is debatable as lithium batteries, and rechargeable lithium-ion batteries in particular, are extremely complex and can contain a large number of different elements in varying degrees. This relationship is also reflected in the environment labeling requirements specified by Swan, which currently regulates these three heavy metals and, in the case of rechargeable batteries, arsenic.

Rechargeable Batteries are Preferable

Generally speaking, rechargeable batteries are more environment friendly than single-use batteries when used in the same application. This is because the total amount of battery waste will be lower as the same battery can be recharged numerous times, hundreds of times as a rule. Within the group of primary batteries (single use batteries), lithium cells offer an advantage in the form of higher energy density compared to alkaline batteries, which enable a longer operating time. Most primary lithium cells also have a higher cell voltage, which means they need fewer cells to achieved the desired operating voltage in the apparatus. Both of these characteristics help make primary lithium cells appear more advantageous than other primary cells from an environment perspective, as fewer cells are required to achieve the same performance and lifespan. These same arguments can be used in favor of lithium-ion cells, as these have a higher cell voltage than other rechargeable cell types.

Nickel from the Toyota Prius can be Recycled

Recyclability is completely dependent on the availability of efficient collection systems that ensure batteries do not end up in landfill sites and that there are financial incentives to recover the materials found in batteries. Here, traditional chemical batteries (lead, nickel cadmium and nickel metal hydride batteries) are actually at an advantage compared to lithium-ion batteries, as traditional batteries have a higher content of metals that have a second-hand value on the commodities markets. Exhausted lead batteries can be used directly in the manufacture of new lead batteries. Nickel from nickel cadmium and nickel metal hydride batteries is used by the steel industry in the manufacture of stainless steel. However, recycled nickel is not yet of sufficiently high quality to be used in new batteries. Cadmium can also be recovered and recycled in the production of new nickel cadmium batteries.

Toyota has developed a method that enables them to recover nickel from old Prius batteries that can be used in new ones. It will be interesting to follow this development and whether this method can be used for nickel metal hydride batteries of the consumer type.

Spent Cell Content Used in the Construction Industry

Lithium-ion batteries contain relatively small quantities of elements that are financially viable to recover. The large variety of cell chemistries available on the market also makes recycling more difficult. There are recycling processes currently available for lithium-ion batteries that recover cobalt, nickel and copper from battery waste. The residual cell content is combusted and the ash can be used in the construction industry. The trend within lithium-ion technology is moving towards a development characterized by an increased use of materials that are not of interest to recover, such as manganese dioxide, iron phosphate and mixed oxide materials with little or no cobalt in the mix. As a consequence, the cost of collection and recycling of lithium-ion batteries can largely fall on users when the manufacturers attempt to recoup their manufacturer product liabilities.

Heavy Metals in Lithium-Ion Batteries

Although lithium-ion batteries do not contain mercury, cadmium or lead, the content of these batteries does include other heavy metals that can be problematical for the environment. Cobalt, copper and nickel are examples of metals that occur in significant quantities in many cases. There are also a large number of trace element metals that can reach toxic levels if batteries are discarded in sufficiently large quantities in a limited area. To which can be added electrolytes in the form of organic solvents with various different ingredients, such as flame-retardants that can damage the environment if the batteries are not collected and disposed of in a professional way. In this respect, one can also include the original environmental impact of mining the minerals that are used in the cell manufacturing raw materials. Cobalt production in Congo-Kinshasa has been named as a potential problematical process from both an environmental and ethical perspective. It is not out of the question that the fast growing demand for lithium-ion batteries globally within the car industry can lead to the focus falling on other elements and manufacturing processes.

Product Life Cycle Must be Considered

The environmental impacts of batteries is a very complex issue. In order to be able to evaluate and compare different batteries against each other, it is desirable to take the entire life cycle of the product into account: the extraction and refining of the raw materials, cell and battery manufacturing, product lifespan in operation plus waste disposal and recycling processes. Both manufacturers and consumers of battery-powered products should do their utmost to minimize the total number of batteries required during the lifetime of the product in order to minimize its environmental impact. It is also important to persuade users to take batteries to recycling points and to continue work on developing technology that enables as much recycled material as possible to be used.

Intertek's expertise in battery testing and energy storage services ensures products meet performance, reliability and safety criteria. Throughout design, manufacturing and system deployment cycles, Intertek provides evaluations for performance, electrical safety, interoperability, fit for use, component selection and more.

For more information, please visit www.intertek.com/energy-storage or call 800-967-5352.

Green Backup Power Solutions Growing

Fuel Cells Help Telecom Operators Reduce Carbon Footprint

Kathy Fosberg, Marketing Communications Manager
IdaTech LLC

As companies around the world are increasingly focused on reducing their carbon footprints, fuel cell technology is helping mobile network operators meet both sustainability and business goals. Driven by high energy costs, limited access to electricity in many developing countries, increased legislation and market pressure, network operators are more frequently choosing clean technology solutions for their backup power needs over traditional options. Clean and energy efficient fuel cells can help reduce CO_2 emissions by 50 percent as well as decrease other toxic emissions and deliver additional environmental and efficiency benefits, making them more often the first choice for telecom carriers today.

A Clean Alternative

With society's reliance on mobile networks to power smart communications devices, having backup power at base station sites is critical in the event of power loss from severe weather, natural disasters or limited grid capacity.

Traditional telecom backup power solutions include VRLA battery strings for short duration backup, and diesel and propane generators for longer duration backup. Batteries are relatively

Telecom Backup Power Technology Comparison
Fuel Cell Systems vs. Diesel Generator

	ElectraGen H2 System Fuel Cell System with Direct Hydrogen	ElectraGen ME System Fuel Cell System with Methanol-Water Reformer	Diesel Generator
Exhaust Emissions [1,2]			
Nitrogen Oxides (NOx)	0 g/kWh	0.007 g/kWh	7.5 g/kWh
Carbon Monoxide (CO)	0 g/kWh	0.17 g/kWh	8.0 g/kWh
Sulfur Oxides (SOx)	0 g/kWh	0 g/kWh	12.0 g/kWh
Particulate Matter	0 g/kWh	0 g/kWh	0.8 g/kWh
Carbon Dioxide (CO_2)	0 g/kWh	783 g/kWh	1,500 g/kWh
Noise Emissions [3]			
Decibel Rating	Quiet: 52 dB at 1 m	Quiet: 52 dB at 1 m	Loud: 68 dB at 7 m
System Efficiency			
System Efficiency (%)	50%	33%	10-25%
Operational Costs			
Maintenance (visits per year)	1	1	2-4
Theft Costs (fuel, parts)	None	None	Fuel & Parts
Reliability	Fewest Moving Parts	Few Moving Parts	Many Moving Parts

Note 1: ElectraGen™ ME System emissions data from IdaTech *(subject to change)*
Note 2: Diesel generator emissions data from EPA standards for 2007 and newer generators, *EPA Standards of Performance for Stationary Compression Ignition Internal Combustion Engines; Final Rule July 11, 2006*
Note 3: ElectraGen systems operated at 75% power output during noise test

inexpensive for one to two hours of backup power. However, batteries are not ideal for longer duration backup power applications because they can be expensive to maintain, unreliable after aging, temperature sensitive and hazardous to the environment after disposal.

Diesel and propane generators are capable of longer duration backup power. While diesel generators are popular primarily due to their relatively low initial cost; unreliable operation for diesel generators is common, and operating costs are high due to poor efficiency and high service costs. Their environmental impact is significant due to their high emissions, low efficiency and loud operation.

Fuel cells offer improved system reliability, more predictable performance in a broad range of climates and a reliable service life when compared to battery strings and diesel generators.

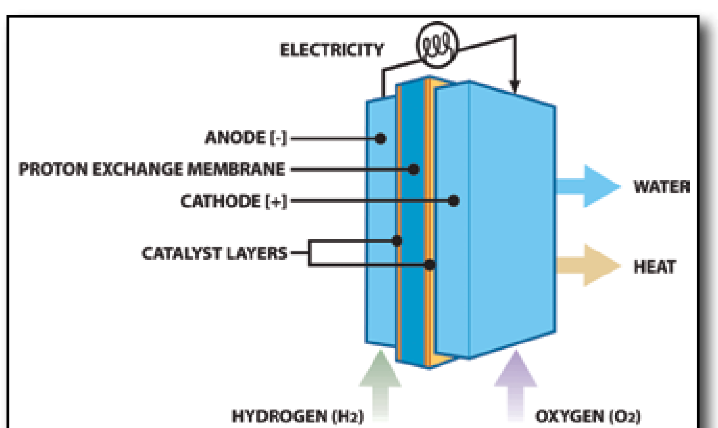
Lower fuel cell operating costs are the result of only one maintenance visit per year and significantly higher system efficiency. Fuel cells also offer environmental and economical advantages to end users because disposal costs and liability risks related to lead acid batteries are an increasing concern. In California, for example, telecom sites with more than 500 pounds of lead acid batteries or one gallon of acid face fees from the state.

How Fuel Cells Work

A fuel cell is a solid-state DC power generator that converts chemical energy into electricity. Hydrogen and oxygen (air) are the two fuels of that reaction. One great appeal of fuel cells is that they generate electricity with zero pollution; hydrogen and oxygen are combined to generate electricity, with water and heat as the only by-products.

The system continuously senses the direct current (DC) bus voltage and seamlessly takes over critical loads if the DC bus falls below a customer-determined set point. The system is fueled by hydrogen, which is delivered to the fuel cell stack in one of two ways: either from a commercial-grade hydrogen supply or a methanol and water liquid fuel, using an integrated reformer system.

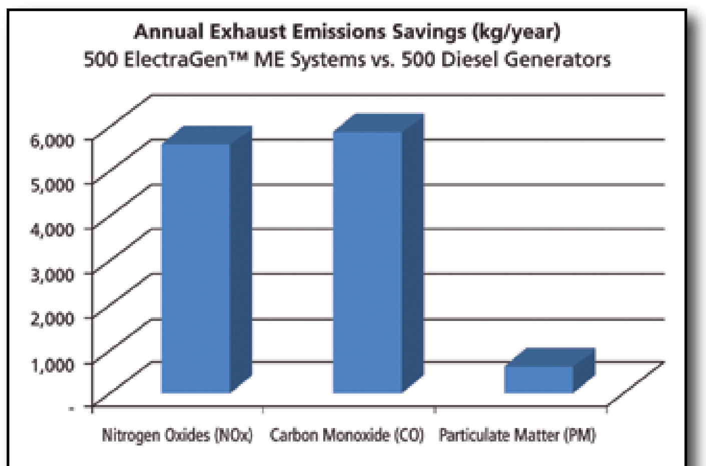
Electricity is generated by the fuel cell stack as direct current. The DC energy is passed to a DC/DC converter, which converts the unregulated DC electricity from the fuel cell stack into high-quality regulated DC electricity to serve the required loads. Fuel cell systems can provide multiple days of backup power since run time is limited only by the amount of hydrogen or methanol-water fuel stored on site.



Eliminating Emissions

Fuel cells can virtually eliminate the two most highly toxic emissions of diesel generators: nitrogen oxides (NOx) and sulphur oxides (SOx), which together are the main causes of acid rain and also contribute to the ozone formation in the air and ground.

Network operators who choose a methanol-water fuel cell system over a traditional diesel generator can realize significant exhaust emissions savings of a 50 percent reduction in CO_2 emissions and more than a 95 percent reduction in CO, nitrogen oxide and sulphur oxide emissions. Unlike methanol, diesel generators also produce particles and un-reacted heavy hydrocarbons.



Increased Efficiency

Fuel cell systems can be more than twice as efficient at producing electricity than internal combustion engines such as diesel and LPG generators. Increased efficiency reduces fuel consumption and lowers operating costs. Furthermore, a more efficient system produces fewer exhaust emissions, lowering the impact on the environment

Fuel cell systems are quieter and have significantly less vibration than diesel generators. Quiet operation is highly valued in areas where people live and sleep and can result in a lower incidence of vandalism.

Other Green Benefits

A fuel cell stack consists of graphite plates and polymers, whereas VRLA batteries include materials harmful to the environment and are difficult to dispose. Fuel cell stacks are recyclable, and refurbished (replacement) fuel cell stacks are available.

Another benefit is that fuel cells require less air conditioning. In tropical environments, telecom cabinets and shelters are typically cooled using traditional AC air-conditioning units. Typical VRLA batteries are required to be maintained at temperatures around 22°C (± 2°C), in order to avoid rapid degradation.

However, most telecom transmission equipment can operate at temperatures up to 35°C to 40°C without any deterioration or performance degradation. By removing batteries from the shelter, a more efficient cabinet cooling method can be used such as DC air-cooling systems.

New-generation DC air-cooling systems offer improved efficiency and performance for telecom sites. Backup power fuel cell systems operate at temperatures up to 46°C and do not require air conditioning. Reducing batteries at a telecom site and adding a fuel cell system will relax the temperature cooling requirements and will lower operating costs.


Photo Courtesy of IdaTech, LLC

Renewable Fuel Possibilities

Fuel cell systems that run on methanol-water can also use a renewable fuel, a combination of bio-methanol and water. Bio-methanol can be produced from synthesis gas, derived from biomass feedstocks, such as wood waste. A fuel cell system powered by a renewable fuel has a very low impact on the environment.

Government rebate programs are available for telecom carriers to buy fuel cell systems at a substantially discounted price. In California, federal and state incentives for implementing a system that uses bio-methanol renewable fuel can potentially offset the entire system purchase price. New Jersey, Oregon and Tennessee also offer state rebate incentives. In addition, all states are eligible for 30 percent federal cash rebate for installing fuel cell systems.

As our society continues to increase its reliance on wireless technologies and also its commitment to protecting the planet, backup power fuel cell systems will present clean technology solutions that lower operating costs, improve network reliability and benefit the environment.

Kathy Fosberg is marketing communications manager at IdaTech, LLC. For more information, please e-mail kfosberg@idatech.com or visit www.idatech.com.