Tomorrow’s LCDs: Porsche performance, Vespa mileage

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Modern LCDs are like imported sports cars. They are sleek. Radiant. Richly colorful. And they aren’t just pleasing to the eye: They’re also fast and responsive. Powerful. They ruin you for older, lesser models.

Given that superb performance, does it seem a little defensive to add that your monitor or television also gets good mileage? Shouldn’t we just shut up and enjoy the ride?

Actually, no.

Because unlike a Ferrari, this year’s top-line LCD is surprisingly affordable. We can all have one. Or more. That’s why the displays are being used in more and bigger televisions, an explosion of smartphones, and new devices—like tablets and handheld gaming consoles—that didn’t exist a few years ago. And because we are using more and more LCDs, for longer and longer times, it is very important that they use as little energy as possible (at least until most of our energy is renewable).

Fortunately, LCDs manufacturers have a remarkable history of driving down energy consumption as relentlessly as they have boosted performance. And there are multiple existing technologies that can provide even better energy use if they are more widely adopted.

Power diet

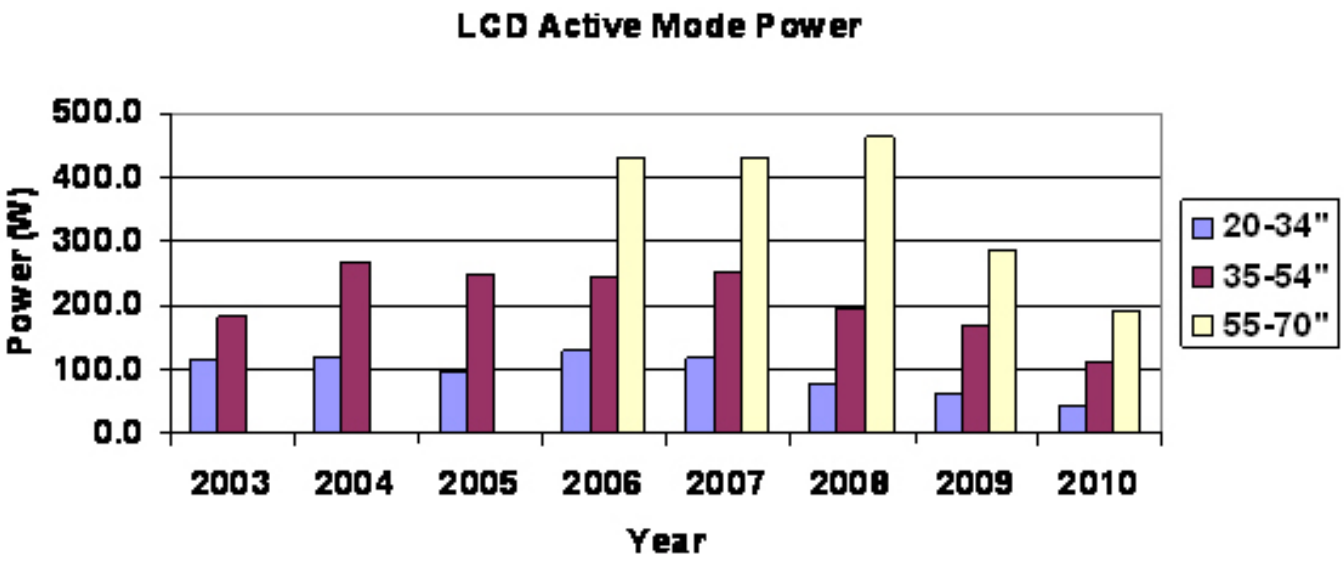
Any power reductions that lie ahead are especially remarkable when one recognizes the great strides in energy efficiency that LCDs have already made in the past decade or so.

Televisions illustrate this point.

According to a study commissioned by the Consumer Electronics Association,

between 2003 and 2010, LCD TVs showed a marked reduction in their power density (the power draw divided by the size of the screen). Over that time, the power density of sets in the Active mode dropped 63 percent, from 0.35 W/in2 to 0.13W/in2.This is the key metric, because Active mode use accounts for approximately 90 percent of a TV's annual energy consumption. Nevertheless, the even greater gain in Standby mode—an impressive 87 percent—is still significant and important.

The reduction in Active mode power density is even more amazing given that it occurred despite a rapid transition to high-definition TVs. Because these screens have more pixels and consequently allow less light through the liquid crystal panel, they require more powerful light sources than earlier, low-resolution TVs.



These very significant reductions in LCD TVs can be traced to several influences, beginning with the release of the Energy Star guidelines in 2008, which set goals and made consumers more aware of the variations in energy efficiency among sets. This established power draw as a market differentiator, which prompted manufacturers to compete on providing better efficiency.

Additionally, a host of technologies then available—and others that followed—allowed manufacturers to meet the 2008 guidelines and the more stringent subsequent guidelines. The CEA report attributes much of the improvement to "advancements in power supply design" and "clever power-management algorithms." In addition, brightness enhancement films (such as highly reflective mirror films, light-concentrating prism films, gain diffusers, and reflective polarizers) have been able to improve backlight power efficiency by more than 50 percent.

Staying hungry

Electronics manufacturers should be proud of this progress, but they cannot relax. It appears that the rapid proliferation of LCDs over the past decade is only the first ripple of a much larger wave of displays—of larger size, with better resolution, in more devices.

Again, televisions are a good example of what to expect. Today, nearly 250 million televisions—the vast majority of them LCDs—are sold worldwide every year. The number of units is expected to increase to more than 290 units by 2014. Because LCD technology allows for large, light-weight and affordable displays, the average size of these many televisions is growing. Between 2010 and 2014, average TV display area is projected to increase from 0.32 m2 to 0.35 m2 diagonal. Finally, the hours of television use—for entertainment, information and gaming—continue to climb, which increases electricity consumption.

Currently, televisions (along with their set-top boxes) use more power than any other consumer electronic device and are the fifth largest consumer of residential energy in U.S. homes (after air-conditioning, lighting, water-heaters, and refrigeration). Globally, televisions used over 250 terawatt-hours (TWh) in 2008. But as televisions become even larger and more pervasive, that power demand is expected to undergo a staggering increase to 800 TWh by 2030.

At the risk of belaboring the point, it should be underscored that is just the anticipated power demand for televisions. Other liquid crystal displays—in smart phones, monitors, laptops and tablets—will add to the electricity needed in the future.

Finding new ways to cut power

Clearly, it would be wise to continue, or ideally accelerate, our gains in energy efficiency. But is it possible for LCDs to continue to make additional progress after the past decade’s dramatic improvements?

Absolutely.

One big improvement is already underway. Since the CEA study, which drew on 2010 data, many LCD devices have moved from cold cathode fluorescent lamps (CCFLs) to light-emitting diodes (LEDs). While there was some early debate over LEDs’ energy efficiency, at least one manufacturer now asserts that some LED displays “use as much as 30 to 50 percent less power than CCFL displays.”

In fact, LEDs could offer even greater efficiency. CCFLs generate from 50 to 70 lumens per watt; LEDs currently give off more than 100 lumens per watt. And while CCFLs appear to have reached a practical upper limit of their potential, researchers believe LEDs can continue to improve their efficiency in the near future. In any case, given the already vast and growing market for LCDs, even a modest gain in efficiency will have a meaningful impact on LCD energy use.

At the same time, manufacturers continue to explore the better power designs and “clever power-management algorithms” noted by CEA.

Tried and true

Surprisingly, the simplest route to dramatically better LCD energy efficiency is also the best known and most trusted. Light management films have been available for two decades and have proven their ability to reduce power. Using just a reflective polarizer can reduce backlight energy consumption by up to 52 percent and overall

device consumption by up to 32 percent. They can also increase the acceptable viewing angle, remove optical artifacts, and improve other performance attributes.Yet more than half of all LCDs don’t use the full complement of these films.

The films improve backlight efficiency in two ways. Gain diffusers and prism films direct the light toward the viewer (so it is not “wasted” by being emitted at angles far above, below, and to the side of the normal viewing position). Highly reflective mirror films and reflective polarizers reduce light absorption. Liquid crystal panels can use only one of two polarization states of light; the reflective polarizer bounces the unused light back to the mirror film through the backlight, and in the process, a portion of this unusable light is converted to the useful polarization state and redirected toward the display.

Light management films have been used in LCDs since the early 1990s, when their ability to reduce power consumption played a role in making early laptop computers practical devices (by allowing them to run longer on a single battery charge). Their moderate penetration is somewhat surprising, but it offers a relatively straightforward opportunity to slash LCD power demands for televisions and other devices.

Power-over-Ethernet

Televisions are crucial but hardly the sole contributors to LCDs’ impact on energy consumption. Other devices play a role and one category—the desktop monitor—presents an opportunity to radically reduce energy use within enterprises and, to a lesser degree, homes.

By combining light management films and power management technologies, at least one major electronics supplier has launched a full-color, high-definition, 18-inch display with enough integrated computing power to communicate with a server, keyboard, and mouse. Because the HP t410 All-in-One Smart Zero Client runs on just 12 watts, it can be powered with the electricity available through a common, powered Ethernet cable.

The implications of this “smart zero client” are striking. As software and data functions become centralized on enterprise servers, such a device could render the desktop PC obsolete. This would slash electrical consumption required for enterprise computing. This power-over-Ethernet configuration would also significantly reduce the heat generated by each user, which would translate into a reduced demand for air-conditioning.

Using what we have

Our electronic devices have become indispensible tools for productivity and communication. They also amaze and entertain us. And their functionality improves continually, at a speed that astonishes even those of us who work in the industry and drive the evolution.

But those of us who work with these devices also know that their popularity is a source of vulnerability. The growth of LCDs and the corresponding growth in energy

consumption is not sustainable.

The good news is that solutions are at our fingertips. Energy efficient LEDs, improved power-management technologies, light management films, and ultra-low-power “smart zero clients” are not theoretical innovations. They are all in the marketplace. We only need to take advantage of them.

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