Fuel cell systems provide backup power in telecom applications

By Kathy Fosberg – Marketing Communications Manager, IdaTech LLC, Oregon, USA

With wireless communications systems rapidly expanding around the world, there is a critical need for dependable and economical backup power. Cell towers are often sited in remote locations, making regular maintenance costly and emergency servicing extremely difficult. This article explains how fuel cell systems provide reliable backup power that enables wireless networks to remain operational for extended periods of time.

Introduction

Today's telecommunications networks demand backup power solutions that provide highly reliable, cost-effective power for extended periods of time. With an increasing need for reliable backup power at cellular sites, telecom carriers are choosing fuel cells over traditional solutions such as valve-regulated lead-acid (VRLA) batteries and diesel generators.

The type of fuel cell commercially available today and most appropriate for use with telecom sites is the proton-exchange membrane (PEM) fuel cell. These fuel cells are compact, durable, reliable, quiet, and operate at peak efficiency in a wide range of climates (–40°C to +50°C) and adverse weather conditions. In addition, they have few moving parts (thus needing minimal maintenance), come in sizes ranging from 250 W to 250 kW, can readily adjust their electronic output to meet shifting power demands, and offer a high energy density.

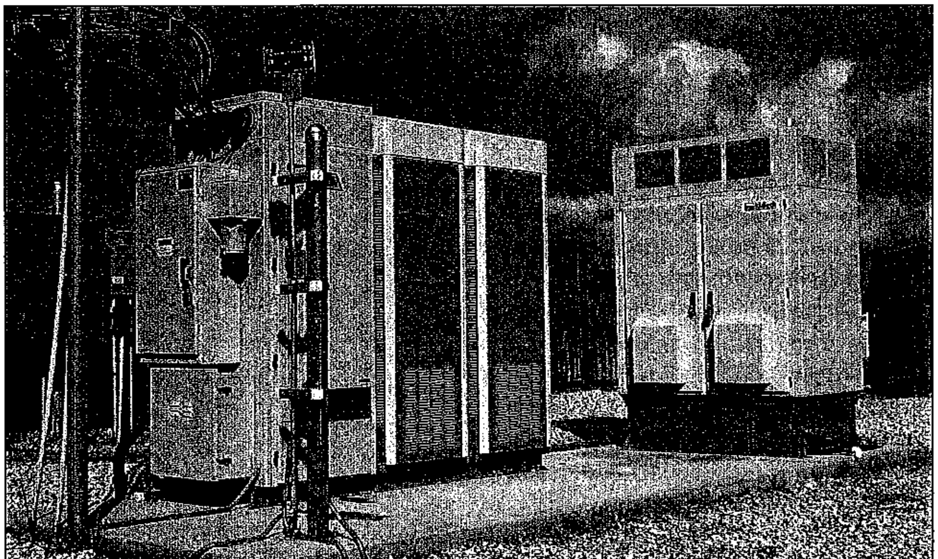

Figure 1. An IdaTech ElectraGen™ XTI installation at a telecom site.

Hydrogen bottles it

Typical backup power fuel cell systems use pressurized bottled hydrogen, which powers the fuel cell stack and produces regulated DC power, as well as clean exhaust and waste heat. Bottled hydrogen is suitable and cost-effective for a range of telecom backup requirements, including 8 hours or less of backup power time, lower power needs, and where convenient access to hydrogen refueling is available.

The typical runtime for one of today's fuel cells operating on six cylinders of hydrogen (where one T-cylinder holds 7392 liters of hydrogen) is 10 hours at 5 kW of output power. For longer runtimes, additional cylinders of hydrogen can be hot-swapped into the hydrogen storage cabinet.

However, there can be limitations as to how much backup power runtime can be achieved by hot-swapping hydrogen cylinders. The runtime can be limited by the amount of space for hydrogen storage at a telecom site and/or the remoteness of a site, which makes hot-swapping of hydrogen cylinders less desirable.

Fuel processing the key

When critical sites require more than 8 hours, or even days of backup power, then a liquid fuel system with a fuel processor can be the more practical and economical solution. Liquid fuel, such as a mixture of methanol and water, provides an attractive alternative to hydrogen gas for powering fuel cell systems.

A fuel processor uses a liquid fuel to make hydrogen onsite and on demand. Fuel processing is the act of converting hydrogen-rich fuels into a pure hydrogen stream as needed, then feeding the pure hydrogen directly into a fuel cell stack. IdaTech, a fuel cell manufacturer based in Bend, Oregon, has developed fuel processors for a variety of common fuels, including methanol (found in windshield washer fluid and other common products).

In the comparison between liquid fuel and hydrogen bottles, 59 gallons of methanol/water fuel mixture used in IdaTech's fuel processor will provide the same amount of power for the same length of time as 30 hydrogen cylinders. In situations where hydrogen storage is difficult because of space and weight restrictions, the liquid fuel combined with IdaTech's industry-leading fuel reformer makes sense.

Fuel processor basics

To create power, the fuel cell system first activates a burner to drive the reaction, followed by fuel vaporization. Within the catalyst tubes, the fuel is broken into hydrogen molecules

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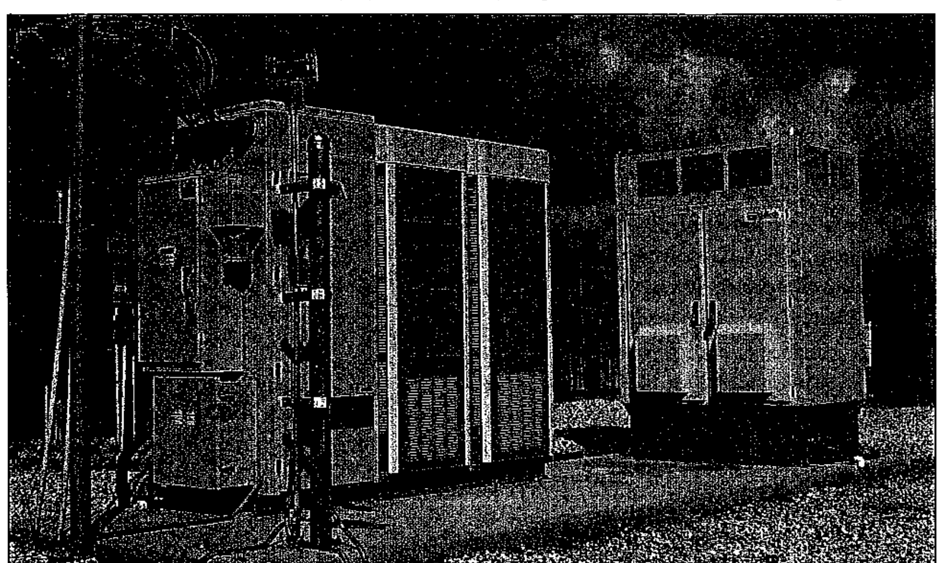

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Fuel processor basics

To create power, the fuel cell system first activates a burner to drive the reaction, followed by fuel vaporization. Within the catalyst tubes, the fuel is broken into hydrogen molecules and other components. From there, the raw reformed fuel (H_2, CO, CO_2 etc.) is purified by the metal membrane, and the waste elements are recycled in a clean, efficient operation, producing >99.9% pure hydrogen. The key differentiator in the fuel processing stages is the method of hydrogen purification.

IdaTech's ElectraGen™ ME backup power PEM fuel cell system includes a fuel reformer module designed to produce hydrogen, onsite and on-demand. This system provides virtually unlimited backup power runtimes, and is ideal for sites where hydrogen storage is not practical, or in remote locations where hydrogen delivery is not feasible.

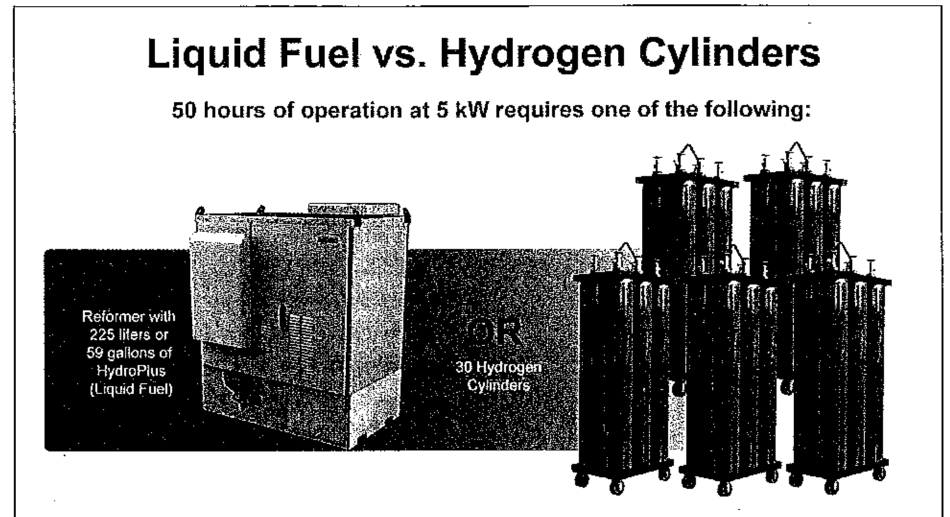

Figure 2. Liquid fuel versus hydrogen cylinders: hydrogen storage can be difficult because of space and weight restrictions.

Reforming methanol

HydroPlus, the fuel used to operate the ElectraGen ME fuel cell system, is an easy to handle fuel mixture of methanol and water. Methanol is a readily available fuel that is currently used in common applications such as windshield washer fluid, engine additives, molded seat cushions, latex paints, clear plastic bottles and silicon sealants, among others. The majority of US methanol production is in Texas, with other plants located in Tennessee and the Midwest.

As a fuel, methanol is beneficial as it is easily transported, water-miscible, biodegrades quickly, and is sulfur-free. Methanol is less flammable than gasoline, and burns with a cool, low particulate flame. The fuel is already used as a transportation fuel.

Case study: Off-grid telecommunications in Wales

Orange UK, the UK's leading wireless and wireline carrier, was tasked with replacing an LPG (liquid petroleum gas) generator at a remote radio transmission and base transceiver station (BTS) off-grid site in a natural park in the Elan Valley in Wales. Although a difficult-to-access remote site, it is essential that the power remains on, as the site supports critical public safety communications.

Orange UK wanted an environmentally sound solution for the off-grid location, with dependability, reliability and seamless transition to power all mandatory elements for the replacement system. Quiet operation was also a goal because of the natural setting.

After a careful selection process, Orange UK chose the IdaTech ElectraGen 5 System and ElectraGen XTR module for an extended-run solution. The 5 kW integrated fuel cell system was installed to work in combination with a 2.5 kW solar panel array and a 2.5 kW wind turbine for a truly hybrid solution. A 1000 Ah battery bank stores the energy generated by the fuel cell, solar array and turbine, and powers telecom equipment located on the site. The outdoor installation incorporates the three renewable energy systems and an integrated stainless steel methanol storage tank.

The ElectraGen 5/ElectraGen XTR solution was selected to reliably recharge the battery string when sun or wind power is not available, to ensure continuous power for the site power requirements through an environmentally friendly energy combination.

The IdaTech solution was an attractive combination to Orange UK, as the ElectraGen 5 fuel cell system is able to provide up to 5 kW of charging power, while the ElectraGen XTR module liquid-fueled reformer enables extended runtimes by producing high-purity hydrogen from a hydrogen-rich liquid fuel. In combination, the two systems remove the need for onsite hydrogen storage, as the hydrogen is created and purified on demand. This is important, as its ability to operate on liquid fuel simplifies fuel delivery logistics.

The ElectraGen XTR module operates on the methanol/water HydroPlus fuel mixture, removing any need for onsite hydrogen storage. This fuel provides a higher energy density and lower siting risk than hydrogen-only solutions. As a liquid, HydroPlus is a more compact fuel,

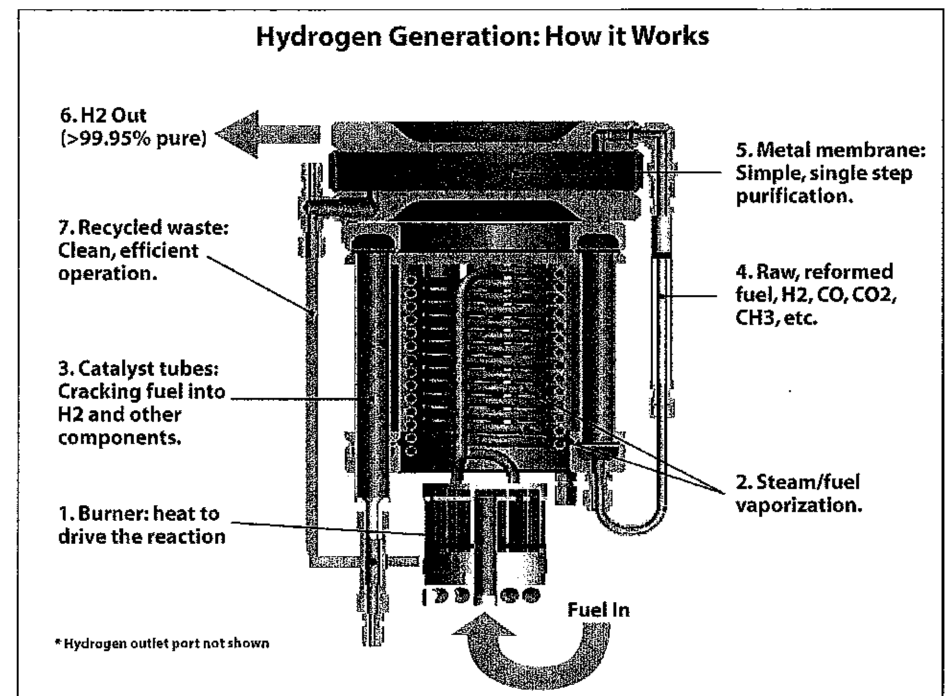

Figure 3. Hydrogen generation in a fuel processor.

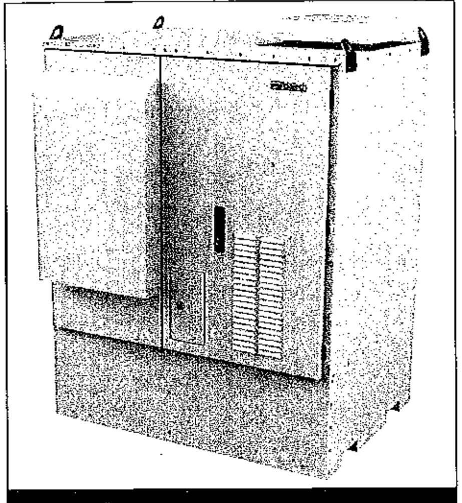

Figure 4. The ElectraGen™ ME fuel cell system is already commercially available for critical and remote telecom backup power applications.

enabling significantly longer power autonomy at the site, which is difficult to achieve with industrial hydrogen cylinders. In addition to the onsite hydrogen generation aspect, the IdaTech extended-run fuel cell solution was chosen for its remote monitoring capabilities through a GSM connection, and its low maintenance requirements.

Case study: Trinidad deploys reformer-based systems

The telecom carrier in Trinidad wants a backup power solution that is environmentally friendly, requires minimal maintenance, and offers a long backup time, in excess of 40 h with one fuel filling. The system footprint is also a major concern, because most sites have very little equipment space left. Some sites are small, while others are exposed to traffic, and therefore system footprint, noise, emissions, and fuel logistics were key deciding factors in choosing a backup power system.

In addition to backing up its wireless infrastructure, the carrier was also looking for a backup power solution for its expanding DLC (digital loop carrier) infrastructure, which delivers phone, TV, broadband and security services to its customers. These expanding services have positioned themselves as the telecom leader in their market.

In September 2009, after comparing leading competitive solutions, Trinidad's telecom carrier selected IdaTech's ElectraGen XTi fuel cell system for commercial deployment, from Precision Power & Air (Caribbean) Ltd, IdaTech's Caribbean partner. In addition to providing the systems, PP&A delivers an end-to-end solution that includes installation, maintenance, refueling, and remote monitoring of the fuel cell systems.

The ElectraGen XTi fuel cell system provides extended-run backup power for several days, not just hours. Its fuel tank holds 59 gallons (220 liters), which allows the system to run for 50 h at 5 kW output power. Refueling with HydroPlus is an easy task, and even simpler when using IdaTech's fuel transfer unit (FTU), which offers a safe and reliable refueling solution for systems deployed in the field.

The deployment of the ElectraGen XTi fuel cell systems on the network has improved network availability, and has been a valuable addition to the network. Precision Power has deployed 59 IdaTech fuel cell systems in the telecom network on the islands of Trinidad and Tobago. This sizable installation confirms the attractive value proposition of fuel cells in this application, and demonstrates the growing trend to support eco-friendly solutions.

When loss of electric power occurs, these systems quickly start providing power without loss of any telecom service. Precision Power continues to provide maintenance, refueling, and fuel cell remote monitoring services, enhancing its value as a full service provider on the islands of Trinidad and Tobago.

Ready for critical telecom backup power

In summary, fuel cell backup power systems have numerous advantages versus traditional stand-alone battery or diesel generators. In addition to those benefits, and combating the 'hydrogen challenge', reformer technology solves hydrogen siting issues, providing virtually unlimited backup power.

The ElectraGen ME fuel cell system is already commercially available for critical and remote telecom applications. IdaTech's fuel cell products for critical backup power are a prime example of the range of solutions that can be addressed today using fuel cell and fuel reforming technology.

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Research Trends

Selected papers from 11th Grove Fuel Cell Symposium (London, UK, September 2009)

J. Power Sources 195(23) 7787–7848
(1 December 2010).
www.sciencedirect.com/science/journal/03787753

Microstructural, electrochemical characteristics in redox cycles for Ni/YSZ SOFC anode

H. Sumi et al.: *J. Electrochem. Soc.* 157(12)
B1747–1752 (December 2010).
DOI: 10.1149/1.3491345

Environmental MRI to investigate water distribution in operating PEMFC membrane

S. Tsushima et al.: *J. Electrochem. Soc.* 157(12)
B1814–1818 (December 2010).
DOI: 10.1149/1.3486168

Effect of ceria coatings on H_2S poisoning of Ni/YSZ SOFC anodes

J.W. Yun et al.: *J. Electrochem. Soc.* 157(12)
B1825–1830 (December 2010).
DOI: 10.1149/1.3499215

Pillar structure membranes suppress HTPEMFC cathodic concentration overvoltage

M. Aizawa et al.: *J. Electrochem. Soc.* 157(12)
B1844–1851 (December 2010).
DOI: 10.1149/1.3502613

Highly flexible, anhydrous Nafion-1,2,3-triazole blend membranes for HTPEMFC

J.-D. Kim et al.: *J. Electrochem. Soc.* 157(12)
B1872–1877 (December 2010).
DOI: 10.1149/1.3503598

$Ce(Mn,Fe)O_2$-$La(Sr)Fe(Mn)O_3$ composite for anode of IT-SOFC with $LaGaO_3$ electrolyte

T.H. Shin et al.: *J. Electrochem. Soc.* 157(12)
B1896–1901 (December 2010).
DOI: 10.1149/1.3500979

Hydrogen fuel cell hybrid scooter with plug-in features

J.L. Shang et al.: *Int. J. Hydrogen Energy* 35(23)
12709–12715 (December 2010).
DOI: 10.1016/j.ijhydene.2010.08.075

Performance degradation, microstructure changes in freeze-thaw cycling of PEMFC MEA