The Electronics Industry: The Power to Change

"If we all did the things we are capable of doing, we would literally astound ourselves."
–Thomas Edison

by John East, President and CEO, Actel Corporation

If Thomas Edison had known what his initial inventions would spawn, would he be delighted or horrified? The answer is probably a little bit of both. Given the amazing technological innovations over the past 150 years, and the dramatic improvements to our everyday quality of life, Mr. Edison surely would be pleased. However, these technological advances have come at a price. As made famous by Al Gore's *An Inconvenient Truth*, the electronic devices that we use every day are contributing to the greenhouse gases associated with global warming today. So while these electronic innovations are making our world better, they are at the same time posing a very real threat. According to a United Nations report issued in May 2007, the average global temperature will rise by as much as 11°F by the turn of the century, even with an aggressive program aimed at minimizing this rise.

Another recent report from the International Energy Agency in Paris, notes that from 2003 to 2050, the world's population is projected to grow from 6.4 billion people to 9.1 billion, a 42 percent increase. If energy use per person and technology remain the same, total energy use and greenhouse gas emissions will be 42 percent higher in 2050. Thus, today's high-tech community has the opportunity to play a major role in resolving the world's global warming problems with further technological change.

The 1990s brought a proliferation of electronics to our society as the world became increasingly dependent on technology including desktop PCs and a rising variety of portable devices, such as smart phones, portable media players and GPS systems. A significant increase in the demand for power has accompanied this technology growth, and unfortunately most electronic devices are not as energy-efficient as they could be. According to the Climate

Savers Computing Initiative, today's desktop PCs waste nearly half of the power delivered to them, making them a perfect example of the need for low-power offerings.

And, while the size and type of devices we use may change, we remain increasingly dependent on our electronic devices to interact, inform and communicate. Designers of portable, battery-powered equipment are faced with a daunting challenge—how can they continue to satisfy the insatiable consumer demand for smaller, cheaper, feature-rich portable devices with longer battery lives in shrinking market windows? But the challenge goes beyond simply satisfying consumer demand. Unfortunately, the generation of the electricity required to power electronic systems, both large and small, contributes to a surprisingly high proportion of greenhouse gases. How can users stay in touch and informed without destroying the planet in the process? Semiconductor suppliers have the power, if you will, to make key changes that can dramatically improve greenhouse gas emissions caused by the operation of electronics.

Reducing Energy Across the Power Continuum

Power in semiconductor devices takes two basic forms: static and dynamic. Static power is consumed when the part is not doing any useful work, while dynamic power is consumed when the device is actively working. Until recently, dynamic power was the dominant source of power consumption. Once helping to manage the dynamic power problem, device supply voltages (VCC) had scaled downward with process shrinks and subsequent lower system voltages, but the days of continued scaling are gone. Additionally, the physics associated with integrated circuits (ICs) on smaller process geometries have dramatically increased power related to leakage. And, with leakage worsening, static power has begun to dominate the power consumption equation as the biggest concern (Figure 1).

Today, many technology companies are talking about reducing energy usage across the power continuum—from chips to systems—with the goal of helping to protect the environment.

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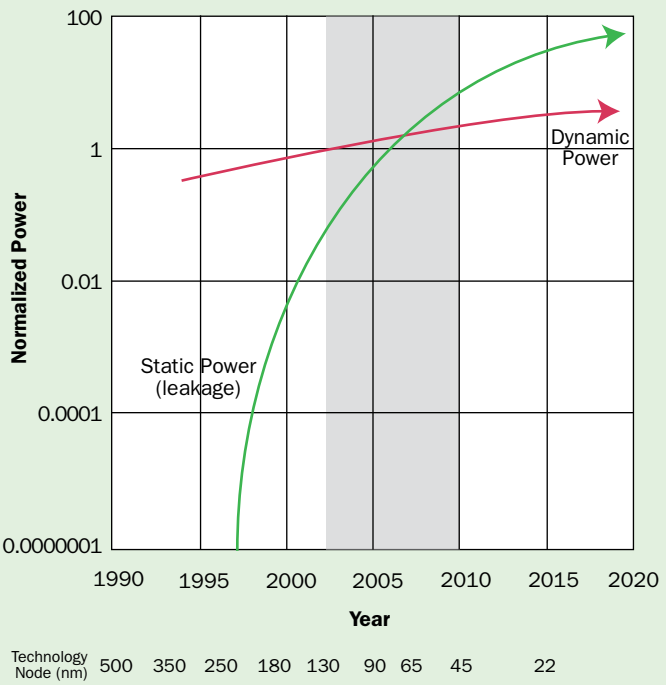
Though environmentally friendly steps have been taken, such as lead-free initiatives and RoHS compliance, the electronics industry has not adequately addressed the power issue. And while the presence of small quantities of lead in electronics devices does indeed present a problem, its scope is minimal compared to the disastrous effects that could come if we fail to control global warming.

From a global perspective, there are many advances underway to combat the greenhouse gases that are a direct result of electronics emissions. Under EU and domestic rules, utilities can charge higher rates for alternative energy through government-mandated prices, which reward companies for building carbon-friendly power plants. Such subsidies have helped Europe build up this industry by providing financial incentives to companies that invest in new technologies. In August 2007, *BusinessWeek* claimed Europe's emphasis on wind power has put it ahead of other regions in the race toward green power.

The 1997 Kyoto Protocol also addresses climate change and assigns mandatory limitations for the reduction of greenhouse gas emissions. As of December 2006, 169 countries and other governmental entities had ratified the agreement. Notable exceptions include the United States and Australia. In Japan, the Japanese Ministry of the Environment has launched a national campaign named "Team 6 Percent"

to help reach the country's Kyoto Protocol objectives. The campaign refers to the effort to reduce greenhouse gas emissions to a level six percent below the level of 1990 through a variety of programs, including setting air-conditioning to higher temperatures, avoiding water waste, choosing and buying eco-friendly products, stopping car idling, eliminating excessive packaging and unplugging devices not being used.

figure 1



Static vs. Dynamic Power by Process Node

As another example, China has created a team led by Premier Wen Jiabao to fulfill its energy conservation and pollution cutting tasks outlined by Greenpeace and the European Renewable Energy Council (EREC) in its Energy Revolution global study. The Premier and his team have set an aggressive goal of cutting energy consumption by 20 percent and pollution emissions by 10 percent by 2010. Additionally, China is becoming more ambitious about the development of wind energy and solar photovoltaic (PV) systems. China has set a target that by 2020, 16 percent of the country's primary energy will come from renewable sources.

In stark contrast, of the total energy consumed in the United States, about 39 percent is used to generate electricity, yet the national average for participation in renewable energy programs is only one percent. In the Silicon Valley alone, data from California's Energy Commission and Department of Transportation suggests that carbon dioxide emissions in 2006 were 5.6 percent above 1990 levels, not 20 percent below them as specified in climate-changing laws like AB 32. From a governmental perspective, programs from the Environmental Protection Agency (EPA) are aimed at cleaner energy sources. And while schools, businesses and consumers are beginning to make efforts to go green, the United States is not doing nearly enough. We, the electronics industry, have the capability to make broad sweeping changes that could dramatically affect our environment.

I believe the U.S. electronics industry needs to make a coordinated attack on power consumption—from chips to systems. While lots of companies are talking about power reduction initiatives, much, much more can be done. The new power paradigm calls for the electronics industry to take responsibility for reducing energy consumption, improving power efficiency and ultimately, reducing greenhouse gasses. The industry can accomplish this starting with the design of ultra-low-power chips and systems through to the development of industry-wide power efficiency guidelines.

For example, no Environmental Protection Agency (EPA) Energy Star guidelines exist for semiconductors to date, even though these semiconductor products directly contribute to the power efficiency and management of Energy Star-rated products. Our industry needs to rally around an approach to benchmarking power efficiency for "low-power" ICs. Well-conceived requirements for semiconductors would enable boards, systems and end products to minimize energy consumption, improve power efficiency and reduce greenhouse gases. If the industry supported such a program, semiconductor manufacturers would be held accountable for designing power-efficient chips. This could make a dramatic difference in greenhouse gases.

Efficiency Changes That Can Be Made Today

There are other immediate things that we, as engineers, in the electronics industry can do. A key area for immediate change is electric motors, which are used in nearly everything from elevators to home appliances. In 2005, the United States consumed 4,055 billion kWh of electrical power. More than 50 percent of this power was used in electric motors, translating into a staggering 2000 billion kWh. Unfortu-

nately, many of the motors currently in use are inefficient and waste a substantial amount of the power they consume.

For example, the efficiency of small AC motors can be as low as 50 percent. While motor efficiency improves to more than 90 percent as motor size increases, there is still opportunity to improve efficiency and reduce energy consumption. By adding intelligent load matching or variable speed control, the power efficiency of electric motors across the full range can be increased. This can be accomplished for a range of motor types at a cost attractive for most applications. In fact, coupled with best practices, this combination can result in motor efficiencies approaching 95 percent and, when implemented broadly, could result in annual reduction in U.S. energy consumption of as much as 300 billion kWh, saving billions of dollars and reducing greenhouse gases by more than 180 million metric tons.

Generally, when designing a system, a power goal is set. Often, however, if the designer "approximately" meets this specification, little additional effort is expended to improve the design, leaving watts on the table. Because electronic systems are sold by the hundreds of millions, a few watts of inefficiency in each system eventually translates into staggering amounts of resources being consumed unnecessarily, which ultimately has a detrimental impact on the environment. Unfortunately, there is usually no easy way to track power down to the individual components or voltage rails, making the job of removing all unnecessary power from devices a difficult task. There is also rarely a way to measure voltages, currents and temperatures when the system is in operation, which complicates the ability to recognize when things are going badly.

The proliferation of new standards, such as Advanced Telecommunications Computer Architecture (ATCA), MicroTCA and Intelligent Platform Management Interface (IPMI), prove that the world needs and wants system enterprise-level power management. These applications require the ability to measure voltages, currents and temperature in real time and recognize problems; the ability to log and communicate this data; and the ability to take corrective action when appropriate. After all, knowing that a power supply is providing more current than it should, or that the board temperature is higher than it should be, is not helpful unless steps can be taken to correct it.

The electronics industry needs to step up, take responsibility and play a leadership role in developing and delivering low-power devices for our changing world.

System management has historically required multichip solutions. With as many as 10-15 extra chips, these designs cost money, consume valuable board space and burn additional power, which means that the "solution" to the problem is not a solution at all. Multichip solutions also require substantial engineering resources, which are often a scarce commodity. And yet, despite these significant costs and the availability of single-chip solutions, the industry has put little effort forth into being smarter about managing and controlling system power.

I believe much can be done with the power-efficient technology available today. The electronics industry needs to step up, take responsibility and play a leadership role in developing and delivering low-power devices for our changing world. It is no longer a choice. It's mandatory.

We as an industry have the power to make dramatic changes. Mr. Edison was definitely right. If the electronics industry did the things we are capable of doing, we would literally *astound ourselves*. ●

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