

COMPARING BACKUP POWER OPTIONS FOR COMMUNICATIONS

As the nation has shifted its focus to the importance of reliability, maintenance costs and environmental cleanliness, fuel cells have become a winning option for more and more locations.



Today's fuel cells for
proven, reliable power.

FOUR REASONS COMMUNICATIONS PROFESSIONALS SHOULD CONSIDER FUEL CELLS FOR THEIR NETWORKS:

REASON 1:

Fuel cells are cost-effective

FACT: Fuel cells in communications environments can offer savings of up to 30% on capital cost over diesel generators

REASON 2:

Fuel cells can be easily refueled

FACT: Multiple hydrogen storage and refueling methods make fuel cells easy to refuel for normal or disaster recovery operations

REASON 3:

Fuel cell reliability outstrips that of diesel generators

FACT: Fuel cell reliability is rated at 99.6% compared to diesel generator reliability of up to 88.4%. Which solution do you want to trust your network to?

REASON 4:

Fuel cells win on environmental issues

FACT: No hazardous emissions, low noise, vibration and heat signatures make hydrogen fuel cells a winning solution for many locations, including neighborhoods and national parks.

TODAY'S FUEL CELLS FOR PROVEN, RELIABLE POWER.

After more than a decade of commercial use, Plug Power's hydrogen fuel cell solution, GenSure (formerly known as ReliOn) has gained significant traction with communications professionals in a variety of industries including telecommunications, utility, railroad and government communications.

Communications professionals are currently using fuel cells to provide backup power at more than 6,500 locations in North America alone, with thousands more being used globally. It is clear that fuel cells are a growing solution to the need for reliable energy in locations as diverse as cities, suburbs, rural, off-grid and environmentally-sensitive areas.

Cost-effective hydrogen fuel cells provide zero-emission power without combustion. The by-products are water vapor and heat, making them a clean technology that can be used even in environmentally-sensitive areas. Hydrogen storage and refueling offerings allow the system to run continuously, as long as needed for extended outages. Based on technology available today, customer sites can be provisioned with fuel for days or months of runtime.

Turnkey offerings, like Plug Power's GenKey "power, fuel, serve" model, simplify the transition to hydrogen and fuel cells for communications professionals by allowing them to offload the technical details to experts in the fuel cell industry.

By focusing on the similarities and differences between diesel generators and fuel cells, it is easy to see there are multiple reasons for communications professionals to consider fuel cells for their networks.

REASON 1: FUEL CELLS ARE COST EFFECTIVE

FACT: Fuel cells in communications environments can offer savings of up to 30% over diesel generators.

Traditionally, in addition to being a technology that operators are familiar with, diesel generators have been a lower initial cost power option when compared to fuel cells. However, GenSure solutions have advanced and come down in price. This has happened in parallel with communications equipment increasing in efficiency. The outcome is that, in many scenarios, GenSure fuel cells are less expensive than internal combustion generators



On a lifecycle model, fuel cells offer up to 30% cost savings when compared to combustion generators.

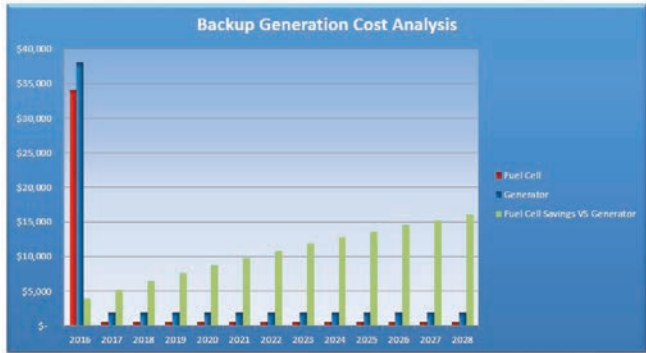
Item	Typical Fuel Cell: 5kW system in Integrated Power Cabinet with fuel storage		Diesel Generator: 20kW with ATS and fuel storage
Capital Cost			
Hardware		\$35,920	\$20,000
Permitting/Installation		\$13,000	\$17,500
Incentives: Federal Tax Credit*		\$14,676	\$0
Total First Cost		\$34,244	\$37,500
Operational Costs			
Annual Maintenance / materials		\$300	\$1,400
Annual fuel & delivery		\$223	\$500
Total Annual Operational Costs		\$523	\$1,900
Cost savings		Immediate	
Cost comparison in year 2		\$34,767	\$39,400
Cost comparison after 5 years		\$36,859	\$47,000
Cost comparison after 10 years		\$39,474	\$56,500
* Federal tax credit is \$3/W or 30% of the installed cost of the fuel cell, whichever is less. In this case, \$3/W * 5kW = \$15,000; 30% of cost is \$14,676.			

Maintenance Costs

Diesel Generator
Generator maintenance consists of a quarterly service call comprised of seven separate system checklists:

- Cooling System
- DC Electrical System
- AC Electrical System
- Air Induction & Exhaust System
- Power Unit
- Lubrication System
- Fuel System

These quarterly maintenance issues, including fuel, cost the customer approximately \$1,900 annually.



Fuel Cell
GenSure fuel cell maintenance call happens once a year and involves inspection of and possible exchange of a standard air filter. This decrease in maintenance is attributable to the simplicity of fuel cell design and the fact that they have very few moving components. Fuel cell maintenance, including fuel, costs the customer about \$525 annually.

REASON 2: FUEL CELLS CAN BE EASILY REFUELED

FACT: Multiple hydrogen storage and refueling methods make fuel cells easy to refuel for normal or disaster recovery operations.

Intrinsic to both fuel cells and diesel generators is the need for fuel in order to operate. Hydrogen is widely available through multiple refueling models.

A fueling network, similar to the diesel “bump truck” model, is available for regular refueling needs as well as top-offs prior to an expected outage event or continual refueling on a schedule during a long term outage. This development has broadened the market for fuel cells to address higher capacity installations and sites requiring extended run times of several days.

A second option is the replacement of empty hydrogen cylinders at a site with full ones. For some more remote locations, this remains the option of choice.

A third option for providing fuel for fuel cells is the fuel reformer. The reformer separates the hydrogen from a hydrogen-rich fuel (bio-methanol, methanol, natural gas, etc.) in order to deliver it to the fuel cell. Because these fuels tend to be liquid, energy density is better than with gaseous hydrogen, allowing for more runtime to be stored on site in a smaller space. However, reformers introduce additional complexity to the fuel cell system and can reduce the reliability of the system as a whole. Hydrocarbon fuels, because they are not simple hydrogen, also emit a small amount of pollutants in the reforming process. The amount of pollutants is much less than those emitted by diesel generators; however, fuel cells running on straight hydrogen emit no pollutants.



HYDROGEN STATISTICS

- About ten million metric tons of hydrogen are produced in the United States annually, enough to power 20-30 million cars or five to eight million homes. (Source: U.S. Energy Information Administration)
- A large hydrogen production site exists today near almost every major U.S. and European city. They are within reach of most major U.S. metropolitan areas, which accounts for roughly 70 percent of the U.S. population. (Source: California Fuel Cell Partnership)
- Hydrogen is used safely today in many different industries: food manufacturing (hydrogenation), food production (ammonia in fertilizer), welding, cryogenics, weather balloons, oil refining, household use as hydrogen peroxide and fuel for transportation & stationary power.
- A Plug Power GenFuel hydrogen refueling into a forklift, industrial vehicle or stationary fuel cell happens every 11 seconds today – that's nearly 9,000 fills each day...and growing (source: Plug Power).

REASON 3: FUEL CELL RELIABILITY OUTSTRIPS THAT OF DIESEL GENERATORS

FACT: Fuel cell reliability is rated at 99.6% compared to diesel generator reliability of up to 88.4%¹. Which solution do you want to trust your network to?

The reason power engineers add backup power to the site design is to increase the reliability of the site, so that the company can continue to provide service to its customers despite events that knock primary power out of service. Thus, the reliability of the backup power equipment is paramount to the goals of the operator.

Diesel generators of the size routinely used at communications outside plant sites have a reliability rating of up to 88.4%¹.

Plug Power's GenSure fuel cells have a reliability rating of 99.63%, arrived at through third party testing in commercial customer environments over the course of three years.

REASON 4: FUEL CELLS WIN ON ENVIRONMENTAL ISSUES

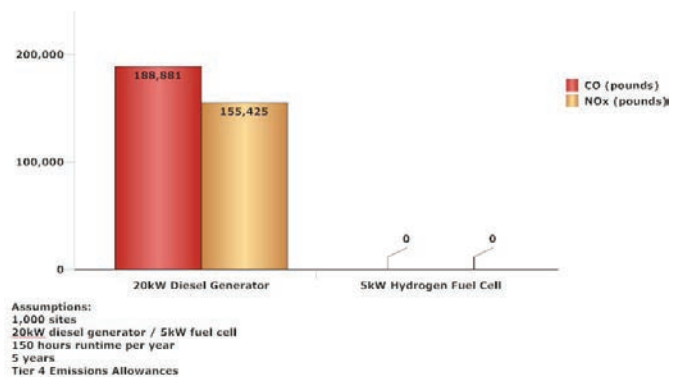
FACT: No hazardous emissions, low noise, vibration and heat signatures make hydrogen fuel cells a winning solution for many locations, including neighborhoods and national parks.

One telecom site using a 25-kilowatt diesel generator, meeting the Environmental Protection Agency's stringent Tier 4 emissions standards, being used for one week of backup power per year emits an incredible amount of pollution — enough pollution to represent 1.35 vehicles driving back and forth to work, activities and vacations for an entire year.

Exhaust

Diesel generators are notorious for their pollutants, whereas hydrogen fuel cells emit none.

Federal guidelines limit the amount of emissions allowed by generators². But even the most stringent Tier 4 standards allow 5.5 grams of carbon monoxide per kilowatt-hour, 4.7 grams of NOx per kilowatt-hour and 0.03 grams of particulate matter per kilowatt-hour. When one extrapolates to 1,000 generators providing 150 hours of runtime per year each for 5 years, the environmental impact becomes very clear.



Comparatively, fuel cells running on hydrogen emit no pollutants. This makes them an ideal solution for locations where air quality is an issue. Hydrogen fuel cell emissions are comprised entirely of a small amount of heat and a little water.

Noise

Sensitivity to noise is dependent on the location of the site needing backup power. Sites located in neighborhoods or locations where people congregate will have a lower threshold than remote sites, though remote locations may also have noise sensitivity due to wildlife and security concerns.

Diesel generators and fuel cells both have ranges of noise levels, depending on the product selected and its configuration. A survey of diesel generator and fuel cell specs shows that the average fuel cell provides about 19% quieter operation than diesel generators. Quiet enough for neighborhoods and national forests.

Toxicity

Fuel toxicity has the potential to add costly cleanup in case of fuel spills. Diesel fuel, being heavier than air, spills directly onto the ground and can lead to significant contamination of the soil if not dealt with promptly. Soil must be excavated and surrounding areas tested for acceptable levels of contaminants.

More extensive measures must be taken if contamination reaches ground water and public water supplies.

Hydrogen does not have these issues. Hydrogen is non-toxic and because it is lighter than air, it disperses quickly if leaked.

HYDROGEN AND FUEL CELLS HAVE BEEN EMBRACED BY COMMUNICATIONS PROVIDERS IN MULTIPLE INDUSTRIES.

After more than a decade of commercial success, hydrogen and GenSure fuel cells have gained significant traction with communications professionals including telecommunications, utility, railroad and government communications.

These forward-thinking leaders have made the strategic, long-term decision to utilize hydrogen fuel cells to power their communications equipment based on the desire to improve business operations through increased reliability, lowered operational costs and reduced greenhouse gas emissions:

SouthernLINC³

Plug Power executed a multi-year contract with SouthernLINC Wireless, a wholly-owned subsidiary of Southern Company, for its GenSure integrated fuel cell solution and GenFuel hydrogen services at up to 500 new LTE sites. Plug Power is providing GenSure integrated backup power fuel cell solutions to SouthernLINC Wireless for use in its wireless network, which supports Southern Company's communication needs and provides a wireless communications network for customers. Southern Company is an Atlanta-based energy company serving 4.4 million customers in the Southeastern United States.

Sprint⁴

Sprint has integrated roughly 500 hydrogen fuel cells to power their network, one of the large pioneering deployments of hydrogen fuel cells in the U.S. wireless industry. Their work with fuel cells began in 2005, when they deployed more than 200 GenSure (ReliOn) fuel cells to wireless network cell sites, largely in hurricane-prone areas like New Orleans, Houston, and Jacksonville, Miami and Tampa, Florida. In 2009, Sprint was awarded a \$7.3 million grant, funding earmarked for fuel cell technology, from the U.S. Department of Energy as part of the American Recovery and Reinvestment Act (ARRA). The purpose of the project was to prove the economic and operational viability of 72-hour fuel cell systems as critical backup power and a clean, renewable alternative to diesel-powered back-up generators.

CSX Railroad⁵

CSX Railroad was the earliest adopter of fuel cells for railroad applications starting in 2009, and today has over 200 GenSure (ReliOn) hydrogen fuel cell systems deployed, including about 150 for backup power at PTC radio base stations, as well as units at numerous signal locations.



AT&T⁶

AT&T has installed GenSure (ReliOn) fuel cells at approximately 450 locations to date and continues to install fuel cells at a number of new locations annually. In 2009, ReliOn was awarded a U.S. Department of Energy grant as part of the American Recovery and Reinvestment Act (ARRA). AT&T, through a partnership with Plug Power (ReliOn), installed fuel cells at 180 locations in ten states within this program.

Pacific Gas & Electric⁷

PG&E has installed fuel cells at more than 25 locations in its California customer territory, including 9 sites partially funded by a U.S. Department of Energy grant as part of the American Recovery and Reinvestment Act (ARRA). PG&E continues to replace end-of-life generators with GenSure fuel cells in order to increase the reliability of its communications network while reducing noise for neighborhoods where it operates.



CONCLUSIONS

Although one can argue that diesel generators have a much longer history of use at telecommunication sites than do fuel cells, growth is based in innovation and change. Analysis shows that GenSure fuel cells are able to provide much more highly reliable backup power at a cost that saves the communications provider money while helping to address sustainability objectives.

The facts cannot be denied:

- Fuel cells ARE a cost-effective solution for the communications industry
- Hydrogen fuel cells CAN be refueled for normal operations and disaster recovery models
- Fuel cells ENABLE predictability and reliability of communications sites during grid outages
- Fuel cells WIN on multiple environmental issues

	GenSure Fuel Cells	Diesel Generators
Cost	Savings of up to 20% on capital cost over diesel generators	Ongoing quarterly maintenance costs hit operations budgets hard
Fuel	Multiple hydrogen storage and refueling methods make fuel cells easy to refuel for normal or disaster recovery operations	A robust diesel fueling infrastructure makes normal operations simple, but disaster recovery may be challenging due to the large demand for diesel
Reliability	99.63%	Up to 88%
Environmental Sustainability	No hazardous emissions, low noise, vibration and heat signatures	High pollution, even with Tier 4 standards, noise, vibration and fuel toxicity

It’s no wonder communications professionals are turning to hydrogen fuel cells for their networks.

GENKEY

GenKey makes the adoption of hydrogen and fuel cell power simple. GenKey takes complexity out of the equation for customers by delivering a complete solution. Plug Power’s GenKey solution for the stationary market links together everything you’ll need for an easy transition:

GENSURE POWER SOLUTIONS

GenSure (formerly called ReliOn) was developed to meet critical customer backup, grid-supplement and off-grid power needs for markets including telecommunications, railroad, utilities and government. The fuel cell solutions provide scalable, clean, cost-effective performance while offering an unparalleled degree of flexibility in addressing the space and runtime constraints of customer locations, with both indoor shelter and outdoor cabinet options. With more than 100 million installed hours of site power protection, GenSure products are field proven.

GENFUEL HYDROGEN STORAGE AND REFUELING

GenFuel hydrogen storage solutions enable customers to house hydrogen fuel on site, maintaining a constant fuel supply as needed for their GenSure fuel cell systems. A variety of storage options are available, providing the ability to scale the hydrogen supply to meet a wide array of runtime requirements. Our tiered response offering allows you to manage both normal refills and disaster recovery models.

GENCARE SERVICES

GenCare provides ongoing service for both GenSure fuel cells and GenFuel hydrogen infrastructure, offering a menu of tiered services on either a comprehensive or a la carte basis. Services include everything from preventive maintenance, health checks and managed spares programs to monitoring, in-the-field service and extended warranty options. Proactive one stop shopping makes it easy to ensure that your GenSure fuel cells are ready to provide optimal power when power is critical and takes you out of the maintenance business.

The GenKey package was developed based on customer feedback and Plug Power’s proven performance. Plug Power acts as a single-source vendor, managing full turnkey implementation: site surveys, site acquisition, power installation & commissioning, fueling and service, so customers can focus on the important work they do on a daily basis.



ABOUT PLUG POWER INC.

The architects of modern hydrogen and fuel cell technology, Plug Power has revolutionized the industry with its simple GenKey solution, elements of which are designed to increase productivity, lower operating costs and reduce carbon footprints in a reliable, cost-effective way. Plug Power's GenKey solution couples together all the necessary elements to power, fuel and service a customer. Plug Power is the partner that customers trust to take their businesses into the future.

For more information about Plug Power or to contact a Plug Power sales representative, visit www.plugpower.com, or contact us at GenSure@plugpower.com

References and Notes

1. Survey of Reliability and Availability Information for Power Distribution, Power Generation and HVAC Components for Commercial, Industrial and Utility Installations, Hale/Arno, IEEE Industrial and Commercial Power Systems Technical Conference, 2005
2. <http://www.dieselnet.com/standards/us/nonroad.php#tier3>
3. <http://www.ir.plugpower.com/profiles/investor/ResLibraryView.asp?ResLibraryID=74560&GoTopage=8&Category=44&BzID=604&G=795>
4. <http://goodworks.sprint.com/planet/climate/renewable-energy/>
5. http://www.progressiverailroading.com/rail_product_news/details/ARMSPlug-Power-GenSure-fuel-cell-solutions-for-PTC-backup-power--48327
6. https://www.hydrogen.energy.gov/pdfs/review12/h2ra006_maxwell_2012_p.pdf
7. https://www.hydrogen.energy.gov/pdfs/review12/h2ra006_maxwell_2012_p.pdf

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