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**From:** Palivoda, Monica M. (GRC-M000)  
**Sent:** Tuesday, October 06, 2009 9:33 AM  
**To:** Pierce, Angela L. (GRC-X000)  
**Cc:** Humphries, William R. (GRC-M000); Free, James M. (GRC-M000); Harrington, Tammy L. (GRC-ML00); Wiersma, Lynne M. (GRC-M000); Tyburski, Timothy E. (GRC-MC00); Lytle, John K. (GRC-MAC0); Reehorst, Sandra T. (GRC-MA00)  
**Subject:** Code M response to FOIA request #GRC-09-048  
**Importance:** High

Angela,

A thorough search was conducted pertaining to the subject FOIA request ("Feel Good Cars", Zenn Motor Company, and EESTor, Inc.) and we are submitting the attached two items.

>>>-----Original Message-----

>>>From: Mercer, Carolyn R. (GRC-MAC0)  
>>>Sent: Thursday, October 01, 2009 7:59 AM  
>>>To: Lytle, John K. (GRC-MAC0)  
>>>Subject: RE: FOIA request #GRC-09-048

>>>

>>>John,

>>>

>>>I searched my files and emails for all references to EESTor, Zenn  
>>>Motor, and Feel Good Cars, and found only the attached two files.  
>>>Slide #55 in the RTI presentation discusses an ultracapacitor  
>>>developed by EESTor, and the email from Pat George mentions the use  
>>>of the EESTor ultra capacitor in the Zenn Motor's electric car.

The Energy Storage folks had brief interaction on this topic. All information being provided is releasable.

I will deliver the paper copies to your office this morning.

Monica



FOIA request  
Ultra-Capacitor T...



Too good to be  
true??



*Monica Palivoda*  
GRC Space Flight Awareness Program Coordinator  
Space Flight Systems Directorate Office  
NASA John H. Glenn Research Center  
Phone: 216-433-2570 FAX: 216-977-7537

# Recent Announcements Ultra-Capacitors



- A secretive Texas startup developing what some are calling a "game changing" energy-storage technology announced that it has reached two production milestones and is on track to ship systems this year for use in electric vehicles.
- EEStor's ambitious goal is to "replace the electrochemical battery" in almost every application, from hybrid-electric and pure-electric vehicles to laptop computers to utility-scale electricity storage.
- Claims that the battery-ultracapacitor hybrid based on barium-titanate powders will dramatically outperform the best lithium-ion batteries on the market in terms of energy density, price, charge time, and safety
- Packs 10 times the punch of lead-acid batteries at half the cost and without the need for toxic materials or chemicals
- Claims a specific energy of about 280 watt hours per kilogram, compared with around 120 watt hours per kilogram for lithium-ion and 32 watt hours per kilogram for lead-acid gel batteries
- This leads to new possibilities for electric vehicles and other applications, including for the military

Source: Tyler Hamilton. MIT Technology Review. "Battery Breakthrough? A Texas company says it can make a new ultracapacitor power system to replace the electrochemical batteries in everything from cars to laptops." January 22, 2007. Available:<http://www.technologyreview.com/Biztech/18086/>

**Cordero, Jessica A. (JSC-AP111)**

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**From:** George, Patrick J. (GRC-MC00)  
**Sent:** Friday, January 16, 2009 2:09 PM  
**To:** Mercer, Carolyn R. (GRC-MAC0)  
**Subject:** Too good to be true??

**Follow Up Flag:** Follow up  
**Flag Status:** Flagged

**Categories:** Red Category

Carolyn,  
are you aware of this ?

Pat

Patrick J. George, GRC Constellation Office  
Ph: 216-433-2353, Fax 216-433-2629, Cell: 216-509-0217  
E-mail: Patrick.J.George@nasa.gov, Land Mail: MS 142-5  
NASA Glenn Research Center, 21000 Brookpark Rd.  
Cleveland Ohio, 44135

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**From:** Mazanek, Daniel D. (LARC-E402)  
**Sent:** Friday, January 16, 2009 2:24 PM  
**To:** Ambrose, Robert O. (JSC-ER); Troutman, Patrick A. (LARC-E402); George, Patrick J. (GRC-MC00); Culbert, Christopher J. (JSC-ER)  
**Cc:** Craig, Douglas A. (HQ-BJ000)  
**Subject:** RE: Opinions??? Too good to be true??

Hi Rob,

EEStor is claiming that they have a super secret ultra capacitor that acts like a super battery. They claim that their technology will allow 300 miles of range in the Zenn Motors' electric car and be able to recharge in ~5 minutes (with the proper high voltage charging equipment... ~2 hours at 230 volts).

Their claims equate into 682 Wh/kg according to one website! Much skepticism out in cyber land...

Here's a reference article on Wikipedia (<http://en.wikipedia.org/wiki/EEStor>)

Thoughts? Apparently you do have some version of their technology. Are they a reputable company?

Best of luck in the parade!! We'll all be watching and cheering for you in Virginia!! Enjoy!!

Dan

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**From:** Ambrose, Robert O. (JSC-ER)  
**Sent:** Friday, January 16, 2009 12:56 PM  
**To:** Mazanek, Daniel D. (LARC-E402); Troutman, Patrick A. (LARC-E402); George, Patrick J. (GRC-MC00); Culbert, Christopher J. (JSC-ER)  
**Cc:** Craig, Douglas A. (HQ-BJ000)

**Subject:** RE: Opinions??? Too good to be true??

We have been studying them for use in our regenerative braking scheme, where they need high specific power, but don't need a large total energy. We purchased some and will build them into a flywheel test that we do for all our servo drive systems.

Rob

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**From:** Mazanek, Daniel D. (LARC-E402)  
**Sent:** Tuesday, January 13, 2009 2:43 PM  
**To:** Troutman, Patrick A. (LARC-E402); Ambrose, Robert O. (JSC-ER); George, Patrick J. (GRC-MC00); Culbert, Christopher J. (JSC-ER)  
**Cc:** Craig, Douglas A. (HQ-BJ000)  
**Subject:** RE: Opinions??? Too good to be true??

I had offered ultra capacitors as a technology that was not included in the power storage whitepaper, and Jason Hay at the Tauri Group however, he indicated that there is considerable controversy about the validity of EESstor's claims. He was/is looking for additional input.

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**From:** Troutman, Patrick A. (LARC-E402)  
**Sent:** Tuesday, January 13, 2009 1:12 PM  
**To:** Ambrose, Robert O. (JSC-ER); George, Patrick J. (GRC-MC00); Culbert, Christopher J. (JSC-ER)  
**Cc:** Craig, Douglas A. (HQ-BJ000); Mazanek, Daniel D. (LARC-E402)  
**Subject:** Opinions??? Too good to be true??

From:  
<http://www.autobloggreen.com/2007/01/31/more-on-eestors-ultracapacitor-can-we-believe-the-hype/>

## More on EESstor's ultracapacitor - can we believe the hype?

Posted Jan 31st 2007 at 2:03PM by [Dane Muldoon](#)

Filed under: [Emerging Technologies](#), [EV/Plug-in](#)

<http://www.techreview.com/Biztech/18086/>  
*ZENN Motors vehicle at the EDTA Conference last November*

More details have emerged about EESstor's ambitious ultracapacitor electrochemical battery replacement technology. EESstor sees applications for their Electrical Energy Storage Units (EESU) in everything from hybrid-electric and pure-electric vehicles, to laptop computers, to utility-scale electricity storage. Based on barium-titanate powders, the units are supposed to dramatically outperform the best lithium-ion batteries on the market in terms of energy density, price, charge time, and safety. And since capacitors don't require chemical processes to store power, EESstor said in its patent, the materials the company uses are safer and more environmentally friendly.

Ultracapacitors store energy in an electrical field between two closely spaced

conductors, or plates, upon which an electric charge builds when voltage is applied. Unlike traditional electrochemical batteries, ultracapacitors can completely store and release a charge quickly and indefinitely over many cycles. Where they don't compete though is energy storage; here lithium-ion batteries can store 25 times more specific energy - the amount of energy in a given unit of mass.

Most research into increasing the charge that can be stored by the plates has focused on ways to increase the surface area. Last year, the Massachusetts Institute of Technology said it was working on hugely increasing the plate surface area by researching plates made of microscopic nanotubes.

Up until now, ultracapacitors, have been used in conjunction with traditional batteries to more fully harness the regenerative energy created in sudden bursts by braking activity with their ability to release quick jolts of electricity. Their characteristics are ideal for maximising efficiency in stop-start city driving. Ultracapacitor manufacturer Maxwell Technologies has been able to capitalise on this strategy in their 125-volt BoostCap ultracapacitor module.

EESor's EESU, a ceramic ultracapacitor with a barium-titanate dielectric, or insulator, is claimed to break free of the traditional limitations of small energy storage found in other ultracapacitors. Apparently they have achieved an exceptionally high specific energy and permittivity - the ability of a substance to store electrical energy in an electric field. Normally an ultracapacitor has a permittivity rating of 20 to 30, compared to the claimed EESU rating of 18,500 plus. As you can imagine, such claims have raised questions amongst experts who hold concerns that such ceramic materials can survive and function properly in vehicle applications.

In an interview with [Technology Review](#), Jim Miller, vice president of advanced transportation technologies at Maxwell Technologies said, "We're skeptical, number one, because of leakage. Meaning, if you leave it parked overnight it will discharge, and you'll have to charge it back up in the morning."

In the same article, Andrew Burke, an expert on energy systems for transportation at University of California at Davis said, "I have no doubt you can develop that kind of [ceramic] material, and the mechanism that gives you the energy storage is clear, but the first question is whether it's truly applicable to vehicle applications."

ZENN Motor Company is reported to be getting first access to EESor's EESU technology for use in their Low Speed Vehicles.

Maxwell Technologies meanwhile has [just announced](#) that they are forging ahead with their technology and have received a purchase order for 100,000 square meters / 1,076,400 square feet of proprietary ultracapacitor electrode material from a licensee, Shanghai Sanjiu Electric Equipment Co. This will allow Sanjiu Electric to launch a new ultracapacitor product line based on Maxwell's Cell Architecture for transportation, utility and industrial markets in mainland China.

Mr. Hong Yuan Shuai, Chairman and CEO of Sanjiu Electric parent company, the Ruihua Group, said that Sanjiu Electric has already produced and delivered a variety of prototype electric and hybrid buses, trucks and other vehicles powered by drive systems combining batteries and Maxwell BoostCap ultracapacitors for energy storage and

regenerative braking.

Analysis: The EESU prospects are exciting, but I think Maxwell's use of ultracapacitors in regenerative braking applications is probably a better choice for vehicular applications at this point. Where EESU's products could open up a sizeable lead over the opposition though is in the area of military, direct-energy "ray-gun" weapons. Personally, I'll just stick with better fuel economy in stop-start traffic.

# ***EES**tor, Inc.*

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**• ENERGY • STORAGE  
• TECHNOLOGY**

Richard Weir, President and CEO

[dick\\_weir@eestor.usdick\\_weir@eestor.us](mailto:dick_weir@eestor.usdick_weir@eestor.us)

Cedar Park, Texas

# ***EEStor, Inc., Management Team***

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- **Richard D. Weir, President & CEO**
  - BSEE, California State Polytechnic College, Pomona, CA
  - Experience: IC Fabrication & Ceramic Powder Development
  - IBM, TRW, & Others
  - Founder/Senior Management at Two Start-Ups
- **Thomas M. Weir, Vice President and General Manager**
  - Start-Up Experience in three companies – Experience in Ceramic Materials
  - Nine Years Commercial and Military Sales Experience at Dell Computer
  - Extensive Knowledge of Computing Systems and Software Packages

# ***EEStor, Inc.***

## **EEStor Ceramic Battery Provides: Low Cost - High-Density Energy Power Storage & Delivery**

- **Ultracapacitor** Battery Architecture - Flexible Packaging
  - Commercial Converter Circuits for Charge/Discharge
- 10x Lead Acid Energy Density - 1/10 the Weight & Volume
- 3 x Li-Ion Energy Density
- Charge & Discharge **Capability** --- microseconds ( $\mu$ s) at ultrahigh currents
- **Cost competitive against all battery technologies**
- 100% deep cycle >1,000,000 cycles -- no failures or degradation also **Totally Green**
- Temperature range - 40° C to 65° C
- Can be **racked & stacked** for parallel or series operation without cost or technical penalties

# ***EEStor, Inc.***

## Technology Breakthrough by:

- ❖ Novel use of Composition-Modified Barium Titanate Powder identified in one patent issued and nineteen in process
- ❖ Key Enabling Proprietary Processing Steps
  - **Pre Powder Processing**
    - Optimizes Powder for Ultimate Parameter Improvements
  - **Powder Processing**
    - Utilization of Rare Earth Elements for Powder Parameter Tuning
    - Establishes Optimum Powder Size and Homogeneity
  - **Post Powder Processing**
    - Provides Ultrahigh Resistance Barriers
- Major Parameter Improvements
  - **Capacitance & Working Voltage**

$$\text{Energy Stored in a Capacitor} = (CV^2)/2$$

# Availability of Barium Nitrate Powder

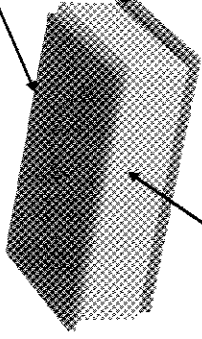
- Estimated present worldwide production of barite
  - 6,600,000 T per year (85% for the CRT TV industry)
  - CRT industry being replaced by new technologies
- USGS estimates the world resources are about **2 billion tons** of barium
  - EEStor has multiple quotes at \$0.23 per pound
- EEStor, Inc. required long-term production requirements for barium compounds:
  - 4,000,000 T per year
- **USGS estimates** the world resources are about **13 million tons of lithium**
  - Cost increased from \$8.00 per pound in 1977 to \$43.00 per pound in 1998
  - Very limited source of Lithium at this price

# EES<sub>tor</sub> Base Building Block: *The Cell*

## Printing Fabrication

Ni Electrodes

- 1  $\mu\text{m}$  thickness
- Offset to each other



CMBT Dielectric layer

10  $\mu\text{m}$  thickness

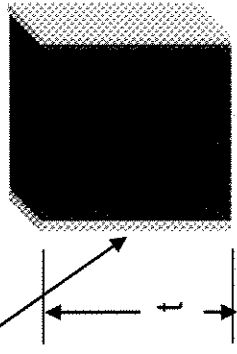
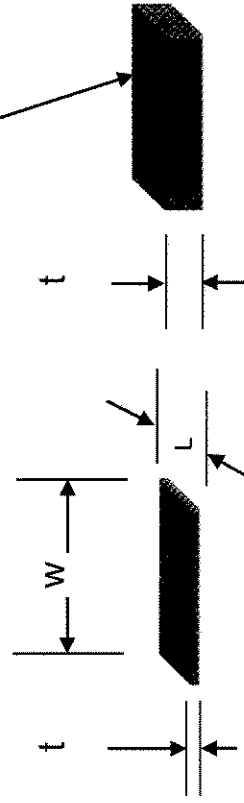
# Dimensions of the Cells, Elements, and Components

## Cell Element Component

Two electrodes 100 Cells 10 Elements  
 One dielectric layer 31,351 component  
**EESU-52**

0.005 inch thick nickel end cap electrode connectors

Element electrode phasing dot



Thickness 0.000462 inches 0.4306 inches  
 Length 0.2 inches 0.2 inches  
 Width 0.45 inches 0.46 inches

# *Competing Battery Technologies: To supply 52 kW•h Storage Capacity*

	EESU	NiMH	LA(FlowGel)	Lithium-Ion
Weight (pounds)	*250	1527	3272	715-1273
Volume (ft <sup>3</sup> )	*2.6	10	25	6.4
Discharge rate	***0.02%/30 days	30%/30 days	3-20%/30 days	5-10%/30 days
Charge time	**3 to 6 min (100%)	6.0 hr (80%)	8 to 15 hr (80%)	6.0 hr (80%)
Specific Power	<b>Extremely High</b>	Low	Low	Low
Life reduced with deep cycle use	none	moderate	high	moderate
Storage capacity reduction with temp.	<b>Negligible</b>	High	Very high	High
Hazardous materials	none	yes	yes	yes

- \* First generation version – Further 2-8 x improvements
- \*\* Charge and discharge rates set by the EESU converter
- \*\*\* The low discharge rate make electrical energy transportable

# *Competing Battery Technologies: EEStor vs. A123*

	<b>* EESU</b>	<b>Lithium-Ion – Nanoparticles</b>
Energy Density W•hr/L	<b>702</b>	<b>EST: 150 - 250</b>
Discharge rate	<b>0.02%/30 days</b>	<b>Low</b>
Charge/Discharge times	<b>Minutes to <math>\mu</math>sec</b>	<b>EST: 1 min. @ 80% – 10 min. @ 100%</b>
Size – ft <sup>3</sup>	<b>2.72</b>	<b>39</b>
Output voltage	<b>Whatever is required</b>	<b>&lt; Than present Li-Ion 3.6 volts</b>
Charge/Discharge times for large units (EV)	<b>Same as above</b>	<b><u>TBD</u></b>
Life reduced with deep cycle use	<b>none</b>	<b>EST: 1% over 1000 cycles</b>
Storage capacity reduction with temp.	<b>Negligible</b>	<b>Negligible</b>
Hazardous materials	<b>none</b>	<b>yes</b>
Cost \$/kW•h	<b>100/250</b>	<b><u>650</u></b>

**\* First generation version – Further 2-8 x improvements**

# EEStor Ceramic Battery vs. PEM Fuel Cell with Fuel Processor (re-formant)

Information provided by Argonne National Laboratory on a PEM Fuel Cell System developed by Honeywell, Plug Power, and Nuvera utilizing a fuel reformer unit to produce the Hydrogen.

## Ceramic Battery      Fuel Cell System

- Life duration      Indefinite      (Projected) 1500 hours
- Efficiency      > 90%      25-30%
- Specific Power      > 10<sup>6</sup> W/kg      (Projected) 250 W/kg
- Energy Density      702 W•h/L      900 W•h/L
- Humidity Range      100%      95%

# Electric Double Layer Capacitor vs. EEStor Ceramic

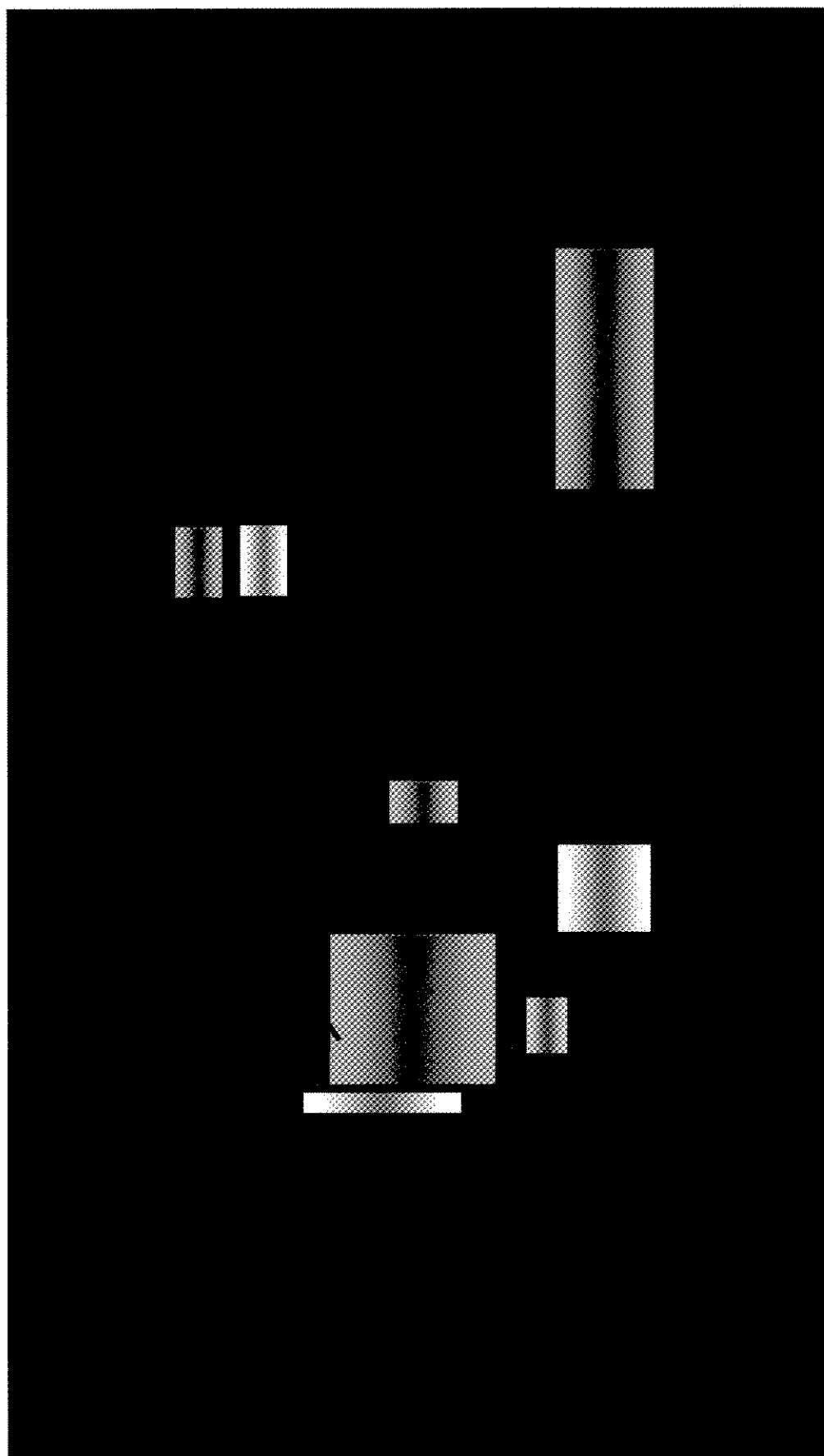
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	EEStor Ceramic	EDLC
● Maximum voltage	3500 V	2.5-3.0 V
● Capacitance	31 F	2500 F
● Balancing Network	No	Yes
● Radiation Resistance	Yes	No
● \$/kW•h – High volume	150	13,148
● Specific Energy (W•h/kg)	460	2.2

## EDLC Manufacturers:

- Maxwell
- Elna
- EPCOS (Electronic Parts and Components)

# *EEStor, Inc.*



# *EEStor, Inc.*

## Key Markets

Portable Tools

Grid Load Leveling

Electric Vehicles

**EEStor, Inc.**

Wind & Solar

PCs and Handheld

HEV Capacitors

Energy  
Delivery Stations

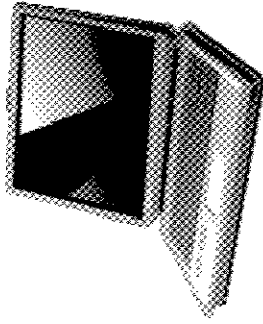
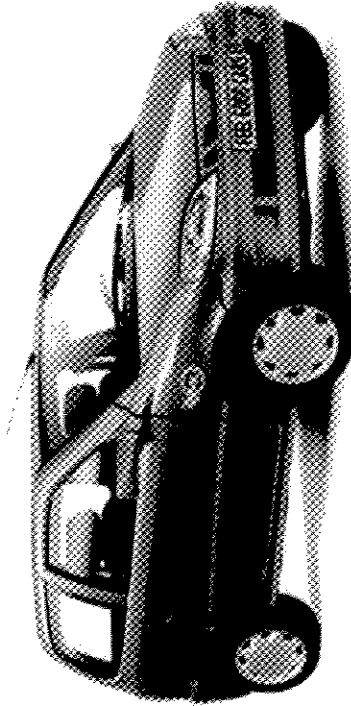
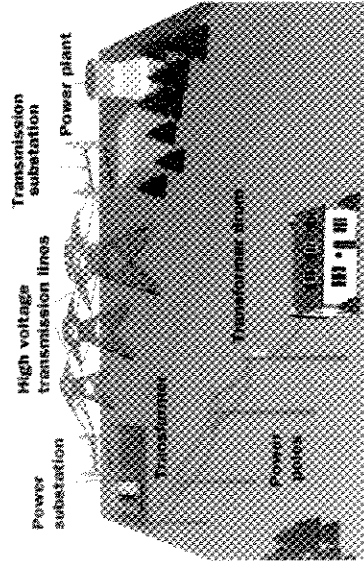
Military and NASA

UPS

# EES<sub>T</sub>or, Inc.

## Versatile Packaging Size and Shape

### Broad Application Range



**Grid Load Leveling,  
Wind, & PV**

**EESU - 52**

- 29" x 29" x 5.4"
- 52 kW•h
- 300 pounds
- Rack & Stack – 4000 MW•h



**ZMC, Inc. – EV – ZENN**

**EESU - 17**

- 15" x 10" x 10"
- 20 kW•h
- 130 pounds
- > 200 mile range



**Personal Computer**

**EESU - .16**

- 5.5" x 3.5" x 0.8"
- 180 W•h
- 1.2 pounds

# Electric Vehicles



## General Motors EV1

- Major problem
  - ✓ NiMH battery - Expensive
    - Limited energy capacity
    - Low Specific Power
    - Relativity short life time
    - High energy leakage

## • EV Advantages

- No emissions
- 92% efficient vs. 25% ICE efficiency
- No propulsion energy losses when vehicle is stopped
- Electronic transmission and direct power to the wheels
- Lower cost and higher safety
- Lower maintenance cost
  - Electric motors last >10 ICE engine
  - No: mufflers, engine oil filters, engine oil, transmission, catalytic converter, gas tank, or spark plugs.
- More HP than ICE vehicles
  - EESU can provide the energy
- All Locomotives are Electrical  
Induction Motor Driven-Next Steps-Hybrid-Then Full Electric

# Convert Wind Energy to a Primary Electrical Energy Provider



- Ultrahigh energy storage would assist in:
  - Providing stable voltage output over a broad range of wind variations
  - Allowing energy capture over the full spectrum of wind intensities
  - Due to improved efficiencies and reduced system complexities, lowering the overall power cost
  - Providing **stable** utility grid power for 24/7
  - **WORLDWIDE - PRIMARY POWER PROVIDER**

# EEStor Technology and Increasing Energy Production

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- **Utility Grid Power Averaging**
  - Allows existing power generating plants and transmission lines to operate at or near maximum efficiency
  - EESU meets all of the requirements for long term utility grid operation
  - Potential of increasing the available electric energy by 45% worldwide
- **Photovoltaic Power Generation**
  - Allows for 24/7 highly stabilized power availability from PV power generating plants
  - EEStor Energy Storage along with the lower cost thin film PV based power generating plants will provide a major source of electrical energy worldwide

# ***EES**Stor, Inc.*

## **Achievements to Date**

- Technology development, testing, and certification
- Manufacturing processes, equip., and suppliers identified
- Engineering level cost analysis
- Potential initial customers identified
- Patent awarded
- File for advanced plastic/ceramic patent
- Nineteen additional processing patents are being filed
- Adding technical operational and production personnel

## **Schedule-Milestones Reflect EESstor's Incorporation of Advance Technologies in the Production Process in Early 2007 Time Frame**

- Powder Tested and Certified 2Q08
- Preproduction EESU 4Q08
- Full production 1Q09

## **Compete**

- **\$3,000,000 Funding from KPC&B - 8/7/05 – Production Buildup**
- **\$2,500,000 Technology Agreement with ZENN Motors**
- **2<sup>nd</sup> Round Funding = \$2,500,000 @ \$70 Million Evaluation**

**Status**  
Complete  
Complete  
Complete  
Complete  
**YES**  
Complete  
Complete  
Complete

# ***EESstor, Inc.***

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## *The Energy Storage Company*

Tuesday, January 17, 2007

EESstor, Inc.  
Cedar Park, Texas

### **EESTOR ANNOUNCES TWO KEY PRODUCTION MILESTONES: AUTOMATED PRODUCTION LINE PROVEN AND THIRD PARTY VERIFICATION OF ALL KEY PRODUCTION CHEMICALS COMPLETED**

The first EESstor, Inc. automated production line has been proven to meet the requirements for precise chemical delivery, purity control, parameter control and stability.

In addition, EESstor, Inc. has completed the initial milestone of certifying purification, concentration, and stability of all of its key production chemicals notably the attainment of 99.9994% purity of its barium nitrate powder.

The independent 3<sup>rd</sup> party chemical analysis was completed by Southwest Research Institute, Inc. located in San Antonio, Texas under contract with EESstor, Inc.

With these milestones completed, EESstor, Inc. is now in the process of producing on its automated production line, composition-modified barium titanate powders and is moving toward completing its next major milestone of powder certification.

It is anticipated that the relative permittivity of the current powder will-either meet and/or exceed 18,500, the previous level achieved when EESstor, Inc. produced prototype components using it engineering level processing equipment.

Richard Weir, CEO and President of EESstor, Inc. added: "We are very proud of the key advancements we have made over the past year. In addition to the milestones identified, the Company has also been awarded a critical patent related to our technology and has 12 additional patents pending. We have built a state-of-the-art facility and have exceptional personnel onboard."

The first commercial application of the EESU is intended to be used in electric vehicles under a technology agreement with ZENN Motors Company. EESstor, Inc. remains on track to begin shipping production 15 kilowatt-hour Electrical Energy Storage Units (EESU) to ZENN Motor Company in 2007 for use in their electric vehicles. The

production EESU for ZENN Motor Company will function to specification in operating environments as severe as negative 20 to plus 65 degrees Celsius, will weigh less than 100 pounds, and will have ability to be recharged in a matter of minutes.

### **ABOUT EESstor, Inc.**

Headquartered in Cedar Park, Texas, EESstor, Inc. is dedicated to the design, development, and manufacturing of high-density energy storage devices. Utilizing revolutionary ultra capacitor architecture and environmentally friendly materials the EESstor, Inc. EESU will compete against all existing battery technologies. The EESstor, Inc. EESU IS capable of microsecond recharging and millions of 100% charge/discharge cycles. The technology is affordable and designed for versatile “racked and stacked” configurations.

**For additional information please contact:**

**Richard Weir**

President and Chief Executive Officer

EESstor, Inc.

(512) 259-5144

dick\_weir@eestor.us



## ***Information***

### **LOCKHEED MARTIN SIGNS AGREEMENT WITH EESTOR, INC., FOR ENERGY STORAGE SOLUTIONS**

DALLAS, January 9, 2008 – Lockheed Martin [NYSE: LMT] has signed an exclusive international rights agreement to integrate and market Electrical Energy Storage Units (EESU) from EESor, Inc., for military and homeland security applications. Specific terms of the agreement were not disclosed.

EESor, based in Cedar Park, TX, is developing a ceramic battery chemistry that could provide 10 times the energy density of lead acid batteries at 1/10th the weight and volume. As envisioned, EESUs will be a fully “green” technology that will be half the price per stored watt-hour than traditional battery technologies.

“Lockheed Martin has a wide range of innovative energy solutions for federal, state and regional energy applications,” said Glenn Miller, vice president of Technical Operations and Advanced Research at Lockheed Martin Missiles and Fire Control. “The EESor energy storage technology provides potential solutions for the demanding requirements for energy in military and homeland defense applications.”

EESUs are planned as nontoxic, non-hazardous and non-explosive. Since the EESU design is based on ultra-capacitor architecture, it will allow for flexible packaging and rapid charge/discharge capabilities. EESUs will be ideally suited for a wide range of power management initiatives that could lead to energy independence for the Warfighter.

“Lockheed Martin continues to focus on providing our Warfighters with new and innovative technologies that will make their jobs easier,” said Lionel Liebman, manager of Program Development – Applied Research at Lockheed Martin Missiles and Fire Control. “Our ruggedized BattPack™ energy storage unit generated considerable interest at the Association of the United States Army Annual Meeting in October 2007 for its potential for fuel savings in vehicular silent watch applications. The potential of an even safer, smaller and more powerful EESU in BattPack™ would significantly enhance the Warfighter’s capabilities.”

EESU qualification testing and mass production at EESor’s facility in Cedar Park is planned for late 2008.

EESor, Inc., of Cedar Park, TX, originally developed its solid-state EESU technology as a longer lasting, lighter, more powerful environmentally friendly electronic storage unit for a wide variety of applications. EESor’s vision also includes EESU facilitating the conversion of wind energy and photovoltaics into primary electrical energy providers and increasing the role of renewables for increasing energy production. Its CEO and president, Richard Weir, is also the inventor named on its EESU principal technology patent.

Headquartered in Bethesda, Md., Lockheed Martin employs about 140,000 people worldwide and is principally engaged in the research, design, development, manufacture, integration and sustainment of advanced technology systems, products and services.

# # #

Media Contact: Craig Vanbebber, 972-603-1615, [craig.vanbebber@lmco.com](mailto:craig.vanbebber@lmco.com)

*For additional information, visit our website:*

<http://www.lockheedmartin.com>

# EEStor, Inc.

## Specifications on the EESU-52 Ceramic Battery

1.0 Output voltage ( <b>Customer Established</b> )	*5V to 1500V
2.0 Internal dc resistance (ESR)	21.2 $\mu\Omega$
3.0 Stored energy (maximum)	52,220 W•h
4.0 Capacitance (maximum)	31 F
5.0 Inductance	0.142 $\mu$ H
6.0 Leakage current @ 85° C	4.3 $\mu$ A
7.0 Operating temperature range	-20° C to 65° C
8.0 Nonoperating temperature	200° C
9.0 Stored energy reduction over temperature range	< 1%
10.0 Weight (energy storage unit only)	113.5 kg
11.0 Volume (energy storage unit only)	74.4 L
12.0 Corrosive, harmful, or explosive materials	None
13.0 Electrode material	Nickel/Aluminum
14.0 Dielectric material	Ceramic basis
15.0 Solder material	Tin (Sn)
16.0 Hook-up material	Copper (Cu)
17.0 Cycle life, 100% cycles	$> 1 \times 10^6$
18.0 Type of cooling	Not required
19.0 Type of internal connections	Copper
20.0 Shock	**TBD by customers
21.0 Efficiency at end of life	> 94%
22.0 Charge rate ( <b>charging time will be established by the converter circuit capabilities</b> )	TBD by customers
23.0 Price \$/kW•h (depends of battery input and output converter circuit power requirements)	100 – 250
24.0 Power density, W/L – <b>determined by converter circuits</b>	***
25.0 Energy density, W•h/L	702
26.0 Specific power, W/kg – <b>determined by converter circuits</b>	***
27.0 Specific energy, W•h/kg	460
28.0 Packaging types	
• Highly corrosion resistant (EPC)	Stainless
• Noncorrosive	Titanium
• Light weight	Aluminum

\* **The buck-boost convert circuit can be configured to meet a wide range of output voltages, power delivery, or charging requirements.**

\*\* The EESU design can be tailored to meet a wide variety of impact profiles.

\*\*\* The peak power will be established by the converter circuit. These parameters can be significantly increased with high power converter circuits. **The energy storage unit will not be the limiting factor in determining these parameters due to the fact that a full charge of energy can be delivered to or removed from the energy storage unit at electronic speeds if required. This capability of delivering high amounts of energy at electronic speeds is excellent for some mission critical military applications.**

### NOTE:

1. All of the packaging types are sealed in a metal box with dry air internal to the unit.
2. The dc resistance can be lowered by 1000 or greater by increasing the amount of copper in the input and output hook-up wires and providing multiple input and output nodes.

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# ***EESstor, Inc.***

***The Energy Storage Company***

Wednesday, July 30, 2008

EESstor, Inc.  
Cedar Park, Texas

## **EESTOR ANNOUNCES CERTIFICATION OF ADDITIONAL KEY PRODUCTION MILESTONES AND ENHANCEMENT OF CHEMICAL PURITY**

Edward D. Golla, PhD, Laboratory Director for Texas Research International (acting as an independent agent) has certified that EESstor, Inc. test equipment, procedures, and techniques are capable of providing the EESstor, Inc. required testing accuracy for EESstor's chemicals and powder production processing analyses.

Since the beginning of 2007, EESstor, Inc. has been advancing its chemical purification and powder production processes. The decision to focus on these processes was made to help assure that EESstor, Inc. could meet the most critical demands of business segments for production throughput, cost, and energy storage. The certification data described in this press release will assist in indicating the success EESstor, Inc. has had in completing its objectives.

EESstor, Inc. has achieved success on one of its most critical technical milestones and that is the certification of the completeness of the powder crystallization of the constituents utilized in producing its CMBT powders. The percent of the constituents crystallized in the CMBT powders ranged from 99.57% to 100.00% with the average being 99.92%. This level of crystallization provides the path for the possibility of EESstor, Inc. providing the published energy storage for present products and major advancements in energy storage for future products.

The purification of the EEStor, Inc. chemicals has been certified by the same chemical analysis company as EEStor's press release dated January 17, 2007 and now indicates that EEStor has improved its chemical purity to the parts-per-billion range. The aluminum oxide particle coating material purification has been certified to be in the parts-per-trillion level. Achieving these levels of purification are additional major factors in allowing EEStor, Inc. the potential to reach its target working voltage. EEStor, Inc. has certification data from outside sources that purified aluminum oxide, in the range that EEStor, Inc. has certified, can have a voltage breakdown of 1,100 volts per micron. The target working voltage of EEStor's chemical processes is at 350 volts per micron. This provides the potential for excellent protection from voltage breakdown.

It has also been certified by Mr. Ian Treviranus of HORIBA Instruments, Inc. and the LA-950 particle measurement system that EEStor, Inc. has achieved their goal of producing powder particles in the range of 1 micron with a very narrow particle size distribution. EEStor, Inc. has certification data that indicates achieving powder particle of this size and distribution along with the aluminum oxide particle coating assists EEStor, Inc. in meeting the energy storage stabilization over the temperature range of interest for key applications.

EEStor, Inc. published patent, application number 5812758, indicates the flexible matrix concept that could provide the potential of multiple technical and production advantages. One of the technical advantages indicated is assisting in providing polarization of the ultra capacitors. Polarization along with other proprietary processing steps provides the potential of a polarization saturation voltage required by EEStor, Inc.

These key certified production milestones of particle crystallization, size, purity, and polarization are expected to assist EEStor in providing not only present and future energy storage requirements but also production consistency.

### **ABOUT EEStor, Inc.**

Headquartered in Cedar Park, Texas, EEStor, Inc. is dedicated to the design, development, and manufacturing of high-density electrical energy storage units.

Utilizing revolutionary ultra capacitor architecture and environmentally friendly materials the EEStor, Inc. EESU will have the capability to compete against all existing battery and capacitor technologies.

*For additional information please email [info@eestor.us](mailto:info@eestor.us)*

## Lockheed Martin Signs Agreement with EESor

Posted by Lyle under Battery , Research , Competitors

Rate the post:

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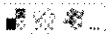
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Figure 3

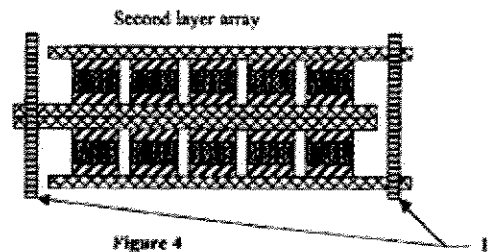


Figure 4

Mostly, we talk about the Volt here, but relevant and related topics are often worth discussing.

We have previously discussed a secretive Texas company called EESor, who are reported to be working on a new type of ultracapacitor that can hold 10x the energy in 1/10th the weight of typical batteries, at a fraction of the cost.

They have an agreement to produce caps for Zenn electric cars but to date have not shown any prototypes. This has led some to suspect EESor as not having the technology they report.

Today, however, Lockheed Martin, the major U.S. military equipment manufacturer has announced a partnership agreement with EESor to develop energy applications.

If these ultracaps can really deliver what they are projected to, they could offer a dramatic advantage for electric vehicles.

To that end, I interviewed Lionel Liebman, manager of Program Development – Applied Research at Lockheed Martin Missiles and Fire Control.

The entire interview can be seen by clicking below.

*Can you tell me what your announcement was today?*

Lockheed Martin and EESstor are working together to find areas for integrating their technology to a variety of power management platforms we're working on.

*Is it a financial contract?*

We're not taking any sort of ownership of EESstor. It is an exclusive rights agreement to allow us to market these technologies to a very limited number of potential customers including homeland security and the defense markets.

*Lockheed Martin builds fighter jets and military equipment?*

And missiles, rockets, ground equipment, vehicles, and systems sensors. Obviously everything that requires power to operate. Power is becoming a sticking point or burden to the warfighter and that's one of the things we're focused on is coming up with solutions that make the warfighter's job easier and more efficient.

*Are you looking to develop portable energy storage for the battlefield?*

Yes there are opportunities not only to help in the area of relieving some of the dependence on fuel as energy. Also to increase the value of some of the renewable energy initiatives that are going on right now. Energy storage increase the value of these types of power generation technologies. EESstor's technology can help in that area.

*What have you seen from EESstor in terms of their technology?*

We've visited their facility. We were very impressed. They are taking an approach that lends itself to a very quick ramp-up in production. We've seen a lot of their testing and efforts to measure the purity of the powders that they use, and the chemistry. We'll be working with them very closely this year to develop prototypes in certain pursuits.

*Have you been able to evaluate any of their current prototypes?*

That's an effort that's ongoing. We're really just getting started to integrate their technology into some of the efforts that we have going on here. That's going to be something that we're doing this year.

*So its a collaborative effort to build the prototypes then?*

That's right.

*Do they have something that they've tested that you've seen which makes you want to work with them?*

We haven't personally tested their prototypes yet. Its something that we'll work on together this year.

*How does Lockheed Martin feel about ultracaps and storage versus li-ion or NiMh batteries?*

Lockheed Martin doesn't have a bias. One way or another its really just a function of what does the customer want. For certain applications being able to provide pulse power is really really important, in another its not so much really pulse power but continuous power. If you talk to the Army they are really interested in hybridized solutions. Suffice it to say that EESstor's technology is a piece of some of these systems solutions that we come up with. We are a system integrator so we look at the EESstor technology as a building block or a tool in a toolbox to provide the best solutions for the soldier.

*Do you see the ultracap as a power solution or an energy solution?*

The EESstor chemistry and architecture lends itself to both types of applications. Its a scalable technology. In the situation where you are trying to store energy, transport it without discharge obviously thats very attractive in the utility grid load leveling (situation). If your talking about powering for example a high energy weapon that requires a short burst of energy a capacitor is a great approach to do that. Capacitors are in hybridized systems today for that reason. The chemistry is great purely form the view of battery technology but its also very attractive for some of these extremely high pulse power applications.

*Are you looking to use this technology in any vehicular type of application?*

We have a number of platforms that were working on. Our applied research group is primarily focused on land forces power management which involves several area including vehicular power.

The needs of a consumer for a hybrid fuel-efficient car versus the need for a soldier in the battlefield are a bit different. The common theme there is 'what can we do to make them more efficient', and battery technology is important for that.

*Are you confident that their technology will offer a greater amount of energy and power density than batteries?*

Yes, and at a fraction of the cost.

*Do their caps hold 10x the energy at 1/10th the weight of a lead acid battery?*

Yes.

*How does the the price of EESstor's capacitors compare with Li-ion or NiMh batteries?*

It really depends on the chemistry, the volume, the packaging, the application. It is really application-specific. It's going to be lower price. Were not just concerned about hardware cost. Really what were focused on is logistics. Especially the logistics footprint in theater. That's probably more important than material cost. And that one of the things that we think this technology can bring. Because it can be used for a variety of applications with a common architecture and chemistry. Its compact, its scalable and can be applied to a

variety of applications. That obviously very attractive to a logistics community, to have more common components and that type of thing.

*Is there a production plan for 2008?*

Yes for EESstor. Their approach is when they start manufacturing these batteries, not just the cells, but also the package assembly, they will be in production. If you can get a visit to EESstor they'll show you their process and everything they've got in place to support that. Assuming that everything comes together in terms of tests and qualifications and that sort of thing, they will be ready to ramp up very quickly, because of the nature if the architecture and scalability of what they are doing.

*Can you say anything about the use of EESstor's technology in commercial vehicles?*

We are basically working with them exclusively and in the homeland security and defense department's markets. The commercial vehicle market, that's what EESstor will pursue. If their is a military application then we're going to help them integrate their technology into those applications, but when it comes to commercial vehicles that's EESstor's responsibility.

**Cordero, Jessica A. (JSC-AP111)**

---

**From:** Jeevarajan, Judith A. (JSC-EP511)  
**Sent:** Monday, September 28, 2009 12:23 PM  
**To:** Taylor, Edith C. (JSC-EP511)  
**Subject:** FW: Patent awarded...

One more..  
*Judy*

---

**From:** Termini, James A. (JSC-ZV)[BAR]  
**Sent:** Monday, January 05, 2009 10:33 AM  
**To:** Jeevarajan, Judith A. (JSC-EP)  
**Cc:** Peterson, Wayne L. (JSC-ZV); Geffre, James R. (JSC-ZV)  
**Subject:** Patent awarded...

Interesting!

[http://www.plentymag.com/blogs/edge/2008/12/secretive\\_startup\\_wins\\_key\\_pat.php](http://www.plentymag.com/blogs/edge/2008/12/secretive_startup_wins_key_pat.php)

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## Secretive start-up wins patent for battery alternative

New, safer batteries will have low production costs and longer lives.

Mon, Dec 22 2008 at 1:31 PM EST

By PlentyMag.com

Read more: ELECTRIC VEHICLES

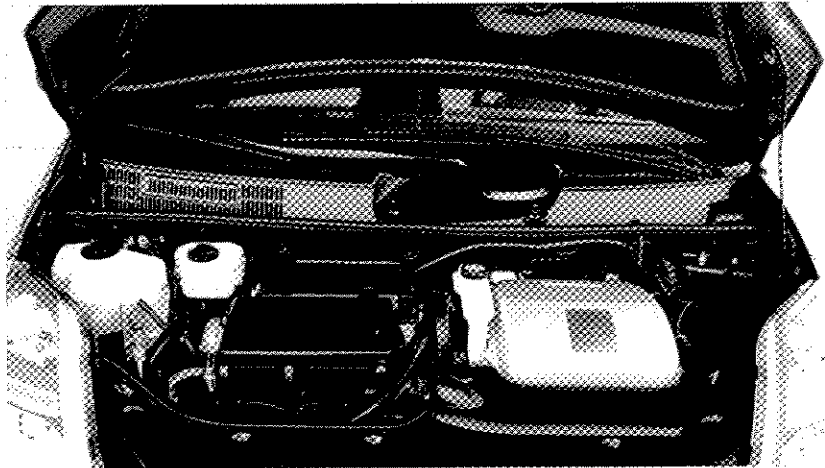


Photo: Beth and Christian

EESstor, an energy storage company, has kept electric vehicle enthusiasts on their toes with claims that it can build a very dense ultracapacitor, a potentially disruptive technology that could beat out conventional chemical batteries in many applications. But EESstor has been famously silent about the details of its device, leading some technology prognosticators and experts to doubt the product's existence. Last week, however, the low-profile company was awarded a patent for its methods, and with the patent came some juicy details.

**PLENTY**  
MAGAZINE

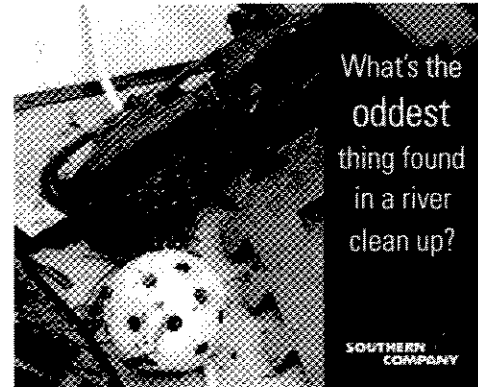
According to the patent application (pdf), the energy storage unit can hold at least 52 kilowatt-hours of electrical energy, weighs about 282 pounds, and recharges in 6 minutes or less. By comparison, a lithium-ion battery storing the same amount of energy weighs more than double that and recharges in 6 hours.

An ultracapacitor-style energy storage device offers a wide range of improvements on existing battery technology. Toxic materials, short lifespans, an underwhelming ratio of power to size, and price are only a few of the problems that EV makers have to juggle in deciding on a battery chemistry. Add to that long recharge times and the explosive nature of lithium batteries (arguably the most promising battery chemistry for cars), and the field looks cluttered with mediocrity. EESstor's devices, by contrast, are made from conventional, safe, and non-toxic materials—basically a titanium powder, copper, plastic, and aluminum—which means they'll have low production costs. Capacitors also don't wear out the way that batteries do, so they ought to have much longer lifetimes.

Despite EESstor's extreme reticence, the company has landed agreements with Zenn Motors, to incorporate the capacitors into Zenn's electric vehicles, and Lockheed Martin, which is pursuing defense applications for the devices. And it's not alone in the field—millions of ultracapacitors currently provide backup power for the memory used in microcomputers and cellphones. They supply brief bursts of energy to numerous consumer products containing batteries, for example by powering the zoom in many cameras. They're also being used in subways to recapture energy vehicles lose during braking.

But scaling up from cameras to cars is no easy feat. Whereas batteries release energy through a chemical reaction, ultracapacitors (also called supercapacitors) are essentially larger versions of the most mundane component in electrical engineering

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**Cordero, Jessica A. (JSC-AP111)**

09-255

**From:** Fox, Jane I. (JSC-AF211)  
**Sent:** Monday, September 28, 2009 1:45 PM  
**To:** Cordero, Jessica A. (JSC-AP111)  
**Cc:** Milner, Dianne (JSC-EA111); Madrigal, Raquel (JSC-EA111); Brekke, Michele A. (JSC-AF211)  
**Subject:** RE: FOIA ACTION JSC-FOIA-09-255

The JSC Innovation Partnerships Office (formerly Technology Transfer) does not have any written correspondence/communication related to "Feel Good Cars", Zenn Motor Company, or EESTor, Inc.

However, while searching the Agency-wide SBIR database there were six proposals identified as being received from EESTor, Inc, in response to a GRC subtopic in the 2002 SBIR Solicitation. All six proposals were evaluated by GRC employees. According to the SBIR database, no SBIR contracts were awarded.

Jane Fox

---

**From:** Cordero, Jessica A. (JSC-AP111)  
**Sent:** Friday, September 25, 2009 7:49 AM  
**To:** Milner, Dianne (JSC-EA111); Madrigal, Raquel (JSC-EA111); Fox, Jane I. (JSC-AF211)  
**Subject:** FOIA ACTION JSC-FOIA-09-255  
**Importance:** High

Please review the attached FOIA request.

**Due date:** 10/2/09

<< File: FOIA-09-255\_2.pdf >>

**Jessica Cordero**

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