Small PEM Fuel Cells (Less Than 1000 Watts)

H. Frank Gibbard and Arthur Kaufman
H Power Corp.
60 Montgomery Street
Belleville, NJ 07109

A typical rule of thumb in the battery industry is that the first commercial application of a new technology comes about 20 years after the first laboratory experiments. By this standard, fuel cells have had an extraordinarily long gestation period since their discovery by Grove in 1839. Considering the potential advantages that fuel cells have over competing technologies, it seems unfortunate that industry has failed, up to now, to make them practical, widely-adopted sources of electric power.

Now a consensus is developing that Proton Exchange Membrane (PEM) fuel cells are within a few of years of mass commercialization for applications that span the range of power from cell phones to buses, and beyond. PEM fuel cells are particularly well suited to meet power requirements below 1 kW, where they may replace small engine-generators because of their greater efficiency and environmental friendliness, and batteries because of their potentially higher specific energy.

This paper reviews the early history of the development of PEM fuel cells and their successful, but limited, application in the U.S. space program; and current initiatives to penetrate niche markets for small fuel cells based on the direct use of hydrogen fuel. Finally, the prospects for the development of Direct Methanol Fuel Cells (DMFC) with extremely attractive specific energy are discussed.

General Electric developed the first practical PEM fuel cells for the Apollo space program in the 1960's. They met the requirements for short missions, but the polystyrene membranes, functionalized with sulfonic acid groups, degraded too quickly for missions over 1-2 weeks. DuPont's Nafion® fluoropolymer membranes provided a quantum jump in lifetime and performance and enabled long-life PEM fuel cells of the type being developed today.

PEM fuel cells have been in use in demanding service conditions, i.e., on the roads and highways of New Jersey, since 1998 (see Fig. 1). Other small fuel cells have shown promise for backup of telecommunication systems and for lighting applications (Figs. 2 and 3), and in powering military applications (Fig. 4).

PEM fuel cells must cross two hurdles on the way to mass commercialization – demonstration of their reliability, and substantial reduction in their cost. A niche-market strategy can overcome both of these issues. Reliability can be demonstrated as PEM fuel cells begin to serve more and more relatively price-insensitive niche markets. Costs will decrease through production experience and economies of scale in serving those niche markets.

Looking to the future, many companies are developing DMFC technology, mainly because of the very large specific energy of the fuel, more than 2000 Wh/kg. Within a few years, DMFC may be able to power consumer electronic devices for much longer operating times than any rechargeable battery system, and refueling these devices may take only a few seconds.

Fig. 1. Solar-Powered Variable Message Sign With Two 50W PEM Fuel Cells For Backup Power

Fig. 2. Rack-Mountable 500W PEM Fuel Cell

Fig. 3. 100W System for Telecom Backup Use

Fig. 4. 50W and 100W Fuel Cells In Military Tests