Brainstorm: Power

"What is the power source of the future? Will it change as dramatically as some predict?"

Bruce Rose, CUI Inc, www.cui.com **[1]**

Power sources in the future will be used and developed based upon economic, political, environmental and technological considerations. Changes will be dramatic but evolving over decades; the changes will be both in the sources of power and perhaps more so in the consequences of creating and using that power.

A large percentage of the world population is rapidly increasing in their power requirements due to changing from subsistence living to more affluent life styles. Emerging economies are often willing to pay more for their power because of the greater incremental benefit of the increased power consumption as compared to mature economies. These increased costs include direct costs (facilities, distribution and fuel) and indirect costs (pollution and casualties from producing the power, etc.).

Any single type of power source will have challenges which will prevent it from being universally adopted. Deep water oil wells, tar sands, horizontal drilling and hydraulic fracturing are all more expensive than conventional techniques and sources. Wind and solar power are intermittent in their ability to produce power and presently are heavily subsidized in their production costs. Geothermal sources are limited in regards to where they are located. Nuclear power is facing considerable social and political opposition at the present time. Emerging power sources require development time and large amounts of resources in order to supply a significant amount of the world power demand.

Future power sources will be a combination of advanced conventional and emerging technologies. The world-wide demand for power and the cost of producing that power are both increasing. The primary factor which will determine which power source is employed will be the overall cost of the power relative to the benefit which it provides.

David Norton, TDK-Lambda Americas, www.us.tdk-lambda.com/lp/ **[2]**

It does not require a crystal ball to foresee that changes in power sources will follow recent trends including higher efficiencies, smaller sizes, reduced heat loads and intelligent interfaces. Advances in electronic components and new power topologies have yielded major improvements in conversion efficiencies (AC-DC, DC-DC), facilitated by ultra high operating frequencies that require much smaller magnetic devices (transformers, inductors) and utilize expanded-life capacitive devices, e.g., ceramic capacitors are replacing dry-out-prone electrolytic types. Moreover, high efficiency conversion techniques will reduce and in many cases eliminate the need for failure-prone fans.

Future power sources will integrate more easily with OEM-equipment as packaging techniques evolve (e.g., advanced brick formats). Digital communications between the power sources and the driven electronics will allow the end equipment to minimize the power used as demands vary and even evaluate if the power section has been running too hot, for predictive maintenance scheduling.

As microprocessors evolve into increasingly denser configurations, their drive voltages will continue to reduce, thus necessitating closer couplings of the power section to the processors in order to reduce wasteful voltage drops in the interface cables and etched conductors.

In large internet server arrays the use of “load shedding” where paralleled power sources can be turned On/Off as the network demands vary will play an important part in conserving energy and reducing operational costs.

Patrick Le Fèvre, Ericsson Power Modules, www.ericsson.com **[3]**

Before considering the power source of the future, it is important to consider how energy generated by fossil fuels and/or renewable sources is actually being used today, and how we could make better use of that energy to make a positive contribution in the eradication of poverty. In the United Nations summary document "The Future We Want" published at Rio+20, §128 includes the statement: "We recognize that improving energy efficiency, increasing the share of renewable energy, cleaner and energy-efficient technologies are important for sustainable development, including addressing climate change", and it is energy efficiency and optimization that could be the most important component in the power source of the near- and possibly medium-term future.

Ongoing advanced research promises a bright future for new sources of energy, from cold fusion to bio-energy extracted from algae, and there is no doubt in the century to come that some of these will move from the laboratory into commercial reality. But until then, we need to develop solutions to reduce unnecessary power losses. One practical example already being deployed in the ICT industry is intelligent board power optimization that employs advanced algorithms to optimize and deliver only the energy required to power a specific load condition.

Dynamic energy management is a disruptive technology that will require systems architects to become masters of 'Energy Optimization", and dramatically change the way systems are designed to reduce both the Total Cost of Ownership and CO2 emissions.

Robert Gendron, Vicor, www.vicorpower.com **[4]**

The power sources of the future will most likely derive from multiple renewable sources, depending on the specific end need and geographic location. With all of these various sources, the delivery efficiency of the converted power will continue to remain the highest priority. This efficiency performance isn't solely dependent on the electrical losses in the power transmission and conversion – system size and weight will play an increasingly important role. For example, electric vehicles must not only maximize power from the battery storage, but just as important, also minimize the weight and size of the powertrain.

With efficiency now measured across three metrics (electrical, size, and weight), this places even greater challenges on power harvesting, storage, transmission, and conversion, especially when factoring in emerging off-grid and mobility trends. Power management schemes also need to be further integrated and personalized into our usage habits and lifestyles. The good news is that we are already seeing innovation in battery technologies, materials, conversion architectures, and power management schemes that we are able to utilize today. So as we ponder future power sources we need to consider the end-to-end usage of that power in the most efficient way possible.

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