Relying on Fuel Cells for Emergency Backup Power

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ABSTRACT

Fuel cell technology is rapidly emerging as a viable alternative or adjunct to incumbent battery backup power in telecommunications infrastructures. Over the last several years, telecommunication service providers, in a continual effort to increase network reliability and decrease infrastructure costs, have been evaluating existing prime and backup power solutions for the network. Recent reliability issues surrounding the existing battery plant during power interruptions, life-cycle costs and maintenance have further imposed the urgency of finding a solution in the near term.

INTRODUCTION

During the last decade, several emerging technologies have been considered as replacements for batteries, such as micro-turbines and fuel cells. Offering advantages in the areas of cost, efficiency, and environmental operating conditions, fuel cell technology has emerged as a viable alternative (Table 1). Initially, when first introduced to the market, the fuel cell was offered at a price point that was prohibitive to wide-scale network deployment. In recent years however, the price of the fuel cell has declined dramatically to one that is on par with existing backup power solutions due to advancements in manufacturing, technology and volume production.

Table 1. Cost Comparison of Available Backup Technologies

Technology	*Estimated Cost of 5-kW Plant*
Lead Acid Batteries	$11,000.00-$15,000.00. Estimated replacement of plant at year 5. Does not include monthly maintenance and disposal fees.
Hydrogen Fuel Cells	$15,000.00-$20,000.00 Estimated life of 10 years. Includes maintenance costs.
Micro-Turbine	>$35,000.00, 30-kW system. Requires additional hardware, extended start-up period and primarily used for prime power.
Photovoltaic	>$25,000.00-$40,000. Requires connection to the grid and additional generator or batteries for operation when grid is not available. May require additional real estate for siting of arrays.

FUEL CELL OPERATION

The basic operation of fuel cells is well understood. Fuel cell technology is presently deployed in a wide variety of applications ranging from prime power for industrial systems, buses and space exploration to backup power for critical communications.

A fuel cell is an electrochemical energy conversion device that combines features from batteries and gensets. Like a battery, a fuel cell provides direct current (DC) power, and like a generator, a fuel cell will continue to operate as long as fuel is provided. For fuel cells and generators, runtime, or energy output, is directly proportional to the amount of fuel stored at the site, making both scalable backup power sources in which system operation can be ensured during extended power interruptions. Fuel cells have the added benefits of reduced noise and lighter weight. Additionally, when operated on pure hydrogen, a fuel cell produces energy with clean water as the only byproduct.

A fuel cell's membrane electrode assembly (MEA) consists of two electrodes—a negative electrode (or anode) and a positive electrode (or cathode)—sandwiched around a solid electrolyte (also known as the membrane). Hydrogen is fed to the anode, and oxygen (usually from the air) is fed to the cathode. Activated by a catalyst, hydrogen atoms separate into protons and electrons, which take different paths to the cathode. The electrons flow through an external circuit, creating direct current electricity. The protons migrate through the electrolyte to the cathode, where they reunite with oxygen and the electrons to produce water and heat (Figure 1).

ECONOMIC JUSTIFICATION

To evaluate the economic justification for fuel cell technology over incumbent battery technology, a cost comparison of equivalent power plants is presented for a hypothetical new 5-kW power plant, sufficient to provide 8 hours of backup power at 100 Amps (see Figure 2). Additional savings resulting from preferential customer pricing or volume discounts are not presented in the graph.

Based upon a list price analysis, the initial capital costs of the solutions are relatively equivalent. However, approaching year 5 (the projected end of life for battery plant), ownership costs diverge.

It should be noted that even if the plant does not need replacement at year 5, there may be other compelling reasons for either replacing or supplementing the existing plant with fuel cell technology. To effectively calculate the overall costs of implementing a backup power technology, all intangible costs must also be considered in an economic analysis of

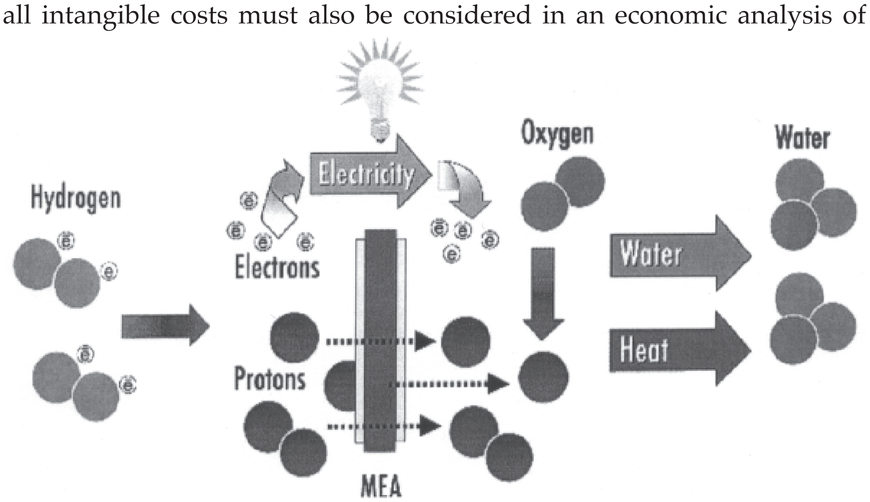

Figure 1. Fuel Cell Operation

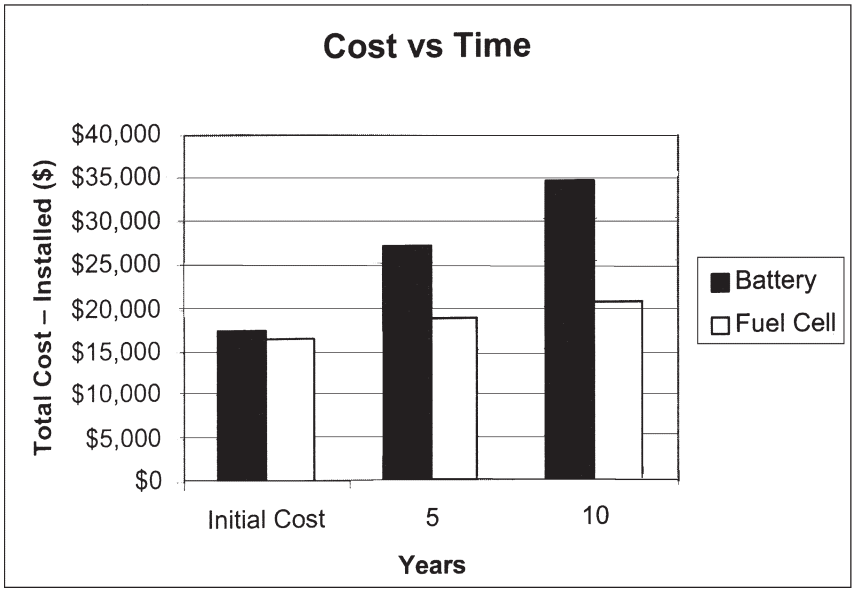

Figure 2. Cost Comparison of New Battery Installation and Fuel Cell Technology

the technologies. The following contributing costs also need to be considered when calculating the overall cost associated with a backup power selection: periodic maintenance, disposal costs, generator relocation and refueling, and personnel callouts during long power interruptions. These costs can be represented by the following equation:

$$C_t = C_i + C_m + C_a + C_c + C_d$$

Where:

C_t = total life-cycle cost

C_i = total initial capital expenditure (product cost and installation)

C_m = estimated periodic maintenance over a 5-year period

C_a = auxiliary power requirements associated with existing technology (costs associated with generator fueling, relocation, and maintenance)

C_c = labor expenditures related to system callouts

C_d = disposal cost at end of life (shipping, de-activation, etc.)

NETWORK CONFIGURATION

When fuel cell technology is implemented, some costs can be dramatically improved by reducing periodic maintenance, generator requirements and subsequent costs associated with personnel providing emergency overtime.

Presently, several configurations are being evaluated for the integration of fuel cell systems into the network. One solution being implemented by several telecom providers is to co-locate both batteries and fuel cell technology in the network, thereby providing extended operation during power interruptions and eliminating the costs associated with generators such as relocation, maintenance and refueling. This schedule of integration allows for immediate cost savings to the user by extending battery service life and, as familiarity with fuel cell reliability is gained, possible elimination of the battery altogether.

Another solution being evaluated by several wireless providers is to potentially eliminate both batteries and generators by relying primarily on the fuel cell for both short and long-term backup power during power outages. The fuel cell is ideal for this type of application because its scalability allows it to be sized for any time duration simply by adjusting the amount of fuel available. The configuration of this integration is shown in Figure 4, and the 10-year life cycle cost of this type of con-

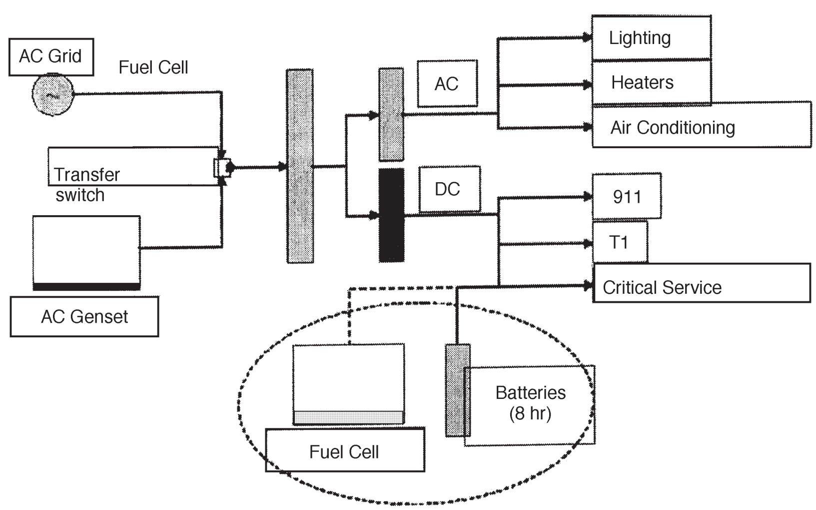

Figure 3. Fuel Cell and Battery in Parallel Configuration

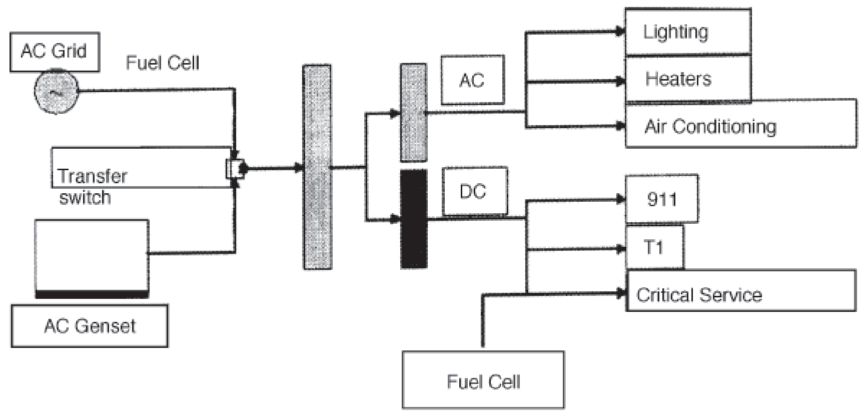

Figure 4. Configuration of Genset/Battery Replacement with Fuel Cell

figuration based on an initial battery plant cost of $11,000.00 and a generator cost of $12,000.00 is illustrated in Figure 5.

CUSTOMER TRACTION

In the U.S., several long-haul and regional telecom providers are known to be evaluating fuel cells as a means of providing backup power for remote equipment in the field (Figure 6). Details are still subject to nondisclosure agreements, but broadly speaking, these trials will simulate a loss of prime power or grid failure several times a week and then assess the response of the fuel cell in providing backup power.

In addition, one of Europe's leading wireless service providers, Orange, has announced publicly that it is evaluating a fuel cell system at a remote base station site in Elgin, Scotland (Figure 7). The site's prime power is supplied by a liquefied petroleum gas generator, while Plug Power's GenCore® system provides the backup power, with enough hydrogen stored to provide 144 hours of power in case of a primary power failure.

SUMMARY

The emergence of hydrogen fuel cell technology as a viable alternative to batteries as emergency backup in a telecommunication plant

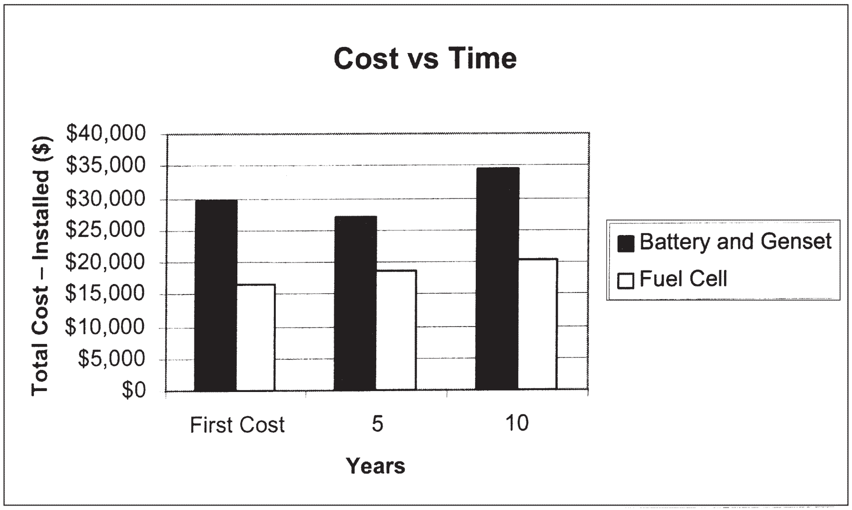

Figure 5. Life-cycle Cost of Genset/Battery Replacement with Fuel Cell

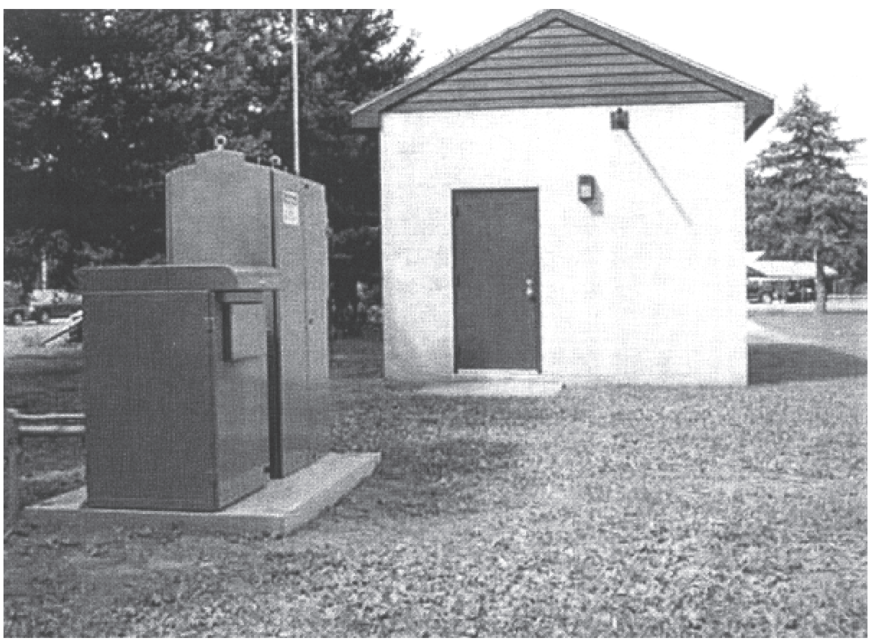

Figure 6. Installation at Oneida Rural Telephone in Holland Patent, NY

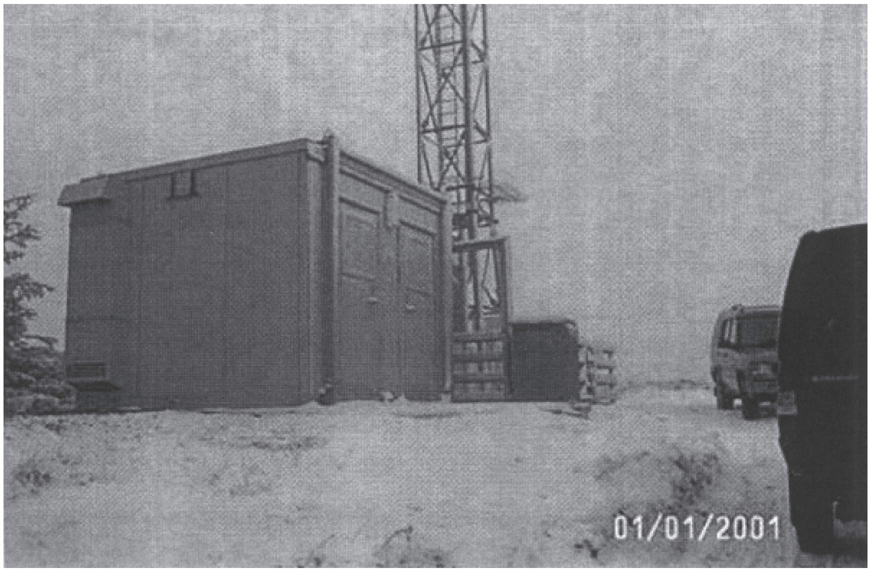

Figure 7. Installation at Orange—Elgin, Scotland

promises to create a radical shift in how communication infrastructures are designed in the future. New and existing high-value data-centric communication infrastructures will soon be powered by clean, quiet, lightweight, reliable energy sources that hold the promise of increasing network reliability and decreasing lifecycle costs. This will lend itself to an increase in overall profitability for network service providers. Future evolution of this technology shows promise for creating a completely grid-independent communication system capable of withstanding any type of power interruption. In addition, a quiet and lightweight power source will greatly expand siting opportunities to benefit both the telecommunications provider and user.

ABOUT THE AUTHOR

Mr. Jim Nerschook joined Plug Power in January 2004 as product marketing manager. He is responsible for all product marketing for GenCore®, Plug Power's backup power system. Mr. Nerschook has over 15 years of experience in product marketing and strategy and has an established proficiency in all aspects of product marketing, including defining market opportunities, product timing and specifications, competitive analysis and support strategies. Prior to joining Plug Power, he worked for NetTest, Inc., where his most recent position was vice president of marketing and research and development. In this capacity, Mr. Nerschook led international marketing and development activities for the test and measurement division and assumed full profit and loss responsibility for the product marketing, marketing communications and research and development departments. Mr. Nerschook received a Bachelor of Science degree in physics from Syracuse University and a Master of Science degree in business management, with a concentration in information systems, from the State University of New York at Binghamton.