Eco-engineering: The next great innovation driver for ICs

Reducing hydrocarbon emissions and putting the global community on the course to sustainability is best accomplished with a bottom-up strategy that improves efficiency across all product types

Innovation is the hallmark of semiconductor technology. From the first battery-powered transistor radios and calculators of the 1950s to the all-encompassing digital revolution of the late 20th century, engineers are forever finding new ways to do the impossible with silicon.

There has always been an innovation driver, a particular application or product type that demanded new ways of thinking, communicating and - in the case of ICs - fabricating. Consumer electronics, computers, and communications have taken turns in requiring the quantum leap from today's technology to tomorrow's.

For most of its short lifetime, the semiconductor industry's marching orders have been determined by the consumer's insatiable demand for ICs that were *faster, better, and cheaper*. But beginning in the last decade of the 20th century new consumer themes such as *greener, healthier and smarter* began merging with the old producing a surprising result.

Innovation itself had to change.

With every leap, all that went before was prelude; and never is that more true than with today's great innovation drivers: Green products and eco-engineering. For more than a decade, NXP Semiconductors has not just recognized but also acted upon the importance of eco-engineering with products such as its GreenChip™ family of ICs, which have increased efficiency of computers, LCD TV power supplies and other end-use applications.

More than ever before, this new innovation space demands the seamless merging of the two formerly separate design domains of analog and digital into a mixed-signal domain.

NXP's high-performance mixed-signal (HPMS) fabrication processes, its in-house design expertise in mixed-signal and its vast systems knowledge have ushered in many more innovations. This "Green Paper" tells how NXP is extending and developing its product strategies with the eco-engineering driver top-of-mind. Five areas have been considered: Photovoltaic/solar, smart power/smart grid, power supplies, automotive and lighting.

The innovation ladder

In addition to adding a new dimension to virtually every product type, eco-engineering is also the confluence of much of the innovation that has gone before. Low-power energy technology, high performance computing and wireless communications have at last found perfect synergy: they make eco-engineering possible. But there are other slightly more nuanced aspects of eco-engineering as well, ones that make advanced eco-engineering possible. These technologies meld the digital and analog domains and include high-performance mixed-signal fabrication technology, advanced packaging technology, mixed-signal design expertise, and system-level application knowledge gained over decades of serving multiple industries.

The gathering storm of global environmental issues also makes eco-engineering inevitable.

Although technology of all types has made many people's lives more enjoyable, the degree of technology adoption correlates roughly with a country's adverse effects on global ecology. This relationship is illustrated in Figure 1, which shows historical trends from 1975 to 2003 for many countries and is charted along the nation's ecological footprint on the vertical axis.

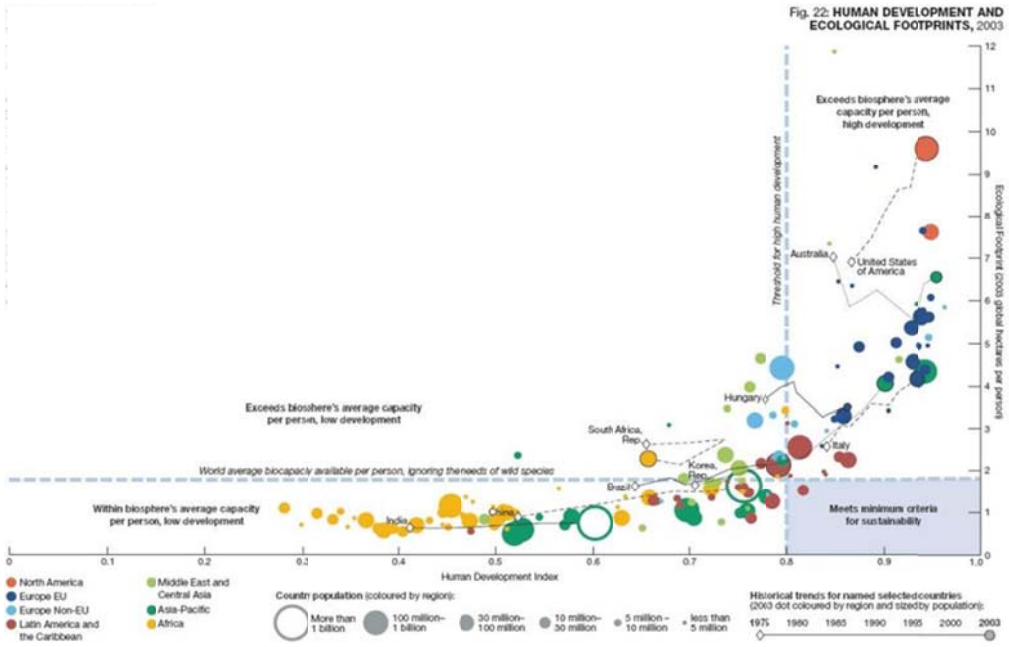

Figure 1. Technologically advanced countries have increasingly large ecological footprints (Source: WWF Living Planet Report 2006)

Consumers are aware of their ecological footprint and its implications and they have been adjusting their buying decisions with societal issues in mind.

Nowhere is this more evident than in the phenomenal success of hybrid and electric vehicles. Manufacturers cannot make them fast enough. According to Global Insight (Hybrids Report 2009), the hybrid car global production was growing over 77% in 2009 and the forecast for 2010 is more than 106% growth.

Consumer preference for energy-efficiency also extends to appliances. Surveys of leading home builders in the U.S., for example, have found that 70 percent of prospective home buyers want energy-efficient appliances.

Governments all over the world are also pushing the environmental movement forward by enacting laws, regulations and energy efficiency goals to reduce carbon emissions and moderate other environmental consequences of energy overuse.

Leaner and greener

Because semiconductors have found their way into virtually all advanced technologies, it is only logical that they can play a vast and effective role in reducing the footprint of technology on the environment.

There are two primary ways to reduce hydrocarbon emissions. Firstly, to produce energy without burning fossil fuels and secondly, to use the energy produced more efficiently. On the energy production side of the coin, renewable energy sources such as photovoltaic and solar systems can drastically reduce the amount of CO_2 created per kilowatt-hour. When it comes to downsizing the massive ecological footprints of industrialized and post-industrial countries, increasing energy efficiency on a global scale is best addressed in end-user applications. This can be accomplished either by hard-coded efficiency improvements such as power supplies or lighting, or, by changing customer behavior as in Smart Grid and Eco-Routing.

Ironically, in both cases, the most formidable player in massive downsizing is the tiniest component – the IC.

How much leverage does the IC have in different applications?

The use of NXP's GreenChip™ technology in power supplies offers an excellent example. Integrating the appropriate member of the GreenChip™ family into a power supply of, for example, a laptop or gaming console, results in typical energy savings of 5 to 10W. However, the leverage calculation is even more impressive because the GreenChip™ itself consumes about 0.5W. That delivers a return-on-investment factor of about 10X to 20X.

"Smart power" has many manifestations, from the smart grid to the smart meter to the smart plug or appliance that saves power by altering its energy consumption to meet real-time demands. The energy saving opportunities available from such a vast installed base of devices is enormous and NXP's smart meter and smart plug product is significant. In buildings, for example, just the ability to have direct feedback from devices connected to the power distribution system can range from 10% to 15%.

In the solar space, the efficiency of photovoltaic systems depends to a large extent on how efficiently the DC power produced by the photovoltaic cells can be converted into AC power used by the grid or other DC values used by DC-loads. NXP's solution can extract up to 30% more power from a solar panel compared to traditional PWM controllers, for example in application like battery chargers.

Similar stories can be told for automobiles and lighting. This Green Paper goes in-depth on all five application areas and describes NXP's competencies, products and activities within each.