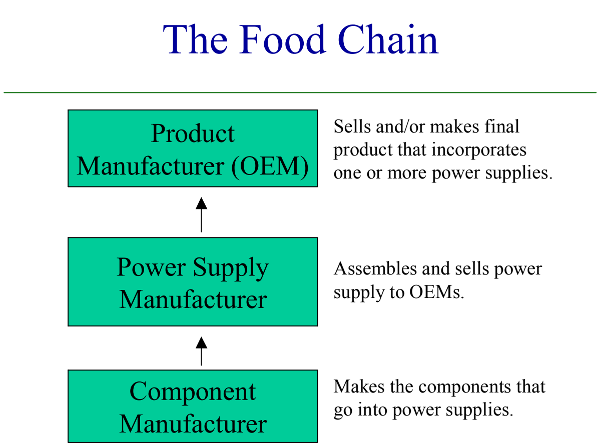
A number of efforts are already underway to reduce standby consumption in power supplies – the power used when the product is turned off or not performing its intended service. NRDC supports these efforts, since standby power use per home is roughly 70 to 125 W and could be greatly reduced through simple design changes. However, many of the technological approaches used to reduce standby power do not automatically improve active mode efficiency – the power used when the product *is* performing its intended service. The most advanced power supply technologies can reduce standby energy consumption, and improve full and partial load efficiency. Given the much larger potential energy savings that can be obtained from the active mode, policy makers and efficiency program designers should move beyond their current focus on sleep and/or standby power usage and add consideration of active mode energy usage as well.

<u>The Power Supply Market – Why Aren't Better Power Supplies Included in Today's Electronics Products?</u>

Our research indicates that the efficiency of most linear power supplies could be improved from the 50 to 60% range to 80% or more. Switching power supply efficiencies could be increased from the 70 to 80% range to roughly 90%. In most cases, the incremental cost for the improved power supply is less than $1. The resulting electricity savings for these products pay for their incremental cost very quickly – typically in 6 months to a year.

Unlike many other energy efficiency technology challenges, the efficient power supplies and the components that go into them are widely available. The need is not to invent a better components or finished power supplies, but simply to encourage the market to utilize the better designs that already exist. This primarily means convincing assemblers of electronic products to specify more efficient power supplies in their product design process, as evident in Figure 2.

Figure 2 – The Power Supply "Food Chain"



The principal challenge is that the purchaser of the power supply is not the one that pays the electric bill. While the consumer pays the electric bill, it is the large companies such as Sony, Hewlett Packard, and Black and Decker that buy the power supplies for use in their TVs, computers, cordless telephones, and portable vacuums and power tools. This is a classic split incentive case where the purchaser, of the power supplies, is not the one that benefits directly from the reduced electricity bills.

To compound the situation, most consumers do not consider the annual energy consumption of a product when they go to purchase one of these products and even if they were so motivated, little to no information is available for them. (Unlike household appliances, there is no Energy Guide label or equivalent for purchasers to use to compare the performance and operating costs of similar products).

Though the energy efficiency benefits of better power supplies are compelling, the non-energy benefits may be even more important to the companies that purchase power supplies for their finished products, the retailers that sell them, and the consumers that buy them. Highly efficient power supplies tend to be smaller, lighter in weight, and more convenient. They operate at cooler temperatures, contain fewer parts, and are likely to result in greater product reliability.

Other product design changes can yield substantial energy savings as well, reducing the need for active ventilation within the product and causing far lower draw on the power supply itself. In fact, efficiency savings on the DC side of a circuit offer an automatic bonus, since each watt saved can yield as much as four watts of savings at the 120 volt AC side of the utility meter when power supplies are only 25% efficient.

The market for power supplies fails to capture these energy savings at present because the products are obscure and their energy efficiency is generally unknown. No clear labeling of efficiency is currently done, and power supplies are often oversized to minimize liability, wasting additional energy when the products operate at part load. The highly competitive electronics industry places a premium on very low manufacturing cost, so even technologies that increase cost by pennies can be rejected as too expensive.

Regulatory Status of Power Supplies

Power supplies themselves are virtually unregulated worldwide from an energy efficiency standpoint. A European "Code of Conduct" addresses only standby power consumption for external power supplies drawing 75 watts or less. In the U.S., there are no utility programs promoting more efficient power supplies. Likewise, voluntary labeling programs like ENERGY STAR for consumer electronics and office equipment currently only address standby and/or sleep mode power consumption. They do not focus specifically on power supply efficiency, and miss the big percentage savings opportunity from active mode in a wide variety of electronic products.

There is considerable activity in the US that is directed at improving the efficiency of products containing power supplies. The EPA has demonstrated a willingness, where appropriate, to address all three operating modes – active, sleep, and off (standby) – in its upcoming ENERGY STAR® product specifications. Through the President's Executive Order on Standby Power Use, most federal government agencies are required to buy products that consume little power in standby mode (1 watt in many products; more in others). Again, this is a great first step, but may not result in any reductions in active mode energy consumption.

Mandatory standards for power supply efficiency are currently under consideration in various proposed Congressional energy bills, though the focus is primarily on standby power use. Likewise, the California Energy Commission is evaluating proposed standards that would improve standby and active mode efficiency for power supplies, though the process is in its early stages and the effective date for such a standard would be many years in the future.

Recommendations

More coordination is warranted between international, federal, and state standards organizations, as well as voluntary industry groups and efficiency program implementers. A wide range of approaches could turn out to be helpful, including utility incentives to overcome higher purchase prices, voluntary or mandatory labeling programs, procurement specifications, and state or federal efficiency standards. It is difficult to pick the most promising approaches this early in the research process, but we offer the following initial recommendations:

- Manufacturers and consumers will benefit greatly from an effort to label power supply efficiency in a clear, standardized way. The current distinction between standby power consumption and active mode efficiency tells only part of the story. Standardized efficiency "curves" that state efficiency across the full range of operating conditions would allow specifiers and procurement officers to readily identify and purchase products that are more efficient overall.

- Voluntary efficiency labeling programs such as ENERGY STAR should account for all energy-consuming modes – active, sleep, and standby – when new specifications are created or older ones are updated for consumer electronics, office equipment, telecommunications products, and appliances. Doing so will increase overall energy savings significantly, since many products consume more energy in active mode than during the longer periods of time when they are not in use. It may make sense to label or regulate power supplies themselves, given their pervasive use in such a diverse array of products.

- Promising end-uses for an early focus on improved power supply efficiency include television sets, computers, and monitors. In most cases, these products have high active power consumption, long hours of operation, or a large percentage opportunity to improve efficiency, with savings accruing across millions of units of annual U.S. sales. We also see compelling opportunities with battery chargers – both the standalone type used for typical consumer battery sizes and the external AC adapters/battery chargers employed by cellular phones and laptop computers. A product-by-product approach is recommended as each one has its own unique supply chains, product requirements, non-energy benefits, and potential solutions.

- Additional research is needed to learn more about the costs and benefits of better power supplies, particularly in high wattage products. In addition, more measurements are needed of when power supplies are operating and how much power they use, particularly in active mode, to better target efficiency programs. A good deal of market research has already been done about current power supply sales and product characteristics, but the reports are proprietary and expensive so should be purchased on a targeted basis.

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