



# FIREFLY ENERGY: A New Look at Lead-Acid Chemistry

By Lynn Valastyan, senior editor

Firefly Energy was launched May 1, 2003, as a spin-out from Caterpillar, a worldwide leader in construction, transportation, mining, forestry, energy, logistics, electronics, financing and electric power generation.

Firefly's mission? To create the next generation of lead-acid battery technology based on material sciences innovation discovered by Caterpillar.

Read on for more on this exciting BCI member company.

**The Battery Man Magazine (BMM):** What was happening at Caterpillar that led to the formation of Firefly Energy?

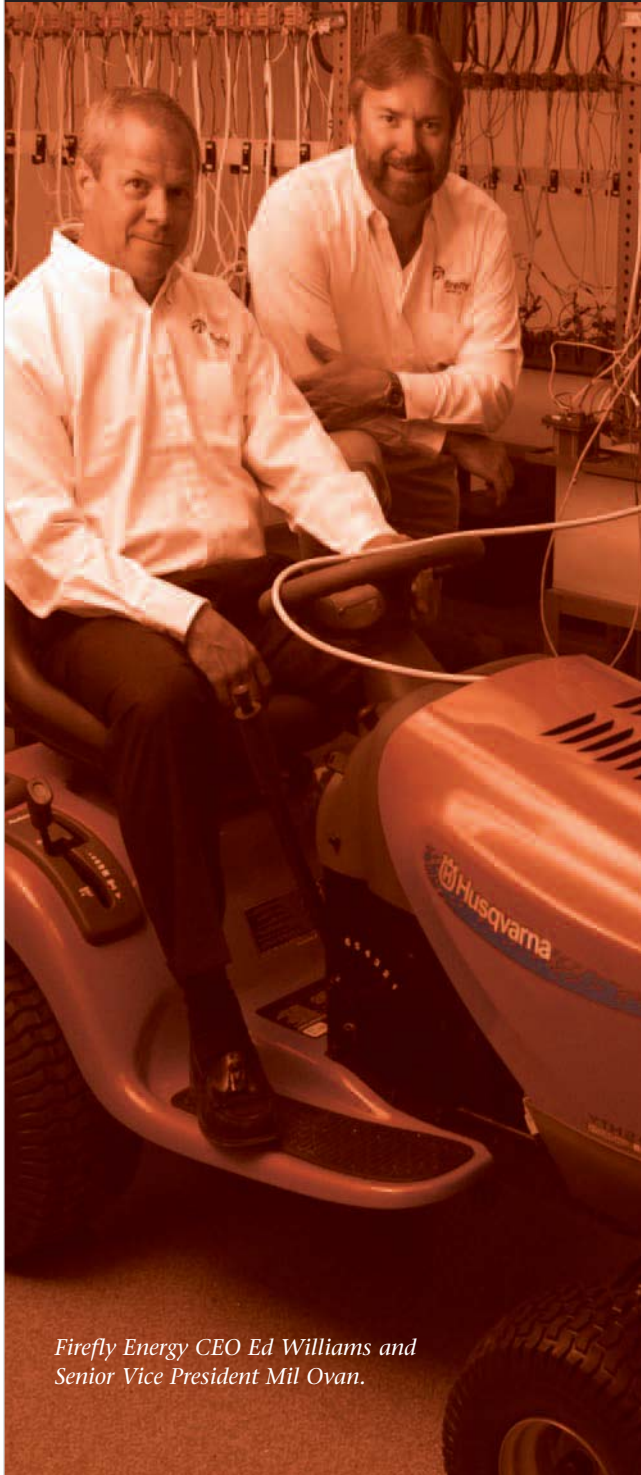
**Mil Ovan (MO):** Firefly Energy and its technology were created and discovered by Caterpillar, Inc., as part of its \$900 million per year research and development operations.

Caterpillar has long been a consumer of batteries for its various heavy equipment products and applies significant research effort into specifying batteries that will tolerate the severe environments that CAT products endure, such as cold and heat extremes, tremendous vibration and frequent/infrequent use.

By 2001, finding that they weren't getting sufficient solutions from the existing lead-acid battery industry, CAT Electronics turned the problem over to Caterpillar's research and development arm to determine ways to improve battery performance commensurate with their customers' expectations. Kurt Kelley, now Firefly Energy's chief scientist, was given the task of how to address the main failure modes of a lead-acid battery: short life caused by *corrosion* (of the battery's positive plate) and *sulfation* (of the battery's negative plate).

Kelley began taking apart Caterpillar's lead-acid batteries and observed how and where the lead plates within these batteries were failing. Following this, his initial pursuit was to prevent corrosion of today's lead grids by applying a specialized coating. In researching prior attempts at coatings by battery companies, he found that these approaches failed, because the active materials applied to the lead grids would prematurely shed, or the electrical resistivity of the grid would increase. By using a new coating material, independent tests showed that these new, coated grids retained the active material from shedding, increased corrosion resistance by at least 40 percent and slowed down the gassing rate of the electrolyte substantially. We call this our Rainbow Grid coating technology.

The second Firefly Energy technology is our Advanced Battery, comprising the application of a lightweight porous composite



Firefly Energy CEO Ed Williams and Senior Vice President Mil Ovan.

material to replace the lead plates in lead-acid batteries. Consequently the technology can eventually remove approximately 70 percent of the lead from a traditional lead-acid battery design but still execute lead-acid chemistry for energy storage. This delivers a formidable jump in specific power, energy and cycle life, delivering a performance very similar to advanced battery materials but can be built for one fifth the cost of advanced material batteries such as nickel metal hydride and lithium.

Similar to the evolutionary Rainbow Grid technology, this product can be both manufactured and recycled within the existing lead-acid battery domestic manufacturing infrastructure that currently exists in the United States. Most advanced material batteries (lithium and nickel) are currently manufactured offshore.

**BMM:** Please provide a recap of company activities—both challenges and successes—since the May 2003 formation.

**MO:** Since formation, Firefly Energy has cumulatively raised \$7 million in private equity from both a seed round and Series A round and has attracted the investment from some of the world's leading corporations, such as Caterpillar, Inc. (\$30 billion revenues), BAE Systems (\$20 billion revenues) and Electrolux (\$16 billion revenues). Further investment has come from venture capital sources, such as KB Partners (\$100 million fund) and the State of Illinois' Illinois Finance Authority. These funds are being utilized to expand research and development, further perfect the core technologies and establish initial manufacturing partnerships.

Firefly has experienced success on both the Rainbow Grid and Advanced Battery technologies. We were told when we started the company that getting the battery companies to adopt our technology would be the chief challenge. However, we're finding a great reception from the industry. Currently Firefly Energy has five leading U.S. battery companies executing tests of the Rainbow Grid. At the conclusion of these tests, we'll enter into licensing discussions. On the Advanced Battery, Firefly has brought in independent

experts from around the world under non-disclosure to assess the potential of this novel technology. The results have led to investment from the global leading companies cited earlier. Also one independent expert, Dr. Robert Nelson, founder of the Advanced Lead Acid Battery Consortium, has joined our company heading up product development!

**BMM:** Let's talk a bit more about the need for Firefly technology innovations.

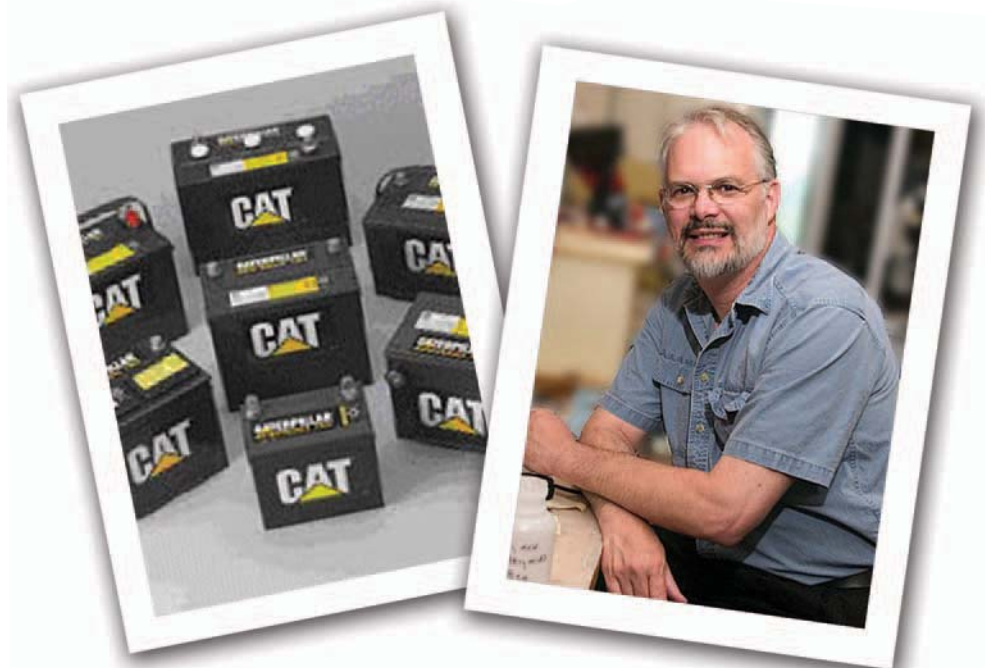
**MO:** Over the past 20 years the domestic (U.S.) lead-acid battery industry has produced minor improvements in performance; hence many battery companies have been starved of major technological innovation based on the commodity nature of these markets. Coupled with worldwide industry consolidation, the people, ideas and talent have been either driven out of the battery industry or forced to exclusively address cost of production issues.

Today, improvements in battery current collector (i.e., grid) design and advances in lead-alloys appear to be reaching a plateau. Research alloys may contain as many as six alloying elements. The battery industry is working in obscure cor-

ners of the periodic table to find alloying elements that will help stabilize current collector behavior. Without the development and insertion of new materials and processes, the lead-acid industry gains appear to be approaching the limits for electrode thickness, alloy corrosion rates and active material pellet structures.

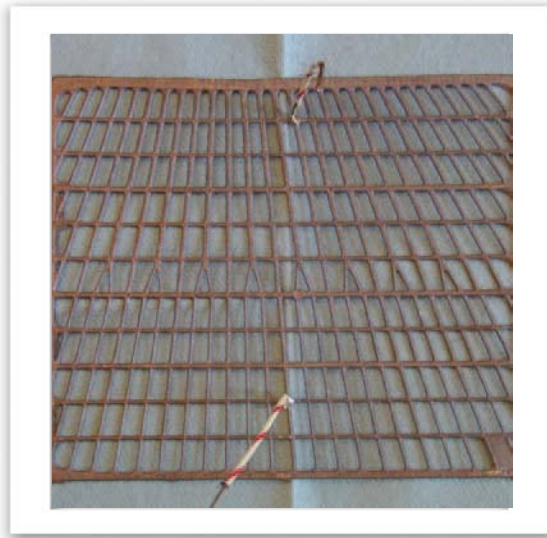
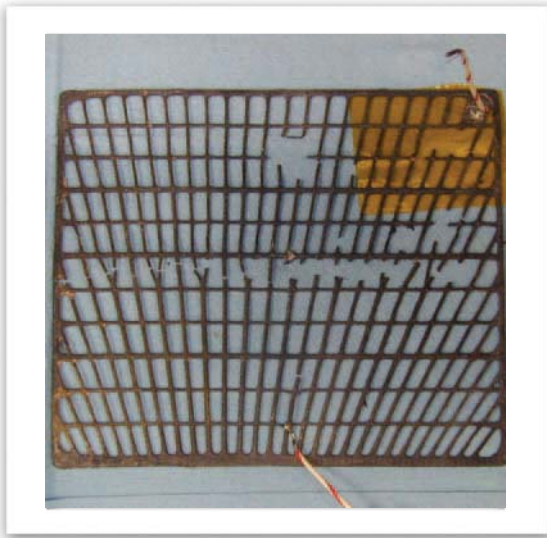
Secondly, this industry and the traditional chemistry of lead-acid for energy storage has been challenged by newer materials (nickel metal hydride and lithium) over the past 10 years, which in many portable product situations are offering greater performance for innovative industrial and consumer product introductions. However, scaling up these advanced materials batteries beyond portable applications has a cost and price penalty of five to 10 times the current cost of lead-acid battery production and are mostly supplied by offshore manufacturing.

This lack of product innovation has saddled the domestic lead-acid battery industry and its customers for years, limiting profitability of the manufacturers and their customers' introductions of advanced products. At the core are the limitations of the industry's lead-acid



*Firefly Energy was formed after Kurt Kelley, then part of Caterpillar's research and development arm, successfully discovered ways to improve battery performance commensurate with their customers' expectations.*

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*Uncoated grid (left) and coated grid (right). Independent tests showed that applying Rainbow Grid coating retained the active material from shedding, increased corrosion resistance by at least 40 percent and slowed down the gassing rate of the electrolyte substantially.*

battery products. To make an advance in battery technology that goes beyond evolutionary engineering improvements requires a paradigm shift to new materials and/or new processes. Firefly's approach attempts to build this bridge.

**BMM:** Please talk about the markets you serve. Where do you see your greatest opportunities? Most difficult?

**MO:** We aim to license the Rainbow Grid technology to those battery companies—not as a universal solution applied to their entire line of batteries, but rather to have them selectively deploy our technology onto a subset of batteries which face challenging operating conditions (like high heat, where the corrosion rate accelerates dramatically for every 15 degree Fahrenheit rise above 70 degrees). Examples of this include outdoor telecom batteries, which face high cabinet temperatures, causing significant “windshield time” costs for the telecom company to go out and replace these batteries frequently. Another example is in golf cart batteries, where antimony migration causes the cycle life of the battery to decrease. Stationary batteries represent a great opportunity in terms of delaying the rate of corrosion in grids, but will be a challenge in terms of time-in-testing before major end user companies will put this into their sizeable strings of batteries.

On the Advanced Battery technology, we're targeting customers who have demanding performance requirements

and are in a current “no-win” situation, caught in between the low price but heavy weight and poor lifetime of today's lead-acid batteries on one end, and the small size/weight, excellent lifetime but high price of nickel metal hydride and lithium ion batteries. The announcement of Electrolux becoming the first customer of our Advanced Battery is a great example of a major customer who was in this situation.

**BMM:** Discuss the timeline from research to market. For example with the Electrolux agreement—what are the steps to take design to product?

**MO:** On the Rainbow Grid technology, we're aiming to sign our first license agreement by the end of this year. For the Advanced Battery technology, our objective is to have commercial quantities for Electrolux' first application in approximately 24 months.

**BMM:** Who are your competitors?

**MO:** Plainly stated, for the Rainbow Grid, our competitors will be a subset of battery companies that choose not to license the technology, either because they're satisfied with the alloys they currently employ to fight grid corrosion, because they're resistant to change or because they're financially challenged.

For the Advanced Battery, our competitors will be nickel metal hydride and large format lithium batteries.

**BMM:** Talk about your facilities. Do you currently have labs only for R&D? Peoria only? Where will manufacturing take place?

**MO:** Firefly Energy currently occupies 8,000 sq. ft. of research, pilot manufacturing and office space in Peoria, Ill., and has ample room for expansion to execute pilot manufacturing for initial field-testing. The company currently has 20 employees with all but three focused on product development and engineering.

The company also utilizes an extended research and development approach for product technologies, having established research collaborations with leading universities, government labs and materials science companies.

**BMM:** Tell us about Firefly Energy leadership—co-founders Edward Williams, yourself, Kurtis Kelley, and now Bob Nelson. What are your hiring plans/needs?

**MO:** Ed Williams, Firefly's CEO, brings to Firefly Energy his significant expertise in directing expansion stage, turnaround and high-growth organizations to exceptional profitability, growth and operational effectiveness. He possesses strong credentials in strategy development, channel and direct sales, marketing, operations, managing equity structure and P&L. Ed is a recognized innovator with a strong track record for building high-performance teams

across large and small organizations.

I am Firefly's senior vice president, and I have more than 20 years of experience focused on introducing innovative high technology products and services and creating new market categories. I have built and run start-up companies, and have created new divisions at Fortune 500 companies. My track record includes building value and taking corporations to the next level by identifying market opportunities, marshalling resources, defining and executing strategy and creating competitive advantage through customer relationships and collaborative partnerships.

Kurt Kelley, Firefly's chief scientist, was previously a senior research scientist in the Advanced Materials Technology Division of Caterpillar's Center for Research and was responsible for developing and applying materials and design solutions to corporate challenges. In his 15 years at Caterpillar, Kurt enjoyed extensive success directing concept-to-product research projects covering multiple disciplines including battery technologies, ceramics, chemistry and various electronic and high temperature materials. He has an extensive scientific and development background and is a recognized expert and innovator over a broad range of technical fields.

Dr. Bob Nelson, Firefly's new vice president of product development, has for the past 25-plus years carried out research and managed the technical side of manufacturing operations for several companies involved with valve-regulat-

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*"The technology can eventually remove approximately 70 percent of the lead from a traditional lead-acid battery design but still execute lead-acid chemistry for energy storage."*

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ed lead-acid (VRLA) batteries. Bob spent 13 years with Gates Energy Products, overseeing the development and successful commercialization of a variety of flat-plate and spiral-wound VRLA products for industrial applications. His group did the original development work on the Optima spiral-wound VRLA automotive battery. He also was responsible for launching the Advanced Lead-Acid Battery Consortium (ALABC) and managing the first three-year/\$20 million research phase.

New employees are coming to Peoria from across the United States and from other countries. Dr. Boris Monahov, the top electrochemist at the renowned lead-acid research institute in Bulgaria, the Central Laboratory of Electrochemical Power Sources, has joined Firefly Energy in a similar capacity. We're finding those top engineers who see the promise in reinvigorating lead-acid chemistry in ways not previously considered, and who want to be part of this new technology.

**BMM:** What lies ahead for Firefly Energy?

**MO:** As we continue to perfect both technologies, we're concurrently developing the supply chain, which will lead to full-scale manufacturing. Both technologies are simpler to produce than previous attempts at higher performing lead-acid batteries (such as "bi-polar" plate designs), which occurred in the mid-to-late 1990s.

**BMM:** How have you been involved as a Battery Council International (BCI) member?

**MO:** As a start-up, we're very focused on product and market development; hence we have not yet participated on any industry committees. We have attended the BCI convention previously. We look for BCI to make available market data beyond SLI shipments. •

*For more information on Firefly Energy, visit [www.fireflyenergy.com](http://www.fireflyenergy.com) or contact Mil Ovan at [movan@fireflyenergy.com](mailto:movan@fireflyenergy.com).*

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