Mixing Sourcing Technologies to Extend the Operational Life of Ultra-Portable Micro-Scale Electronics

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Abstract: Ultra-portable devices like wireless autonomous sensors can be as ubiquitous as cellular phones, if not more, because, among other things, they can retrofit and convert older macro-scale technologies that are difficult to upgrade and expensive to replace in places like factories, power plants, hospitals, and every-day living spaces into intelligent energy- and power-efficient solutions [1]. The problem is micro-scale dimensions constrain energy and power, and by implication, operational life and functionality. Wireless monitoring sensors, just to cite an example, require both high energy and high power because they must not only sense continuously (as in surveillance applications) but also perform power-consuming functions like wireless transmission of measured and stored information. While individual advances in Li Ions, fuel cells, and harvesters attempt to bridge this technology-application gap, scaling them to micro-scale dimensions presents considerable challenges, especially when considering recharging, maintenance, and conditioning after the fact are more often than not prohibitive in the application spaces targeted. State-of-the-art thin-film Li Ions show promise because they can conform and scale down [2], but their energy densities fall considerably short of their fuel-cell counterparts. Although research in direct-methanol fuel cells (DMFCs) is reaching milli-meter scales [3], power densities remain low. Even if Li Ions were to store more energy and fuel cells were to deliver more power, confined volume space presents a fundamental constraint for energy, which is where harvesters claim their place [4]. The proposed talk introduces the system-level challenges of reaching micro-scale solutions within the context of state-of-the-art technologies and presents strategies that combine the complementary advantages of evolving Li-Ion, fuel-cell, and harvesting technologies, as shown in Fig. 1, to extend operational life to practical levels. The driving idea is to exploit the power-delivery advantages of Li Ion batteries and extend their life by drawing energy from fuel cells and mixing it with ambient energy harvested from the surrounding environment.

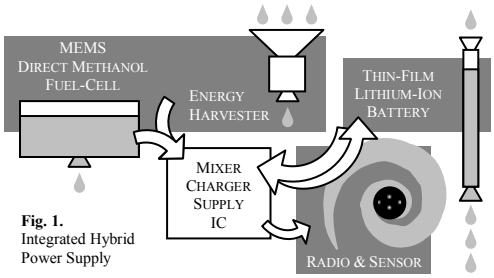

Fig. 1. Integrated Hybrid Power Supply

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[3] C.W. Moore et al., "Microfabricated fuel cells with thin-film silicon dioxide proton exchange membranes," *Journal of the Electrochemical Society*, vol. 51, no. 8, pp. A1606-12, Aug. 2005.

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