Thirty Days with Jadoo Power

Contributing writer John Liskey recently evaluated a pre-production model of Jadoo Power Systems' N-Gen™ product, a portable power system using hydrogen fuel cell technology.

The fuel cell industry has taken its share of bruises in recent years for hype, missed commercialization dates, pseudo product launches and generally being mired in endless research and development. One needs only to look at the blogs covering portable electronics to see the skepticism. The presumption has been that small fuel cells aren't ready yet for commercialization.

During this same time, Jadoo Power Systems of Folsom, California, has been selling complete fuel cell systems with the belief that fuel cell technology is good enough to begin sales into early markets.

Founded in 2001 by Larry Bawden and Lee Arikara, Jadoo has seen impressive growth, to thirty-seven employees today.

Customers of Jadoo's fuel cell products already include the military as well as government agencies – or as the folks at Jadoo like to put it, three-letter agencies.

In 2004, the company expanded their target markets to include professional broadcast with the NABII™ product. Television stations across the country, including KOVR-TV, the CBS affiliate in Sacramento, are using the NABII™ as a battery alternative offering longer run-time.

In 2006, the NABII™ has been replaced by the next generation N-Gen™, further expanding the marketplace to include first responders, hobbyists, law enforcement and other off-grid power situations.

Jadoo's market-based approach has attracted heavyweights in the venture capital arena, including Mohr Davidow Ventures and Venrock Associates, an early

investor in companies such as Apple and Intel. Other investors include Sinclair Ventures, a subsidiary of Sinclair Broadcast Group, one of the largest television broadcasting companies in the United States.

What's N-Stor™?

Hydrogen in the N-Gen™ portable power system is stored and delivered via the N-Stor™ cartridge. Current offerings include the N-Stor130 and N-Stor360, which hold 130 and 360 watt-hours of energy respectively.

Instead of storing hydrogen in gaseous form, the N-Stor™ uses metal hydrides. Special metal alloys inside the N-Stor™ absorb gaseous hydrogen like a sponge and become a new solid material known as a metal hydride, forming a safe, compact, low-pressure storage medium. Metal hydrides can hold three times more hydrogen than can be stored as a compressed gas in the same space.

At one end, the N-Stor™ has a textured rubber grip for easy handling, while the other end sports Jadoo's proprietary State-of-Fill electronics.

Pressing the Jadoo logo button on the State-of-Fill indicator shows the current level of hydrogen fuel remaining in the canister, expressed in terms of eight bars like those you find on your cell phone.

Besides longer run-time, another advantage of the N-Stor™ is that it offers the end-user predictable power. Unlike batteries, which lose capacity with each recharge, the N-Stor™ can be used repeatedly without degradation.

The N-Stor™ even ships fully fueled with hydrogen so one can use it right out of the box. Jadoo was the first fuel cell company to receive U.S. Department of Transportation approval to transport a hydrogen-based storage system via Air Cargo. They received this exemption in 2004 and it speaks well for the safety of Jadoo's N-Stor™ product. It should be noted that not all metal hydride solutions have this authorization.

The N-Stor™ system and its components passed more than a dozen tests on the way to the DOT exemption, including bonfire testing, bursting to destruction, extreme temperature ranges, drop and crush testing as well as projectile testing.

N-Gen™ - Real fuel cells, right now

To use the N-Stor™, you need a fuel cell. The N-Gen™ is Jadoo's 100 watt fuel cell system in a compact five pound package measuring 4.3" x 4.3" x 7.4".

Like the previous generation NABII™, a standard Gold Mount interface allows use with professional video cameras.

The N-Gen™ offers two major improvements. The first is a 66% improvement in continuous power, to 100 watts from the previous 60 watts. The second is a twelve-volt interface, allowing the N-Gen™ to become more than a power source for professional video cameras. Connect an auto adapter for DC applications or add a DC to AC inverter for appliances that use standard AC power.

Using the N-Gen™ couldn't be any easier. Insert a N-Stor™ into the port and turn it to the right until you hear a click and feel it come to a stop. The N-Gen™ is ready for use. Start-up time is quick, no more than two seconds.

Once the fuel cell has started, the user's interactions with it come via a status LED, LCD display and 3-button user interface.

The LCD display is a geeks paradise, telling you all sorts of things you probably do not need to know.

Without pressing any buttons, the LCD keeps you informed of the current voltage, wattage, fuel left in the N-Stor™ (expressed as a percentage), and the current condition of the fuel cell (usually 'OK').

Pressing the second button on the user interface scrolls you through additional information including liters per minute of hydrogen being consumed, data from the hydrogen sensors, total hydrogen consumed in liters and how long the unit has been running. If you're using the N-Gen™ with a professional video camera, the amount of fuel remaining will also be displayed in the viewfinder.

My N-Gen™ also came with a PowerBase™, a stand for using the N-Gen™ on a desktop or tabletop. It attaches via the Gold Mount interface. The PowerBase™ also allows improved airflow to the fuel cell stack for higher power applications when used on a flat surface.

One of the first things I noticed upon powering up the N-Gen™ is how quiet it is. The noise output ranges from silent at low power levels to soft background noise at higher power.

The fuel cell does make two sounds. The first is the fan, located in the bottom of the unit, which adjusts automatically to optimize running conditions.

The second sound is that of the fuel cell stack purging itself. Purging extends the life of the stack as well as maximizes power output. The fuel cell only purges for a few seconds per hour.

Besides creating electricity, a fuel cell also produces heat and water.

Warm air comes out of the exhaust vents on the front of the unit whenever the fan is on. Although the air is moist, I tried to get it to condense on my hand without success. At higher power levels, you can feel the air up to eight inches from the unit.

The N-Stor™ cartridge gets cool and produces water condensation with prolonged use, but Lake Liskey didn't form under the fuel cell. The condensation stays confined to the surface of the N-Stor™ cartridge and evaporates quickly.

Jadoo's products are full of safety features. The N-Gen™ features over-temperature and over-current protection, while hydrogen sensors monitor for any leakage.

In my endurance testing, I was able to power a 21-watt 12 VDC load for six hours and twenty-eight minutes using the N-Stor130. The N-Gen™ enclosure never gets more than mildly warm and only on one panel of the unit.

The N-Gen™ is also hot swappable, which means you can remove an N-Stor™ fuel cartridge and put another in without disrupting operation of your load. I confirmed this capability using my desktop as the load. I had at least 7 seconds in which to insert another N-Stor™ and in some applications as much as 30 seconds.

The N-Gen™ isn't a hybrid like some other fuel cells, which trickle charge a battery that powers loads. It also doesn't use a battery to handle peak power like some fuel cell systems. Only the fuel cell itself is used in the power production process.

Peer through the air vents on the front of the N-Gen™ or in the N-Stor™ port to see the fuel cell stack. The stack is of the fuel cell type known as a Proton Exchange Membrane (PEM).

Finally, I confirmed that the N-Gen™ will operate in high humidity and is orientation independent. It will function normally either on its side or upside down.

The N-Gen™ is maintenance free. How long the N-Gen™ lasts will depend on how often it is used and how it is used. Jadoo offers a respectable two-year limited warranty on all of their products.

Refueling with the FillOne™

When it is time to refuel, Jadoo couldn't have made it any easier.

The FillOne™ is a new product, allowing the user to refuel one N-Stor™ at a time. It is an attractively compact unit about the same size as the N-Gen™ itself.

One of the things I wasn't looking forward to before receiving my evaluation unit was refueling with hydrogen. I say this because I've seen this done with other systems, and it looks pretty annoying -- purging hydrogen lines, setting the correct pressures and even placing the metal hydride canisters in a bucket of water.

What a pleasant surprise to find that Jadoo has taken all of this out of the end-users hands. A fixed pressure regulator is used with the Jadoo system, meaning no need for the user to have to understand what to set it to. The FillOne™ also self-purges and there is no water involved in refueling. It is easy and no mess.

Refueling is as simple as connecting compressed hydrogen and power (12V or 120V) to the FillOne™, opening the supply valve, and then turning the unit on. It runs through a number of checks and then instructs to put an N-Stor™ cartridge in. The FillOne™ then shows the current percentage the N-Stor™ is filled to and also the time remaining to a complete refill.

In my testing, I found that a complete refill took less than ninety minutes. Jadoo says this will vary depending upon the ambient temperature.

An N-Stor™ can be safely removed at any time although it may be hot. It can also be refilled at any time without memory issues like some batteries. It doesn't need to be fully depleted.

The Jadoo system uses industrial grade hydrogen, available in thousands of locations throughout the United States, including local welding supply stores. One K-bottle of compressed hydrogen will provide about 55 refills.

Jadoo also offers a larger refueling station called the FillPoint™, which can fill four N-Stors at a time in under an hour. The FillPoint™ is actively cooled, allowing for a more rapid refill than the FillOne™.

Comparison to other fuel cells

Making a comparison to some of its competitors, Jadoo's fuel cell system is lighter, smaller, more powerful, cheaper and easier to use -- in part due to the use of hydrogen PEM which offers high power density and uses less platinum catalyst than competing products.

The N-Gen™ is lighter than competing direct methanol fuel cells of the same wattage and offers more power in a smaller footprint.

Other competitors using metal hydrides require placing their hydride canister in a bucket of water. Jadoo does not.

Jadoo also offers the best price per watt of any fuel cell system in its class. In fact, there are twenty-watt systems selling for almost twice the price of the Jadoo system. Five times the power for half the price is a no-brainer. You can even find fuel cell stacks of the same power minus any balance of plant or hydrogen storage that cost almost as much as Jadoo's complete system.

Summary

For thirty days I powered all sorts of things with the N-Gen™: various fans, corded electric screwdrivers, HEPA air purifiers, a passport camera, fax machine, point of sale credit card terminal, electric air freshener, food mixer, Norelco™ razor, Linksys™ router, one acre bug zapper, cable modem, light bulbs, electric flashlight, Panasonic VCR, Canon bubble jet printer, GameCube™, Playstation II™ and more.

These may or may not be the typical things one would use the product for, but my point is that Jadoo has done what they set out to do -- expand the useful applications by adding a twelve volt connection and more power with the N-Gen™.

The N-Gen™ not only powers laptops, I found it was also able to power my older Dell Dimension desktop. I even used it to power the FillOne™ during a refueling.

If there's one wish I have for the N-Gen™, I'd like to see a handle on it for carrying purposes.

I came away with more respect for metal hydride storage than I probably had going into my field trial. The rap against metal hydride has always been that it is heavy, but for smaller portable systems I think it works well.

While Jadoo is committed to metal hydride storage for now, the company hasn't locked themselves into anything. In February, Jadoo signed a strategic development and licensing agreement with Millennium Cell. Jadoo is evaluating Millennium Cell's chemical hydride storage technology, which stores hydrogen in sodium borohydride, for future products and applications.

Jadoo Power Systems is an exciting and ambitious young company. They're leading the way to lower priced fuel cell systems that offer better value. They were the first to get a DOT exemption to transport hydrogen-based storage systems via air cargo and the first to sell fuel cell systems direct from their website. With this article, they were the first to make a pre-production unit available for an independent, hands-on review for the public.

Perhaps best of all, these fuel cell systems are for sale now. Jadoo has earned respect along the way with an under-promise and over-deliver approach which some in the industry could learn from.

When the history of small fuel cells is written, Jadoo Power Systems will be counted among the earliest success stories. However, industry bird watchers shouldn't just look to the past or present. They would be well advised to keep an eye on the future of this trailblazer.

On the web: www.jadoopower.com

About the Author

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