

Brainstorm: Do-It-Yourself-Power

Edited by Jason Lomberg

Moving forward, what technology will dominate energy harvesting?

John Perzow, Analog Devices, www.analog.com [1]



Historically, energy efficiency in electronic systems has been largely the problem of power supply designers. Through the 1960's, common linear power supplies delivered energy efficiencies in the range of 40-50%. Through that point in history, however, the electronic content in most sectors was scant by modern standards.

As integrated-circuit-fabrication technologies evolved, OEMs began applying electronic-measurement, -control, -signal-processing, and -data-processing methods to all but a few manufactured products. Meantime SMPS (switched-mode power supply) topologies, multi-stage power subsystems, and distributed power architectures have significantly improved on the historic standard, with typical supplies operating well above 80% and state-of-the art subsystems yielding in excess of 90% efficiency.

As a result, today, even fractional-percent improvements in power-conversion efficiency are noteworthy. Significant improvements focus on further miniaturization and lower cost per Watt.

That is not to say that reducing system-level energy use is no longer possible. A variety of load-side energy-reduction design tactics have emerged as important trends. Three examples illustrate the diversity:

- Improvements in process, device, and circuit designs for analog- and mixed-signal-processing blocks continue to reduce dissipation for given bandwidths, noise, and distortion.
- Functional segmentation and duty cycling reduce quiescent loads without forcing

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an entire chip into sleep mode.

· Energy-recovery and energy-scavenging technologies have emerged to capture small but meaningful amounts of energy from a device's immediate environment. Thermal, mechanical, and electromagnetic sources already power first-generation autonomous devices in industrial and aeronautical monitoring applications.

These and related trends have invited a growing shift in best-in-class product design to include optimizing the energy load for a given functionality and performance. That doesn't leave the power sector with nothing to do. As energy efficiency shifts from supply to demand, distributed power architectures will benefit from greater operational coordination with their loads.

Chris Minter, Components Corp, www.componentscorp.com [2]



As we discuss the impact of energy harvesting technologies and their place in the future, we must consider the current economic and eco-friendly climate of the world today. As many of these technologies present great promise, funding for R & D and substantial monetary investments in equipment to make them cost-effective for broad usage can be prohibitive.

The macro-level energy harvesting techniques currently in the broadest use are wind and solar for both industrial and residential applications, as they generate bulk electric power and the converted electrical energy can be stored for future consumption. These energies are easy to harvest, directly or indirectly, and are cost-effective, sustainable sources. There are few environmental ramifications in the installation of wind turbines or solar panels as they will not result in compromise to delicate ecosystems as can occur when harvesting hydroelectric energy.

As technologies are developing, micro-level energy harvesting will have a great impact on the electronics industry, especially in the area of handheld devices and sensor applications. Micro-level energy is harvested from a number of sources, ie, solar, vibrational, thermal, and biological. At the present these sources of energy seem to be inconsistent.

These ambient energy sources are currently in use for recharging batteries on some hand held devices and are showing promise in the areas and applications for facility lighting and temp control. As advances are made in more efficient harvesting techniques, the battery could be completely replaced. This eco-friendly approach to renewable energy sources could help eliminate the toxic waste from battery

disposal.

This technology is in its infancy, and new design concepts are emerging, incorporating micro-level energy into a number of manufacturing sectors. It will take some time to make this energy-harvesting cost-effective, but as new and broader applications develop, I feel micro-level energy harvesting shows the most promise for the future.

J.F. Debroux, Andrew Glascott-Jones, e2v, www.e2v.com [3]



Considering the main options for energy scavenging—thermoelectric, vibration and photovoltaic—it is clear that the greatest power output can be obtained using photovoltaic sources. Indeed, for large installations, photovoltaic sources will become the obvious choice.

For sensor-ASIC interfaces, however, self-contained systems with short-range wireless communication must also be considered. Examples of these systems include wearable devices and bio-implantable systems.

To that end, industry is studying new developments in thermo-generator devices using the Peltier effect. This is critical, since power outputs of greater than 1mW (with 10–15 degree temperature difference) are available with small generating volumes.

Experts are also studying vibrational sources of energy. An important driver for such systems is cost. In many applications, even where an obvious motion source is available—such as tire-pressure monitoring—it is still cheaper to use a battery. Thus, the potential of low-cost fabrication using MEMS techniques makes vibrational energy harvesters based on this technology very attractive. High capacitance per unit volume is also possible because of the precision of the manufacturing process.

The need for higher voltages and low leakage do pose challenges for the design of these systems, since the generated currents are small. In addition, low-loss power conversion modules are essential.

Of course, the central requirement for these sensor systems is that the power consumption is kept to a minimum. This is an area of expertise for e2v's mixed-signal ASICs division. It produces interface components which operate at microAmp

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levels of supply current and continues to conduct research into low-power, high-performance sensor interfaces.

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A variety of micro power energy harvesting devices and techniques are being introduced to the market. However, harvesting micro-energy is the easy part. The challenge is to efficiently capture and store this energy to power applications. What the industry needs is an ideal energy storage device, one that provides near loss-less energy storage, long life, and sufficient peak current to power wireless radios, microprocessors and sensors. In response to the growing industry and consumer demand for such an ideal storage device, Infinite Power Solutions, Inc. (IPS) has developed a new class of micro-energy storage device which is optimized to store energy harvested from ambient environments.

THINERGY Micro Energy Cells (MEC™) are ultra-thin, flexible, rechargeable, solid-state energy storage cells with unrivaled performance. Operating from -40°C to +85°C (continuous), MECs offer near loss-less energy storage, extremely low self discharge rates, low cell resistance, and high power – truly unique in the world of micro batteries and super-capacitors.

Development engineers across many industries are finding innovative ways to exploit the performance and features offered by THINERGY MECs. Designers no longer need to think in terms of high capacity primary or secondary batteries, as THINERGY MECs deliver incomparable performance in a rechargeable, ultra-thin form factor. For example, when combined with energy harvesting, THINERGY MECs allow wireless sensor nodes to operate for the intended lifetime of the application without maintenance or replacement of the energy storage device. Current users report that THINERGY MECs offer unprecedented charge acceptance and are the ideal solution for harvesting and storing all forms of ambient energy such as solar, thermal, RF, magnetic and vibration energy by efficiently self-regulating and storing the flow of energy, providing a safe, reusable and clean energy source that delivers a lifetime of power to electronic devices and systems.

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