

PAPER FOR THE NHA 15TH ANNUAL U.S. HYDROGEN CONFERENCE

HYDROGEN ROCKS: THE 2003 LOLLAPALOOZA MUSIC TOUR

N. Coleman¹, A. Sorensen¹, R. Engel¹, P. Lehman¹, J. Zoellick¹

1. Introduction

Alternative energy and hydrogen were featured acts on the Lollapalooza tour in summer 2003, and the Schatz Energy Research Center's portable fuel cell system Stack-in-a-Box® was there to demonstrate hydrogen and fuel cell technologies to 300,000 concertgoers across the United States. Established in 1991, Lollapalooza is a music festival that combines entertainment with social and environmental activism. Founder Perry Farrell's "first priority is to make sure everybody's having a good time, but within that bubble of bliss there has to be the serious moment...and the voice that reaches out furthest to people is a musical one" [1]. The educational mission of the Schatz Energy Research Center (SERC), an institute at Humboldt State University in Arcata, California, is to increase energy and environmental awareness and to offer people first-hand experience with clean energy technologies. Lollapalooza provided a unique opportunity to promote public awareness of hydrogen, fuel cells, and renewable energy technologies. On the tour SERC engineer Nate Coleman interacted with diverse groups of concertgoers in twenty-eight cities, including four in which hydrogen was available to show audiences a working fuel cell. In this paper, we describe the participants, the preparation process, the tour experience, and the lessons learned.

2. Participants

The Lollapalooza production team, SERC, W.L. Gore and Associates (Gore), and the National Hydrogen Association (NHA) worked together to organize and execute a successful fuel cell demonstration.

- **Lollapalooza** is a music festival that features headliners and new bands on two stages, as well as the World of Just BeCauses, a tented village at every show for groups promoting political and environmental issues and social activism. When asked about his interest in hydrogen, founder Perry Farrell said, "One day I asked my friend to recommend a good book. He gave me a few different ones written about hydrogen being used as an energy source. I became excited and anxious in anticipation of the new hydrogen economy. I also felt a little angry that we had the technology to move to a clean, renewable fuel, yet continued to tap a dirty diminishing one instead. I felt like I needed to be involved to help get the message out and turn our country and the world toward clean energy. I know I can convince them because hydrogen is sexy as a rocket ship and sweet as the sun."

¹ Schatz Energy Research Center, Humboldt State University
Arcata, CA 95521-8299, USA
<http://www.humboldt.edu/~serc>

- **SERC** is a renewable energy research institute at Humboldt State University (HSU) in Arcata, California. In addition to designing and building complete fuel cell power systems, the Center provides education and community outreach about renewable energy, hydrogen, and fuel cells. SERC engineers attend career fairs, speak as guest lecturers in classrooms, present teacher training workshops, guide tours of the laboratory facilities and the Schatz Solar Hydrogen Project, and develop interpretive signs and brochures to educate students of all ages.
- **Gore** is a privately held Delaware-based company with 6000 associates at more than 45 locations worldwide. Well known for their GORE-TEX® fabrics, Gore also develops innovative fluoropolymer products for the medical and electronics industries, including proton exchange membranes for fuel cells. The company's commitment to "cultivating an environment where creativity can flourish" consistently earns Gore a prominent ranking on *Fortune* magazine's list '100 Best Companies to Work For' [2].
- **NHA** is "a membership organization founded by a group of ten industry, university, research, and small business members in 1989. The NHA serves as a catalyst for information exchange and cooperative projects and provides the setting for mutual support among industry, government, and research/academic organizations" [3].

The alliance between Lollapalooza and SERC began at the NHA's 14th Annual U.S. Hydrogen Conference in March 2003, when the Stack-in-a-Box® caught the attention of Lollapalooza representative Alex Graham. Alex had attended the conference to investigate ways to include hydrogen in the upcoming tour, and he happened upon research engineer Angi Sorensen's presentation on SERC's education and outreach efforts. At the close of the session, Alex approached Angi and inquired about the possibility of taking the Stack-in-a-Box® on tour for the summer. They exchanged business cards and promised to be in touch. Eventually, Alex put World of Just BeCauses manager Claudette Silver in touch with Angi, and they set to work designing an interactive exhibit to educate 300,000 concertgoers about hydrogen and fuel cells.

Claudette and Angi identified the pertinent issues and tasks associated with bringing a fuel cell demonstration to twenty-eight cities in the United States and divided the responsibilities and action items according to expertise. In addition to the audience and media exposure, Lollapalooza agreed to provide exhibit space, transportation and lodging for one person on the tour, and educational materials donated by the Denver-based Fuel Cell Store. SERC agreed to provide an engineer and salary, the fuel cell system and associated hardware, and hydrogen. As the true costs of the tour began to unfold, the Center, a non-profit institute with little discretionary income, reached out to others in the fuel cell industry for sponsorship.

Support from the NHA and Gore was essential to the success of this national fuel cell demonstration. Gore made a generous donation of proton exchange membrane electrode assemblies (MEA) to refurbish the Stack-in-a-Box® fuel cell, ensuring that it would be in top condition for the tour. Gore also provided additional MEAs for the display. The NHA contributed various resources to the project as well, including staff time and hydrogen-related literature for the exhibit. Technical and program development coordinator Patrick Serfass attempted to secure additional sponsors, but the timeframe was not sufficient to navigate corporate channels. Most notably the NHA staff facilitated the hydrogen delivery for the Washington, DC show, the first on the tour at which hydrogen was available. The lecture bottles were shipped to the NHA office, and Patrick hand-carried them to the show. The joint efforts of this unlikely coalition of a music festival, research institute, corporation, and trade group produced an interactive hydrogen and fuel cell demonstration for hundreds of thousands of young people in summer 2003.

3. Preparation

In preparation for the summer's demonstrations, Claudette and SERC staff discussed what would be included in the exhibit and who would be involved. In addition to the display itself, appropriate personnel, logistics of the hydrogen supply, and insurance were important issues. Design of the exhibit was difficult to prioritize because the need for an exhibit would become a moot point if the other issues could not be resolved. SERC's director Dr. Peter Lehman and co-director Dr. Charles Chamberlin sorted through the insurance issues while senior research engineer Jim Zoellick focused on the hydrogen supply, and research engineers Angi Sorensen and Richard Engel worked to develop the exhibit.

Although the hydrogen supply and insurance issues seemed to be the most daunting, the personnel question was not trivial. Many of the SERC engineers were interested in participating in select shows, but no one was interested in committing to the entire tour. It was the opportunity of a lifetime for Angi, a music fan and avid concertgoer, but she was otherwise committed to a personal project. (Her son was born ten days before the start of the tour.) SERC is affiliated with the Environmental Resources Engineering department at HSU; therefore, hiring and training a student intern was a possibility but not an ideal solution, given that most of the students have had limited experience in working with compressed gases and explaining hydrogen technologies to non-technical audiences. The ideal person was Nate Coleman, a previous SERC engineer who was both willing and able to commit to the project. Nate possessed the required technical knowledge, having worked at the Schatz Center for three years, and the personal skills needed to interact with the public both one-on-one and on the stage. Finding the right person was the first milestone, and once Nate agreed to participate, the focus turned to the hydrogen supply.

Arranging for 150 standard liters (sl) of hydrogen (the energy equivalent of about 1.5 fluid ounces of gasoline) at each show proved to be the greatest challenge in

preparing for the tour. SERC's preferred storage medium was metal hydride because it can store a greater amount of hydrogen at a much lower pressure than a compressed gas cylinder. The metal hydride cylinder SERC purchased from HERA Hydrogen Storage Systems Inc. stores 250 sl at 250 pounds per square inch gage pressure (psig), compared with 54 sl at 1800 psig in a lecture bottle. The U.S. Department of Transportation (DOT) had not yet developed regulations for transporting hydride cylinders, so compressed gas was the only option.

The most convenient and cost-effective way to supply hydrogen at each show was to transport a standard 44-liter cylinder in the main transport trucks with the rest of the tour equipment, from which Nate would fill two or three lecture bottles before each show. Initially, the trucking company was reluctant to transport the cylinders, so SERC staff investigated the feasibility of filling the lecture bottles from a cylinder delivered to each concert site or at an industrial gas supply location in each city. The logistics were complicated, and purchasing a cylinder of hydrogen for every show increased the costs significantly, but the plan seemed workable. Further investigation showed that the travel time from the venues to the industrial gas suppliers ranged from a few minutes to nearly two hours and that only a few of the suppliers were willing to allow "transfilling" of customer-owned cylinders at their locations. Due to the travel time, lack of support for transfilling, and the gas suppliers' limited weekend availability, arranging for delivery to each concert venue was preferable to traveling to the gas suppliers.

SERC staff also investigated the possibility of shipping full lecture bottles directly to the concert venues via Federal Express. They determined that five sets of lecture bottles would be sufficient to rotate through the two-month tour. The tanks would be returned to SERC after each show, refilled, and shipped to the next location. With few overnight and Saturday deliveries, the shipping costs were fairly reasonable. Unfortunately, each shipment required a US\$60 hazardous materials handling fee, resulting in about US\$3400 ($\$3360 = \60×28 shipments/show \times 28 shows) in fees in addition to the actual shipping costs. Even lecture bottles vented down to atmospheric pressure contained enough hydrogen to be considered a hazardous material. Delivering 44-liter cylinders and shipping lecture bottles to the venues were both feasible but expensive alternatives.

SERC staff contacted the trucking company to further explore the possibility of transporting hydrogen with the rest of the tour equipment. The main issues were the drivers' qualifications for transporting hazardous materials and the appropriate liability insurance. Under DOT regulations, the drivers needed the proper paperwork describing the hazardous material being transported, including a material safety data sheet (MSDS) and shipping papers with emergency contact information (CFR49/I/C/172/C, CFR49/I/C/172/G, CFR49/I/C/177/A/817). The driver also needed to be trained in the safe handling practices, safety, and physical properties of hydrogen gas (CFR49/I/C/172/H, CFR49/I/C/177/A/816). Other applicable DOT regulations include [4]:

- CFR49/I/C/173/G/301–The compressed gas must be contained in metal cylinders built in accordance with DOT specifications, such as 3AA cylinders, and must have proper pressure relief and valve protection.
- CFR49/I/C/172/E–The storage containers must be properly labeled.
- CFR49/I/C/177/B/834–The storage containers must be properly secured inside the trailer (as described in CFR49/I/C/177/B/840). No smoking or open flames are allowed during loading or unloading, and the handbrake on the vehicle must be set to prevent motion.
- CFR49/I/C/172/F/504–Vehicle placarding was not required because the gross shipment weight was below 1000 pounds.
- CFR49/I/A/107/G/601–The trucking company was not required to be registered for transport of hazardous materials because the gross shipment weight was below 1000 pounds.

After discussing the applicable regulations, the manager of the trucking company was amenable to the idea of transporting the hydrogen along with the rest of the tour equipment, as long as the production company and SERC secured the proper insurance bonds.

After speaking with Lollapalooza insurance agent Roger Sandau, Dr. Chamberlin contacted local insurance agents for quotes on coverage for such a project. Not only was securing the bond possible, the prices were relatively reasonable. Dr. Lehman also contacted the HSU Foundation (HSUF), SERC's parent organization, to determine the extent of SERC's existing coverage. A few days before the first show, HSUF finally ascertained that the existing policy was sufficient to cover the tour, but time had expired. Using hydrogen still required the support and approval of the individual venue managers, and they had already been notified that no hydrogen would be used on the tour. Ultimately, the Lollapalooza production team decided that the best way to draw attention to SERC's exhibit was to include hydrogen in select shows and increase the media presence for these fuel cell demonstrations. Everyone agreed that, even without hydrogen, the teaching opportunity was well worth the effort and expense of sending Nate and the Stack-in-a-Box® on the tour.

4. The Tour

The fuel cell exhibit was a success at every stop on the 2003 tour. Lollapalooza provided a space for SERC in the World of Just BeCauses, the tented village shown in Figure 1 that is an integral part of every show. Nate joined other local and national groups promoting environmental and social causes, including the Sierra Club, BeaverPower!, Plug Power, Fuel Cell Store, and various installers of solar energy equipment. Two DaimlerChrysler vehicles, a Jeep Commander fuel cell hybrid concept car and a commercially available GEM electric car, were also on display, usually directly behind or to the side of the SERC tent. These two vehicles helped to attract crowds to the fuel cell exhibit.



Figure 1. Aerial view of the World of Just BeCauses on the 2003 Lollapalooza tour. Photo courtesy of Claudette Silver.

As shown in Figure 2, the banner over SERC's tent promoted the link between hydrogen and clean energy, as well as the exhibit sponsors. The display included the portable fuel cell system, interpretive signs, literature, fuel cell materials, and toy cars as shown in Figure 3. SERC's Stack-in-a-Box®, the fuel cell system shown in Figure 4, was the centerpiece of the exhibit. Designed specifically for this type of educational demonstration, the Stack-in-a-Box® has been used since the first system was built in 1999, to educate people of all ages and backgrounds about renewable energy, hydrogen, and fuel cells. Nate removed it from the box at each show so the audience could see all the components and trace the gas flow paths in the system. In addition to the Stack-in-a-Box®, the exhibit included five interpretive signs describing fuel cells and electrolyzers and showing schematics of a PEM fuel cell, the Stack-in-a-Box® system, and the solar hydrogen cycle. The NHA and SERC also provided brochures and literature for people who were interested in learning more about hydrogen technologies.



Figure 2. The banner that adorned SERC's exhibit tent in the World of Just BeCauses on the 2003 Lollapalooza tour. Photo courtesy of Claudette Silver.

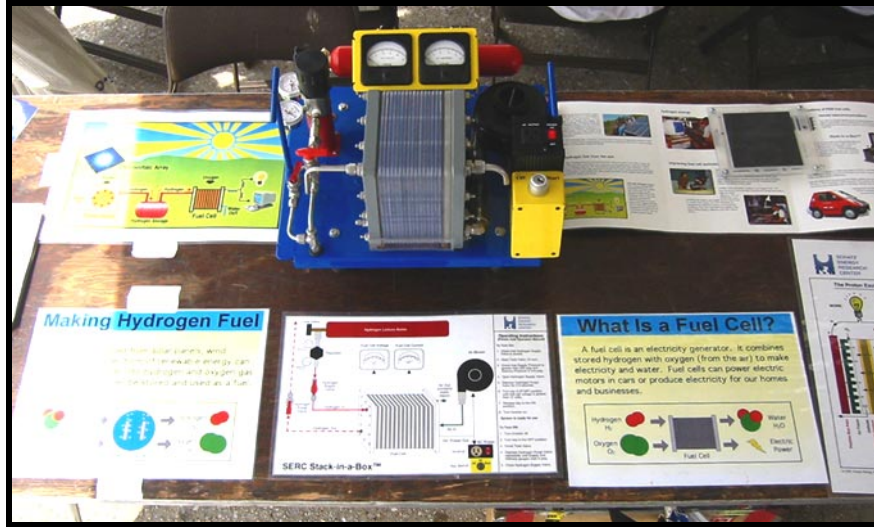


Figure 3. SERC's display table with the Stack-in-a-Box®, interpretive signs, fuel cell materials, and hydrogen-related literature. Photo courtesy of Claudette Silver.

In addition to the Stack-in-a-Box®, interpretive signs, and literature, fuel cell materials and model cars with reversible fuel cells were also on display. The fuel cell materials, a hydrogen flow field plate and a Gore membrane, allowed people to examine two major fuel cell components. Also on the table were toy cars with reversible fuel cells donated by the Fuel Cell Store, an H-TEC HySpeedster fuel cell car and a Hyco Fuel Cell Car Demonstration Kit. As shown in Figure 5, the Hyco kit consists of a reversible fuel cell/electrolyzer, a small photovoltaic panel, and a small model car with an electric motor. A hand-crank generator and AC adapter were also available to provide power for electrolysis. The fuel cell cars were especially popular with younger audiences who enjoyed building electric

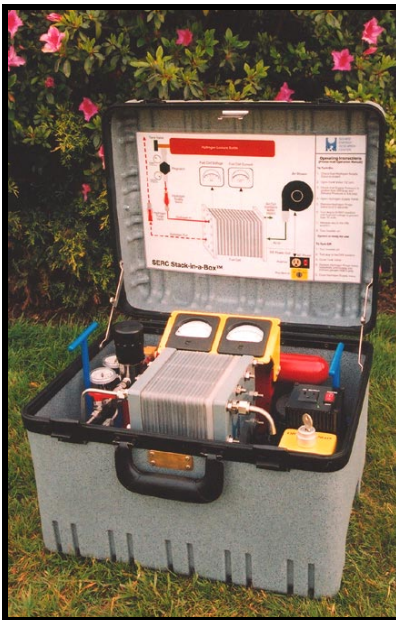


Figure 4. SERC's portable fuel cell system Stack-in-a-Box®.



Figure 5. Hyco Fuel Cell Car Demonstration Kit [5].

circuits and experimenting with the various functions of the kit. They powered the electrolyzer with the solar panel and then allowed the resulting hydrogen and oxygen gases to recombine in the fuel cell to power the car's electric motor. Hands-on experience is a powerful and effective teaching tool, and the Lollapalooza audience embraced the opportunity to examine the fuel cell materials and explore the renewable hydrogen cycle first-hand.

The SERC booth attracted a steady stream of people. On a typical day, Nate talked with hundreds of concertgoers from noon when the gates opened to 7:00 p.m. when the World of Just BeCauses closed. He explained the fuel cell system and discussed renewable energy and hydrogen with interested individuals on a one-on-one basis and in small groups as shown in Figure 6. Feedback from the crowds was extremely positive, as was the feedback from other crew members on the tour. For the most part, the audience did not mind that the Stack-in-a-Box® was not generating electricity due to the lack of fuel. They were simply excited to see a real fuel cell and eager to learn about the technology.



Figure 6. SERC engineer Nate Coleman demonstrates the Hyco reversible fuel cell to Lollapalooza fans. Photo courtesy of Claudette Silver.

The Lollapalooza fans were a diverse group, and their familiarity with fuel cells and hydrogen varied widely. Although attendees were predominantly in their teens or early twenties, younger and older demographics were also well represented. Some fans had previously heard or read about fuel cells and were thrilled to see one up close. They had learned about the technology from high school or college chemistry classes, articles in magazines and newspapers, or reports on television. Although they asked a variety of questions, the most common inquiries from the younger crowds were *“How can I become involved in the fuel cell industry?”* and *“What should I study in college?”*. Other concertgoers had never heard of a fuel cell, and some were skeptical about the technology and its potential benefits. The most common question from this group was *“You mean you can have a car from which the only emission is water?”* When these people learned about the renewable hydrogen cycle, they became excited about the benefits of hydrogen as an energy carrier and its potential for decreasing the U.S.’s dependence on foreign oil. Even without a working fuel cell, the SERC exhibit successfully increased public awareness of hydrogen and fuel cell technologies.

SERC staff shipped hydrogen via FedEx to the shows in Washington, D.C.; Dallas, Texas; Denver, Colorado; and Seattle, Washington. At these four shows Lollapalooza actively promoted the exhibit with increased media attention and presentations with Perry Farrell. His appearance in the exhibit tent or onstage with Nate attracted large audiences to the fuel cell demonstration as shown in Figure 7. Perry began the demonstrations by talking about the need for increased use of renewable energy technologies in the U.S. Then he would introduce Nate to the crowd, and Nate would explain the renewable hydrogen cycle and details of the Stack-in-a-Box® system. Together, Nate and Perry made fruit smoothies in a blender powered by the fuel cell (Figure 8) and shared them with a few lucky fans in the audience (Figure 9). Due to Perry’s participation, the fuel cell exhibit received far more attention at the four shows that included hydrogen.



Figure 7. Perry Farrell’s presence attracts a large crowd to the fuel cell demonstration in Seattle, Washington. Photo courtesy of Claudette Silver.



Figure 8. Perry Farrell and Nate Coleman make fruit smoothies in the Stack-in-a-Box®-powered blender in Dallas, Texas. Photo courtesy of Claudette Silver.



Figure 9. Perry Farrell gives a fruit smoothie to a lucky Lollapalooza fan in Dallas, Texas. Photo courtesy of Claudette Silver.

5. Lessons Learned

Nate's experience on the 2003 Lollapalooza tour indicates that an informal demonstration is a highly effective method for educating the general public about fuel cells and hydrogen. The relaxed atmosphere is well suited to personal interaction and creates a safe environment in which people can ask questions and discuss their concerns and curiosities. The level of enthusiasm shared with Nate at every show is evidence of the public's acceptance of hydrogen as an energy carrier and the great need for hydrogen education in general and hands-on learning experiences in particular. SERC engineers will continue to educate the public at community outreach events such as career and renewable energy fairs, and we hope that the Lollapalooza tour will become one of the regularly scheduled events on the appointment calendar for the Stack-in-a-Box®.

Although the hydrogen exhibit was a great success, it could have been improved given more time to plan and secure sponsorship. Partnering with an industrial gas supplier could have facilitated the process of providing hydrogen at every show, but the appropriate people were not contacted in time. Other sponsors could have contributed funding to enhance the audience's experience at the display booth with small electronic toys powered by the Stack-in-a-Box®, such as fans and video games. Additional funds could have also been used to pay for travel expenses and salary for another person. Talking to the public within close range of a live rock band for seven hours is very demanding work, and the long days took their toll on Nate's health. Somehow he managed to keep a smile on his face, even with a hoarse throat and 103°F temperature, but SERC is determined to provide two staff members for any future tours.

In addition to providing more time to identify additional sponsors, a longer planning period would have afforded sufficient opportunity to educate other stakeholders, including insurance agents, venue managers, fire marshals, and the transport company manager and employees, about hydrogen. Public education was the purpose of the exhibit, but the support and approval of these other groups was necessary to take hydrogen on the tour. Many venues would not permit any hydrogen on their grounds, and one venue required safety personnel to inspect SERC's equipment prior to approving the demonstration. More time would have allowed SERC to discuss the details with all the venue managers so that hydrogen could have been a part of every show. A person's initial reaction to hydrogen is often fear, and SERC engineers are experienced in discussing the safety issues and dispelling myths. Once people see the Stack-in-a-Box® system and the lecture bottle for themselves, they quickly become comfortable with the technology and are eager to learn more, as Nate's experience in summer 2003 demonstrated. The planning process for the traveling fuel cell demonstration is evidence of the need for education among the various target populations identified by the U.S. Department of Energy—educators, code and zoning officials, professional and trade organizations, public and private fleet operators, and the general public [6].

Although Nate spoke with the press on several occasions, he was not aware of the vast potential for media exposure until the end of the tour. Notifying the media in advance might have increased public awareness of the demonstration and generated more attention in every market. In addition to the media events on the tour, the hydrogen exhibit was covered in the NHA newsletter *NHA News* and Peter Hoffman's *Hydrogen and Fuel Cell Letter*, as well as the local newspapers that serve the community in which SERC is located. SERC will take fuller advantage of the media potential in every market on future Lollapalooza tours.

6. Conclusion

In the summer of 2003 the Schatz Energy Research Center sent engineer Nate Coleman on tour with the Lollapalooza music festival to increase public awareness of hydrogen and fuel cell technologies. The twenty-eight-city tour provided a unique opportunity to interact with 300,000 people across the United States. Concertgoers and the Lollapalooza team alike responded to hydrogen and fuel cells on the tour with overwhelming enthusiasm, and the crowds' reactions proved that first-hand experience is a necessary and effective method of dispelling fears and myths about hydrogen. SERC's staff looks forward to continuing this hydrogen education campaign on future Lollapalooza tours.

7. Acknowledgements

We are grateful to Perry Farrell, Claudette Silver, and the Lollapalooza team for their dedication to increasing public awareness of hydrogen and renewable energy technologies. We also acknowledge the generous contributions of David Lane and W.L. Gore and Associates, the National Hydrogen Association, and the Fuel Cell Store.

8. References

1. Perry Farrell. 2003 Lollapalooza Site. [online] <http://www.lollapalooza.com/>, accessed March 2004.
2. W.L. Gore and Associates. [online] <http://www.gore.com/news/100best.html>, accessed March 2004.
3. National Hydrogen Association. [online] <http://www.hydrogenus.org>, accessed March 2004.
4. U.S. Department of Transportation Office of Hazardous Materials Safety. Code of Federal Regulations SubChapter C: Hazardous Materials Regulations. [online] <http://myregs.com/dotrspa/>, accessed May 2003.
5. The Fuel Cell Store. Hyco Fuel Cell Car Demonstration. [online] <http://www.fuelcellstore.com/cgi-bin/fuelweb/view=Item/cat=/product=77>, accessed April 2004.
6. U.S. Department of Energy. Hydrogen Posture Plan, February 2004.