EEVC NEWSLETTER

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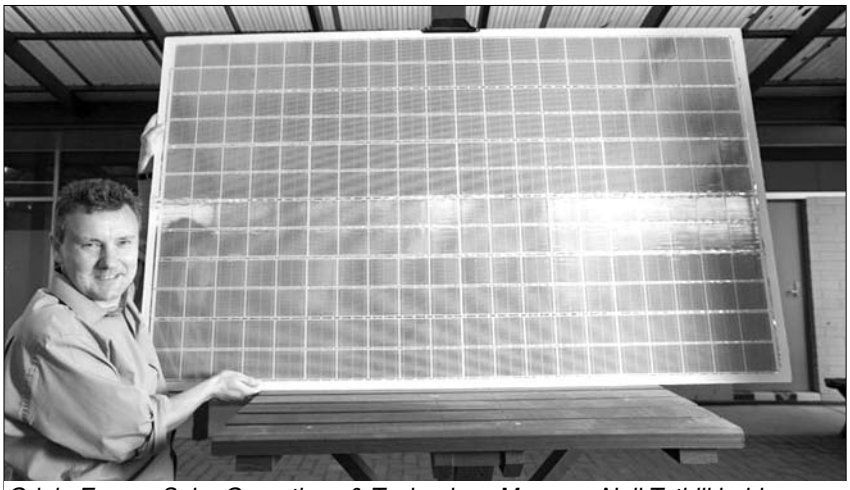
SOLAR MOVES AHEAD DESPITE SILICON SHORTAGE

Most solar cells are made of semiconductor-grade silicon polysilicon), and in recent months a shortage of that material has developed that has increased the price from $32/kg in 2003 to $75 to $80/kg, according to the *San Francisco Chronicle*.



Origin Energy Solar Operations & Technology Manager Neil Tothill holds a prototype 150W SLIVER panel.

Much of this is due to increasing demand from makers of solar cells. A complex microprocessor may use a piece of silicon the size of a postage stamp, but solar arrays tend to be measured in feet or even yards on a side. That's a lot of silicon.

The result of this has been a decrease in the growth rate of solar cell production "from 67 percent in 2004, to roughly 30 percent in 2005, to a projected 10 percent in 2006, according to Piper Jaffray analyst Jesse Pichel, one of the first market watchers to sound the alarm," says the *Chronicle*.

What makes polysilicon so expensive is the processing required to bring silicon from its raw state, called metallurgical silicon, to the 99.99999 percent ("seven nines") of polysilicon.

What to do?

High-tech people are nothing if not inventive, and several companies are working to find a solution. Perhaps the most direct is an Australian company called Origin Energy (www.originenergy.com.au), which is developing a line of solar cells and panels that use a fraction as much silicon as conventional units. The secret is to make the individual cells in the form of thin slivers 100 mm long, 1 mm wide (wafer thickness) and 50

SLIVER cells are long, thinner than a human hair, quite flexible and perfectly bifacial.

microns thick, so they can accept light from both directions, and are very flexible. The company claims conversion efficiencies of its SLIVER cells exceed 19% with voltages of 680 mV.

Another approach

RenewableEnergyAccess.com reports that researcher Alp Findikoglu of Los Alamos National Laboratory has "created a breakthrough in solar cells using aligned crystalline silicon (ACSi) and a buffer layer created through specially directed ion beams." The result, claims Findikoglu, is the performance of crystalline silicon with the cost of the amorphous variety (amorphous — glass-like — silicon is used to power things like pocket calculators where its low conversion efficiency is not a problem and its low cost is a distinct benefit). Estimated efficiency of the new cells is more than 15%, and the resulting cells would cost 40% less than single-crystal solar cells. In addition, reports *RenewableEnergyAccess.com*, the material can be turned out in large sheets and rolls.

Better tools

The *San Francisco Chronicle* reports that Santa-Clara-based semiconductor equipment maker Applied Materials has announced plans to start selling fabrication equipment intended specifically for solar cells. The *Chronicle* quotes *Bloomberg News* that the company hopes "to drive down the cost of generating a watt of electricity from the sun from roughly $3 now to more like $1, but did not specify when."

Dow Corning weighs in

An article by Ann Steffora Mutschler in *Electronic News* for September 4 reports that Dow Corning Corp. has announced the creation of solar-grade (SoG) silicon called Dow Corning PV 1101. Derived from metallurgical silicon, the material is said to exhibit "good solar cell performance characteristics when blended with traditional polysilicon feedstock."

More thin-film

Energy Conversion Devices, Inc., aka ECD Ovonics, has announced that it is expanding its thin-film solar module manufacturing capacity by another 60 MW per annum by adding a second facility at its Greenville, MI site. Operation is expected to begin in mid-2008. The company says that its goal is to expand its solar module manufacturing capacity to more than 300 MW per year by 2010.

PRESIDENT'S MESSAGE
Oliver Perry

Our EEVC presented two electric vehicles at the Maple Shade, New Jersey, annual September Main Street Festival this past Saturday, September 9th.

The festival is primarily a day for vendors and local organizations to display their wares on Main Street. On one end of the closed street Classic Corvettes were displayed, on our end, two electric cars.

(l): Wayne Knight and his VolksBaker. The front is a 69 VW and the back is the rear of an old Studebaker truck. (r) EEVC Vice President Mike Deliso, who helped Wayne to convert the vehicle to electric.

Interest in our two vehicles was modest. We handed out about a dozen EEVC Newsletters and informed a few people about the unique characteristics of our vehicles. My reply to an often repeated question, "Do you think the day of the electric car has finally come?" was, "I think that the plug in hybrid is going to make some noise!"

But, any car that won't be able (in theory) to travel unlimited range without stopping for long fueling periods will not be sold in large quantities. Even if people seldom travel beyond the range of one fuel stop, they want their car to be able to go to California if it has to. The electric battery-only car will always be limited in range and need plug in time. Quick charge could change that but is quick charge a practical near term reality? I usually suggest having an electric for the second car, but most people fear that even their second car might be called upon for a "once in a lifetime" trip beyond its range. Most people balk at the thought of purchasing a car that cannot go nonstop and needs a six hour charging time every so many miles. I believe that until we can demonstrate to people that they can save money with an electric, they are not willing to seriously consider owning one, especially if it cannot go nonstop across the country.

The best selling feature that I found for the electric car is especially appealing to women especially in states where you have to pump your own gas (in New Jersey you can't). The electric charging idea is very appealing to them, especially when they are dressed up for special occasions and in poor weather. I think that idea is worth marketing.

EEVC president Oliver Perry with the Olympian.

Car shows always seem to bring out the unexpected old friends. An old friend that I used to work with part time in a TV repair shop stopped by and updated me on his life and career changes. I had not seen John in thirty years. A few hours later John took us to the big metal box near the corner. Using his personal key he opened the door and exposed the latest up to date electronic and electrical controls to the traffic light at the intersection. We received a mini lesson on how traffic lights are now automatically controlled. In the bottom of the cage rested 6 sealed 12 volt lead acid batteries which would automatically be switched into the circuit should the main power go out. My friend John years ago had left the dying TV repair industry and moved into county traffic control maintenance. Before we parted company John and I discussed how quickly the electronic industry moved from analog to digital and how it has impacted our whole electrical and electronic world. As he said, a man has to keep learning or be left behind. As soon as you learn a trade it becomes outdated.

ZIPPING AHEAD WITH ADVANCED BATTERIES

We recently received an e-mail exchange between Dave Goldstein, president of EVA/DC, and Jeff Chan concerning advanced batteries and the activities of electric motorcycle racer Bill Dube, designer, builder and owner of The KillaCycle, the world's quickest electric motorcycle and the official world record holder in the mile drag:

On Aug 14 2006 Jeff Chan wrote:

"Regarding the availability of advanced batteries, have you seen: www.a123racing .com/html/testimonials.html?

"In November 2005, Dube learned about A123Systems, developer of a new generation of Lithium-Ion batteries. After reading about the battery's potential, he contacted the company. With the A123Systems battery back, The KillaCycle goes from 0 to 60 in just a touch under 1.5 seconds."

Dave then replied:

"Although I have not seen this URL, I have seen Bill Dube's incredible KillaCycle bike up close, as well as the custom-built pack of A123 cylindrical cells integrated with an impressive-looking battery management system.

"Bill is an incredible guy who has worked for NREL (DOE's National Renewable Energy Laboratory) in Golden, CO and has a sterling reputation. He is able to obtain advanced battery packs such as this that are typically unavailable or out of reach costwise to most other EV owners and hobbyists, partly because he is able to work directly with the

companys' battery engineers and assure them that he knows what he is doing, and partly because he can offer them added visibility through his NEDRA www.NEDRA.com drag racing efforts.

"Small format cylindrical batteries such as A123's or the 18650's used by AC Propulsion, WrightSpeed, and, I believe, Tesla and others, are a proven commodity, and A123 is one of those rule-breaker companies that I spoke about when I said, 'To be sure, rules are made to be broken, and some companies, notably Valence, which has often been mentioned on this list, have made some notable efforts to work with knowledgeable early adopters.'

"Bill certainly fits that category! And I would guess that applies to you, too, Jeff. But have you, or anyone else on this list, contacted A123 to check the availability and cost of a custom built 28-30 kWh pack suitable for a RAV4-EV? I suspect that you/they will be in for a shock! (Pun intended.) And the delivery time may be far longer than you might expect.

"Plus, you have to wonder what type of warranty is available, and whether or not the company will work with you to test and validate each of the approximately 4000 Asian-built battery cells — that may or may not be built to ISO quality standards — that would go into your pack.

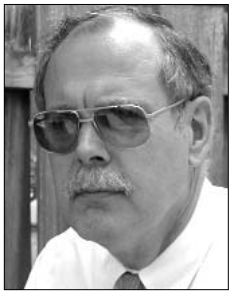
"Will they stand behind you to help identify which and how many of those 4000 cells may have failed as the battery pack ages? And will they work with you on other integration issues such as thermal management and 'tweaking' the charger and battery management system to recognize and operate with an entirely different battery chemistry than it was designed for?

"This is far beyond the capabilities of all but a few end users like Bill, yourself, and perhaps a few others on these lists. And what it suggests, I think, is that there may be a market for a middleman or middlewoman, who can handle the integration issues and provide ongoing customer support — provided that there are enough battery modules available, and enough customers who are willing to pay the price, to make this a viable proposition.

"Would anyone care to invest?"

CALIFORNIA DONS A CARBON CAP

California Pete



One of the biggest pieces of news here on the far side was an agreement between Republican governor Arnold Schwarzenegger and Democrats in the legislature on the Global Warming Act of 2006, which would require industries to reduce emissions of carbon dioxide and other greenhouse gases by 25 percent by 2020. The California Air Resources Board (CARB), which gained infamy by caving in to the auto manufacturers on mandates for production of zero-emission vehicles, would be tasked with developing the specific regulations to achieve the goal. It's a good bet, says the *San Francisco Chronicle*, that ARB will "set up a trading system that will allow companies to buy and sell emission credits." While some purists decry emission credits, claiming that they allow bad guys (i.e., big emitters) to "buy their way out of compliance," in reality such systems work well to reduce overall emission levels while casing minimal economic dislocation.

While legislative Republicans and the state Chamber of Commerce say that the bill will be bad for business, some major companies, including Pacific Gas and Electric Co., have voiced support, and the Bay Area Council, a business group that includes the 275 largest employers in the Bay Area, are also backing the bill, saying that "new companies developing environmentally clean technologies will create jobs in California, and companies could save money by becoming more energy efficient."

It's that time again

Ah, autumn, with the smell of burning leaves in the air .... well, burning forests and brushlands, anyway. We're at the height of fire season; as of this writing eight major wildfires are burning. Two are in Placer and El Dorado counties, while a 21 square mile fire is burning in Los Padres National Forest just north of Los Angeles, and has just forced the closure of Interstate 5, the main north-south route between Los Angeles and San Francisco.

Speaking of burning things, it's also time for the marijuana harvest, and authorities are out in force pulling out pot plants. Recently 22,740 marijuana plants worth about $50 million were discovered growing in and around Point Reyes National Seashore, and so far this year, says the *Chronicle*, "law enforcement agents have destroyed more than 1.2 million illegally grown marijuana plants throughout California, and they have an estimated street value of $4.9 billion, Attorney General Bill Lockyer said last week. Last year, the state's program destroyed more than one million plants worth nearly $4.5 billion of illegally cultivated marijuana plants."

While this might seem amusing, today's large-scale pot growers are not hippies but Mexican narcotics cartels, who do immense damage to the areas where they grow their crops. Major pot farms can involve terracing steep hillsides, running miles of irrigation hoses, chopping out native vegetation and spraying large amounts of pesticides and fertilizers. It costs millions of dollars to repair the damage and clean up the sites, and the Park Service doesn't have the money it needs.

WHY BURNING BATTERIES?

In recent months both Dell and Apple have recalled computers because of overheating (and in some cases flaming) batteries.

On August 7, 2004 a prototype lithium battery pack designed for an electric car caught fire at the FedEx hub in Memphis as it was being loaded on a plane bound for France.

What's going on?

An article by Damon Darlin and Barnaby Feder in *The New York Times* for August 16 entitled "We Ask So Much Of Our Batteries; Need for Battery Power Runs Into Basic Hurdles of Science" explains what's inside a lithium ion battery, and what can go wrong. The cathode is a thin layer of lithium cobalt oxide, the anode is a strip of graphite. "These are separated by a porous insulator and surrounded by fluid, a lithium salt electrolyte that happens to be highly flammable."

"When the battery is charged, lithium ions on the cathode migrate to the anode. As the battery is used, the ions migrate back to provide the energy. In the charged state, the cathode without most of its ions is highly unstable. If a spark occurs, the temperature of the cathode can exceed 275 degrees.

"That is hot enough to cause the cathode to decompose and release oxygen. A fire starts, and as heat builds the battery begins what scientists call a "thermal runaway." In the case of the Sony-made batteries recalled by Dell, a microscopic metal particle that contaminated the electrolyte during manufacturing caused the spark."

While safer batteries using other materials are available from other manufacturers, like Valence Technology, the article says, Valence does not have the economies of scale to match the prices bigger companies charge.

It appears that the lithium ion batteries in the computers were defective: tiny metal particles caused internal short circuits, which put the batteries into thermal runaway. Most li-ion batteries contain internal thermal fuses that disconnect them if they overheat, effectively stopping the runaway, but if the short is inside the cell the safety device is useless.

The FedEx incident was traced to improper packing: instead of being packed for shipment as regulations required, the batteries were in cardboard boxes, and metal tools were also included. A little jostling during shipment was enough to short the terminals, and before the safety fuses tripped the current through the tools was enough to ignite the cardboard.

With this in mind, it's useful to look at Dave Goldstein's response to an on-line question as to why advanced batteries for EVs have not been made available, despite their use in other areas, and that the companies have refused even to talk to the EVers. Dave's comments, excerpted below, are instructive:

WHY WE CAN'T GET ADVANCED BATTERIES FOR EVS
Dave Goldstein

In fact, most of the advanced battery makers that I have dealt with over the years, have acted in the same way. This has included a diverse array of battery chemistries, including Advanced Lead Acid, Nicad, Nickel-Zinc, Silver-Zinc, various Bromine and Metal-Air batteries (especially Zinc-Air,) high temperature Sodium-Sulfur and Sodium-Nickel-Chloride ("Zebra") batteries, plus NiMH and various Lithium-Ion and Lithium Polymer combinations.

In most instances, these batteries were

developed and produced by development stage companies that relied upon highly specialized markets, primarily military, aerospace and telecom, to survive.

In many cases, they were stimulated by government R&D contracts from a variety of federal agencies, especially DOE and NASA.

All of these batteries had several things in common:

1. Every advanced battery involves tradeoffs between dozens of characteristics that are focused toward highly specific applications. Without getting too technical here, suffice it to say that a battery designed for missile applications is not likely to work well in an EV or Hybrid, nor have the performance, range, life-cycle, cost, temperature characteristics, safety, recyclability and many other features that may not be readily apparent and which require systems engineering in order to work properly. Very few EV consumers have the necessary skills to get this right.

2. It can take ten to twenty years to bring an advanced battery to the level of maturity and cost required for a mass market.

During that time, the technology continually improves, federal contracts may come and go and competitors may gain a cost or technical advantage.

3. During this time, battery development companies tend to shy away from consumers, even for beta testing, for several very good reasons:

a. the batteries still may have some technical issues and may not fully meet a wide range of consumer expectations. There is a high risk that consumers will be unhappy with one or more of these issues and that the battery developer will end up with a damaged reputation.

b. In our litigious society, there is a high risk that a battery company will get sued for a fire or injury, even when it was caused by consumer negligence. Lawyers could have a field day suing a battery maker for "prematurely releasing an unsafe or unproven product." The battery company could then be driven out of business.

c. Few development stage battery companies have the financing necessary to set up a Customer Service Department. They are, after all, focused upon development issues and working with high-priority clients, chiefly government and aerospace, who already have the necessary engineering expertise to integrate and maintain the batteries.

d. Highly specialized batteries are often hand-built and use limited machinery that is not suitable for a mass market. Production and material costs remain high, although this does not matter for highly-specialized military and aerospace applications. It does matter to consumers.

e. It takes hundred of millions of dollars to engineer and set up battery assembly lines and obtain the necessary materials in quantity, including rare metals. And material costs can vary widely.

f. There are typically not enough "early adopter" consumers to justify this type of expenditure and allow the manufacturer to begin to recover its costs, which include many years of development effort.

b. Thus, advanced battery companies seeking to enter mass production must rely upon other large companies, especially automotive manufacturers and parts suppliers, who represent the only viable market for EV/PHEV batteries.

To be sure, rules are made to be broken, and some companies, notably Valence, which has often been mentioned on this list, have made some notable efforts to work with knowledgeable early adopters. But even they have been forced to reevaluate the economic potential of this market, and the last that I heard, this issue was under reevaluation. I am sending a note to Marc Kohler, whom I still believe is at Valence, seeking his perspective.

Very little of this information will be reassuring to the early adopters on this list who would dearly love to get their hands on some of these advanced batteries and who remain mad that they cannot. This is understandable, as are the many theories spinning around as to why these batteries remain unavailable to EV/PHEV enthusiasts — most of them wrong.

Understanding the real reasons for this is the first step towards finding solutions, although in most cases, frankly, the only solution is to create more market demand for these batteries through government incentives and consumer demand — expressed in a more positive light — through grass roots lobbying, letters to the editor in major publications, and

more public demonstrations of the relatively limited EV/PHEV technology that we presently have available. The current gasoline situation, which this time may not go away and may only get worse, is clearly working in our favor, and we should capitalize upon it.

In a future post, time permitting, I hope to address the question about "where the batteries are" and some of the manufacturers that are developing/producing them, although it cannot possibly be a comprehensive effort. Studies like that tend to cost upwards of $7,000, typically only available to business markets.

While this may not end our "Madness," ;o) I can only hope that this discussion will lead to more productive efforts from the EV Community to address the battery issue, recognizing that until now, battery development has essentially been operating in "geologic time."

The time has come for a "Manhattan Project" in advanced batteries that includes early-adopter consumers in the mix. How that will occur remains to be seen . . .

CHALLENGE BIBENDUM PRESSES ON

This Toyota Prius earned first place in the 2006 Michelin Challenge Bibendum help in Paris in June.

Despite the unexpected death in late May of Edouard Michelin, CEO of the eponymous company and the driving force behind the annual green event, this year's Challenge Bibendum was a success.

The event, held in Mortefontaine, in Paris and at the CNIT, France's industries and technologies center June 9-12, featured presentations, round tables, tests, discussions, demonstrations and other initiatives. There were 2500 participants representing around 100 manufacturers, non-governmental organizations and institutions.

Entries included 26 battery EVs; ten hydrogen fuel cell vehicles; an assortment of CNG, LPG, BTL (biomass-to-liquid), GTL (gas-to-liquid), gasoline, flex-fuel (E85) and diesel-fueled ICEs; and an assortment of hybrids.

First place in the rally event went to a Toyota Prius, followed by a fuel cell-powered Mercedes and a Toyota Avensis diesel ICE vehicle.

HYBRID REBATES RESTORED IN PA

On July 17 Governor Rendell announced new funding for Pennsylvania's Hybrid Electric Vehicle Rebate Program, which provides $500 rebates to consumers who buy new hybrid electric vehicles. This is the second round of funding for the Hybrid Electric Vehicle Rebate Program, offered through the Alternative Fuels Incentive Grant program administered by DEP. The initial rebate offering was so popular that the program issued $1.5 million in rebates in less than 10 months.

The Governor's 2006-07 General Fund budget expands funding for alternative-energy initiatives by $3 million, including funding to restart the rebate program under AFIG.

NEWS UPDATE

Thousands of mpg on ethanol

Control Engineering reported on August 1 on the results of the European Shell Eco-marathon held on May 20-21 in Nogaro, France. The winner, built by engineering students from the Lycée La Joliverie (France), had fuel consumption equivalent to 2885 km/l (6785.5 mpg) of gasoline.

As can be imagined, the winning vehicles are built strictly for the contest, although "there is also a division for Urban Concept vehicles, which must be capable of driving under more normal street traffic. This year's winner was a team from the Technical University of Denmark with a new record of 810 km/l (1,905 mpg) using a fuel-cell-powered vehicle. Their performance was particularly notable in that they developed a method to utilize 100% of the hydrogen in their fuel cell, improving on normal consumption of only

95%. This process is already in further development and will likely be employed in future fuel cell designs."

For more information on the event take a look at www.shell.com/eco-marathon

Peugeot shows off at Green Car Congress

Autoblog.com reports that Peugeot is preparing a fuel cell-driven concept car for the Paris Motor Show. Called the 207 EPURE, it's based on the production Peugeot 207 CC.

Power comes from a GENEPAC 20 (20 kW) fuel cell fed by "five 15-liter hydrogen cylinders stored at the bottom of the car's trunk. The fuel cell powers the EPURE's electric motor (Peak power: 95 hp / 133 lb-ft) and recharges its 50 kW Lithium-Ion battery."

Speedy fuel cell car

In early September Inergy Automotive Systems took its leased DaimlerChrysler F-Cell hydrogen fuel cell vehicle to Michigan's Milan Raceway, where it did the quarter-mile with documented times less than 19 seconds, at speeds in excess of 70 miles per hour. Not all that impressive, but then again there's not a lot of competition for this sort of thing.

COMING EVENTS

Fulton Conference on Sustainability
Sept 15-16, at Wilson College, Chambersburg, PA. For information go to www.wilson.edu/lifeaftercheapoil.

AltWheels — Alternative Transportation Festival
Sept 22-24, Boston, MA. Contact A. Sander, 800-510-6484, sanderalison@ aol.com, www.altwheels.org

Southern California Clean Vehicle Technology Expo
Oct 10-11, Ontario, CA. Contact: Jaime Nack, 310-314-1934, info@cleanvehicleexpo.com, www.cleanvehicleexpo.com

National AFV Day Odyssey
Oct 12, multiple location in the U.S., Canada and Germany. The closest to EEVC territory will be at the Catonsville Campus of the Community College of Baltimore County, 800 South Rolling Road, Baltimore, MD (contact Terry Wolfe, twolfe@ccbcmd.edu, www.ccbcmd .edu) and at the U.S. General Services Administration, 490 L'Enfant Plaza, S.W., Suite 8214, Washington, DC (contact Sylvia McMillian, Sylvia.mcmillan@gsa.gov, www.gsa.gov

Convergence 2006
October 16-18, 20, Detroit, MI. Check www.sae.org.

The Solar Power Conference and Expo
Oct. 16-19, San Jose, CA. Contact Michelle Brownstein, 202-682-0556, www.solarpowerconference.com

Vehicle Energy short course training program
Dec 6-8, University of Michigan, College of Engineering, Center for Professional Development, Ann Arbor, MI. For information go to http://cpd.engin.umich.edu/fmi/xsl/programs/details-short.xsl?-db=offering&-lay=web&-recid=2462&-find=

Hybrid Vehicle Technologies Symposium — 2007
February 7-8, 2007, San Diego. Check SAE at www.sae.org.

Fuel Cell 2007
June 14th - 15th, Rochester NY. Contact Marsha Hanrahan, marshah@infowebcom.com or go to www.fuelcellmagazine.com/fc_2007 conf_index.htm

MEETING SCHEDULE

Meetings are held in Room 35, Plymouth-Whitemarsh High School, 201 East Germantown Pike in Plymouth Meeting, PA, and begin at 7:00 p.m.

October 11

November 8

December 13

January 10

February 14