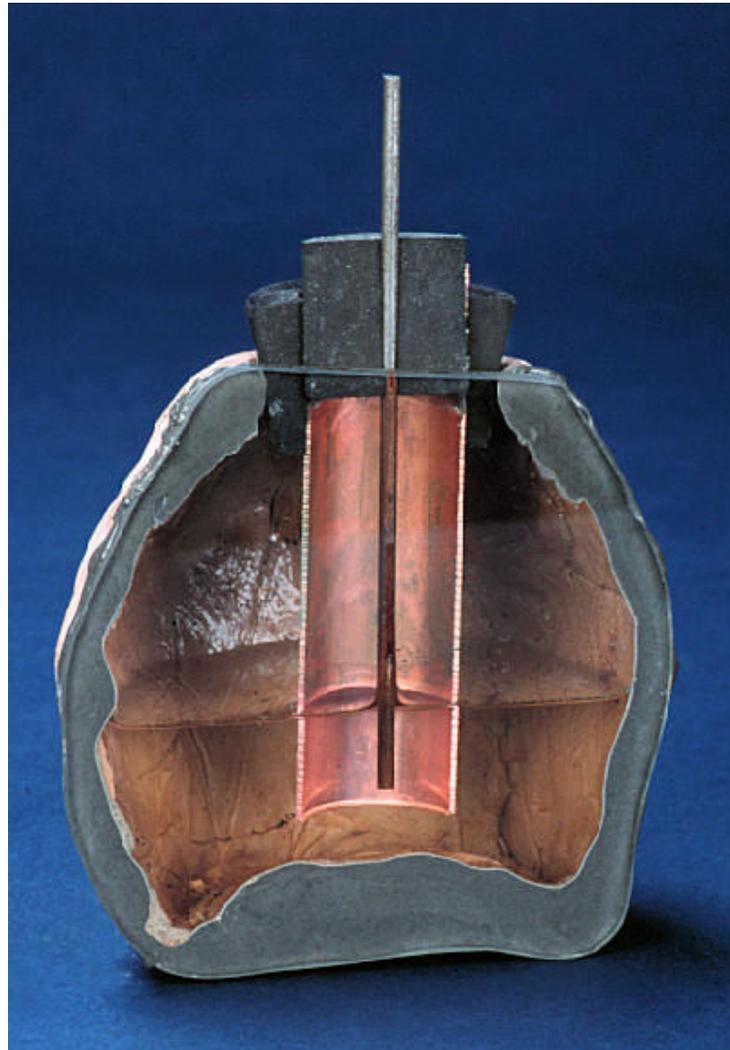


# **Battery World – Mid-Term** **Forecast**

**Advance power sources Conference –  
Batteries & Fuel Cells – Tel-Aviv University  
- 24/12/2006**

**Samuel De-Leon**  
**[shmueld3@bezeqint.net](mailto:shmueld3@bezeqint.net)**

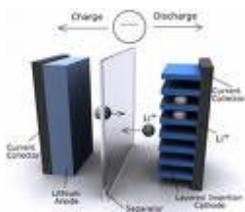


We start from here - Clay jar – with iron rod surrounded by copper cylinder and when filled with vinegar+an electrolytic solution produces 1.1 volts DC. AROUND: 250 BC to 640 ADO

# TECHNOLOGICAL TRENDS FOR THE NEXT DECADE

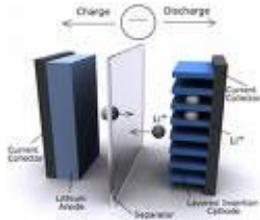


- **Energy Demand** – The need for portable energy sources is the main drive for Electro-Chemical power sources energy density improvements.

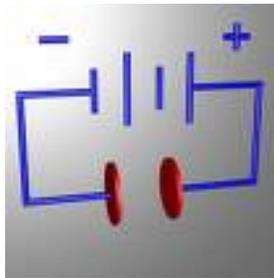


- **Lithium Ion Technology** – Penetrates new applications especially with large batteries/cells in place of other technologies. The Energy density gap to primary cells will decrease.
- **New chemistries** – probably no new chemistry. We will see a new type of Li-ion rechargeable cells and small energy density improvements in primary cells.

# TECHNOLOGICAL TRENDS FOR THE NEXT DECADE



- **Portable Small Fuel Cells** – will take the place of niche markets, mainly expensive applications, and military uses with portable commercial uses like Laptops if there is going to be a cost reduction.



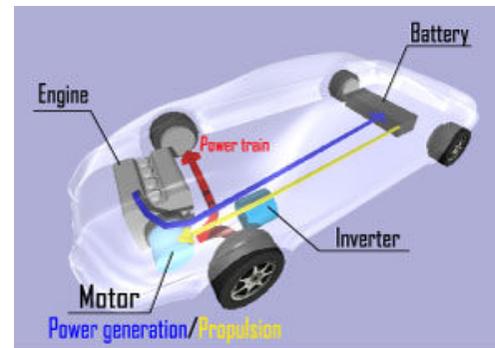
- **Hybrid Systems** – more and more Hybrid - integrate the good performance of different applications like battery + capacitor, battery + fuel cell, primary cell + rechargeable cell etc.

# Energy demands in the next decade

- Increasing demands for Hybrid Cars, Electric scooters, Electric Bikes because of gasoline high cost and needs for a "Green" environment

→ More batteries

Vectrix scooter



Hybrid car



Electric Bike

# Energy demands in the next decade

- Increasing demands for portable communications – more Laptops, PDA'S, Cellular phones, Video cameras, Power tools and integrated applications like PDA with integrated Cellular phone. → More batteries

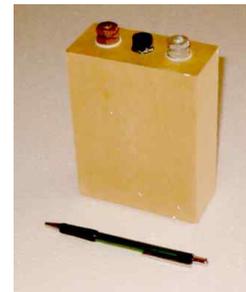




# Lithium-Ion Technology



- Proved technology.
- Wide spread in different sizes, stainless steel, Aluminum packaging and different internal constructions.
- Main development in Western world, Japan and Korea.
- Main production in China.
- Increase in energy density because of new materials developments.



# Li-Ion Materials Improvements

- New materials for cathodes like Nanostructure metallic alloy will increase energy density up to 30% with a intent not to decrease the cycle life.
- Sony new technology – "NEXLION" for video cameras - 15% more energy density with fast charge but cycle life decrease from 600 to 300 cycles.



**General expectation for 15-20% energy improvements**

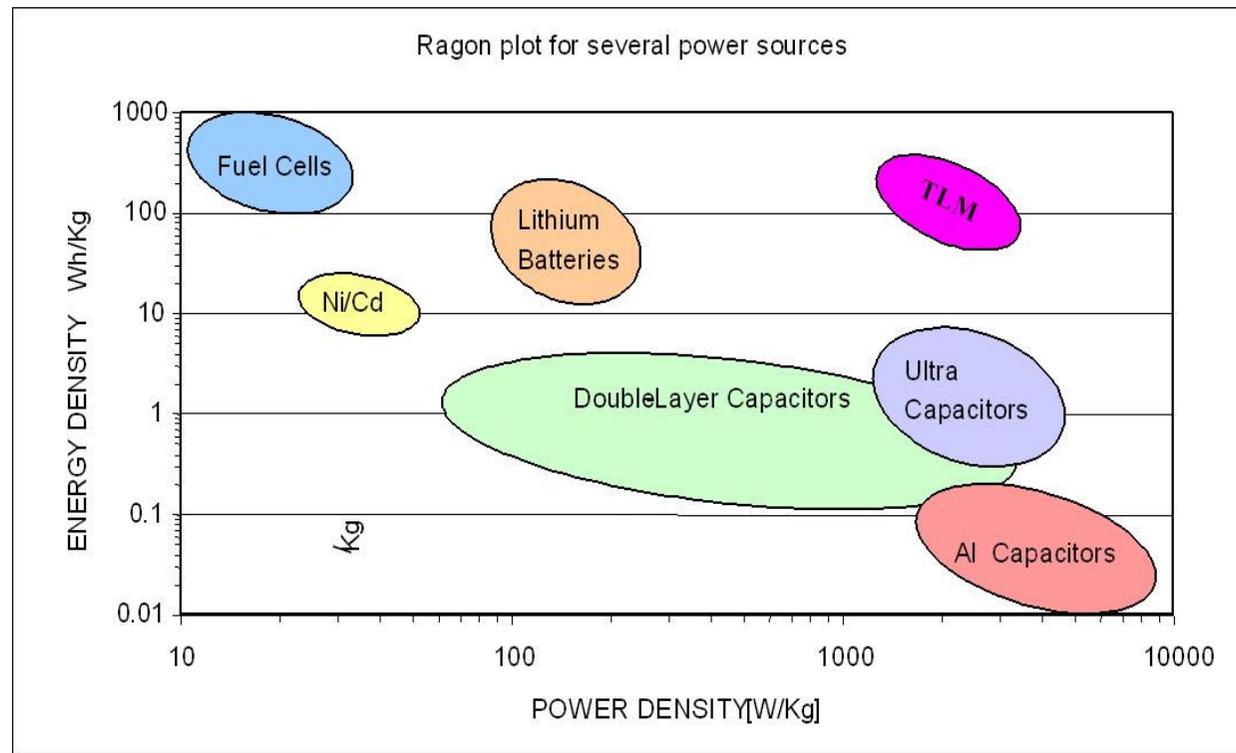
# The current gap Li-Ion VS Primary



<b>LITHIUM SULFURYL CHLORIDE</b>	<b>LITHIUM ION</b>
<b>ELECTROCHEM 3B30 C - SIZE</b>	<b>PANASONIC NCR18650 – LONG A SIZE</b>
<b>7 AH</b>	<b>2.9 AH</b>
<b>444 WH/KG</b>	<b>230 WH/KG</b>
<b>927 WH/L</b>	<b>605 WH/L</b>

# Tadiran new primary Li-Ion cells

- New technology with best power density for a primary system, higher voltage and no passivation.



# The target - to increase performance without decreasing safety

- Sony Li-Ion safety problems lead to a huge economic damage to the company – as has been learned by the world battery industry – Safety! Safety! Safety!



- According to Sony, at the packing phase during the manufacturing process, particles of Cu, Al, Fe and Ni get mixed in and generated the possibility of an internal short circuit .

# Lithium Ion Polymer as a replacement of Li-Ion

- Li-Ion energy density improvements lead to more safety risks , short circuits and fires.
- Lithium polymer batteries use lithium as an active ingredient with no liquids. Lithium Ion Polymer is considered safer than Li-Ion as the polymer is not flammable in comparison to organic electrolyte in Li-Ion.
- many technology improvements has taken place in last years.
- As a result of Sony Li-Ion safety problem Sony President has declared that within 2 years Sony plans to replace Li-Ion by Lithium Polymer for Laptops.



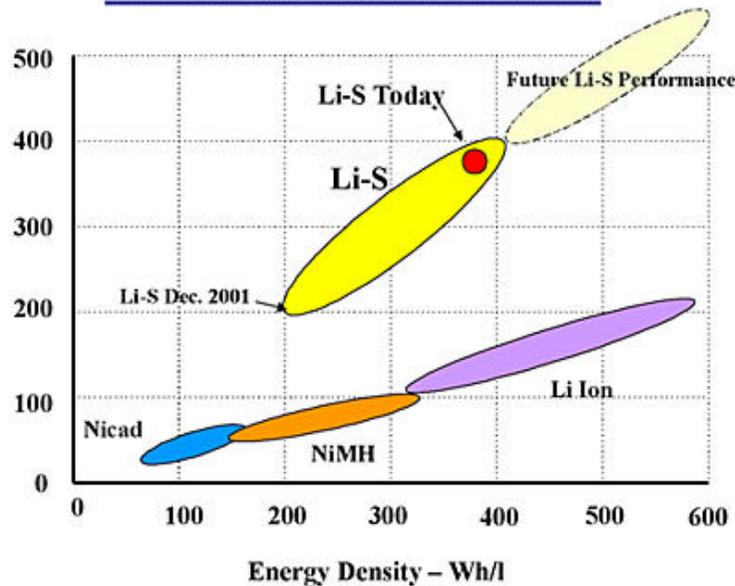
ver 1 - 26/12/2006



# SION – LITHIUM-S RECHARGABLE

- New promised technology development from SION- Rechargeable li-sulfur with weight energy density higher then Li-ION.
- 2.1-2.2V Working voltage.
- Current Cells with energy densities of 315WH/KG and 210WH/L in comparison to 230 WH/KG and 600 WH/L in Li-Ion.

Li-S vs. Other Cell Chemistries



# Primary Cell Improvements

- more lithium prismatic cells in order to gain volume energy density improvements.



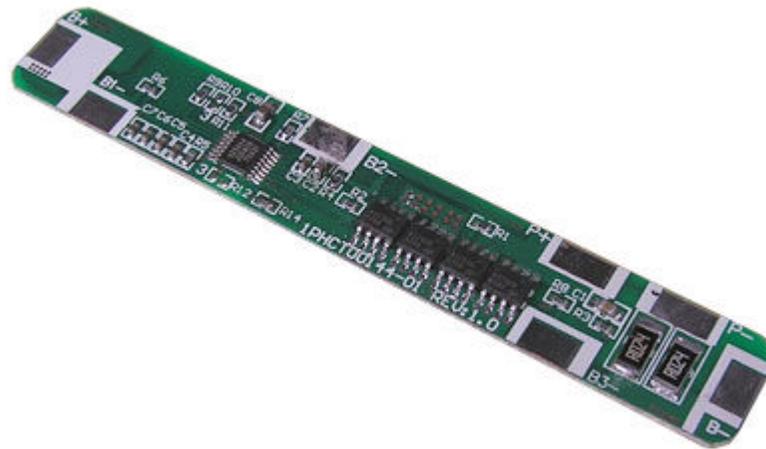
- Decrease in self discharge.
- Increasing operating temperature range.
- Decrease in passivation.

**Expectation for up to 5% energy improvements**

# Primary cell safety improvements

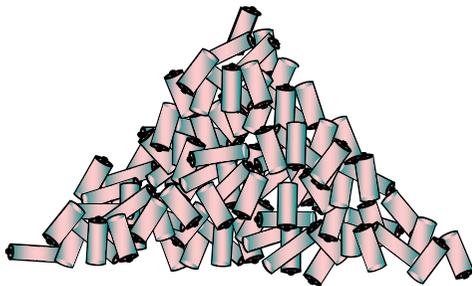
- Shut down separator
- Internal vent
- Internal fuse
- Cell level protection circuit board

EVE Safe  
Plus PCB



# Trends in primary cells for consumer markets

- Increased demands for Alkaline cells drive capacity improvements.
- More Alkaline prismatic cells.
- Alkaline market increase could be even higher - but consumer Ni-Mh rechargeable cells catch some market share.



500 cells of Dry cells → **WASTE**



1 cell of Ni-MH → **Reuse by recharge**



# Trends in primary cells for consumer markets

- New Chinese manufacturers for Lithium Iron spiral cells – Energizer is not the only one.
- Lithium iron market will expand with competition.

Energizer energy to go with Lithium Iron Cells



L91

CHINA SHANDONG HIHON



# Trends in primary cells for consumer markets

- Li-Mno<sub>2</sub> CR123 and CR2 replacements with Li-ION rechargeable cells with control board under the sleeve.



- More rechargeable Li-Ion power packs for charging Li-Ion batteries.



# Trends in Military Batteries Market

- Li-ion batteries and Zinc-Air batteries will replace part of the lithium primary batteries market share.



← Ultralife  
Li-Ion



← Electric- Fuel  
Zinc-Air

- Li-Mno<sub>2</sub> and Li-Soci<sub>2</sub> will replace part of the Li-So<sub>2</sub> market share due to better energy density and cost reduction + competition. There are many Li-Mno<sub>2</sub> manufacturers (more than 50) and Li-Soci<sub>2</sub> manufacturers (more than 27) but only 3 Li-So<sub>2</sub> manufacturers (US, Canada, China))



← Vitzro  
Li-Soci<sub>2</sub>



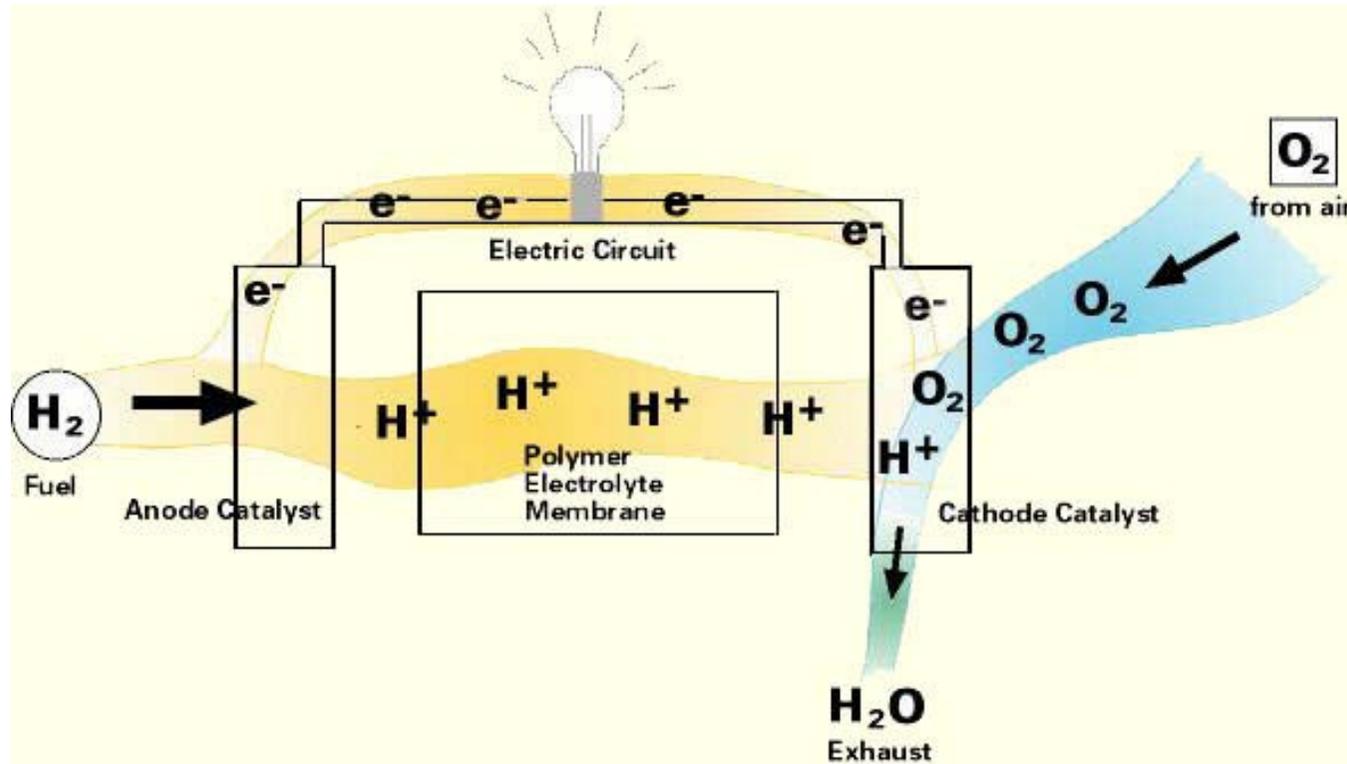
← Ultralife  
Li-Mno<sub>2</sub>

## **Trends in Military Batteries Market**

- **Li-CFX seem do be a possible candidate for a new chemistry battery for military batteries.**
- **3 manufacturers, Eagle-Picher Energy, Quallion, Spectrum Brands (formerly Ray-O-Vac) have developed a D-size Li-CFX Cells with around 15ah capacity for military batteries.**

# Fuel Cells

- Fuel cells produce energy from chemical materials and not a storage device like batteries.



# Portable Fuel Cells

- The technological and economical challenges are about to penetrate the market with a is cost reduction in Li-Ion cells and performance, cost, reliability competition.
- Potential energy densities up to 5 times higher than batteries.
- Intensive development world wide-spread.
- Intended for payable markets!!!.
- Are more expensive than batteries.
- Use batteries for start-up or power peaks.



**Fuel cells and batteries are complementary products.**

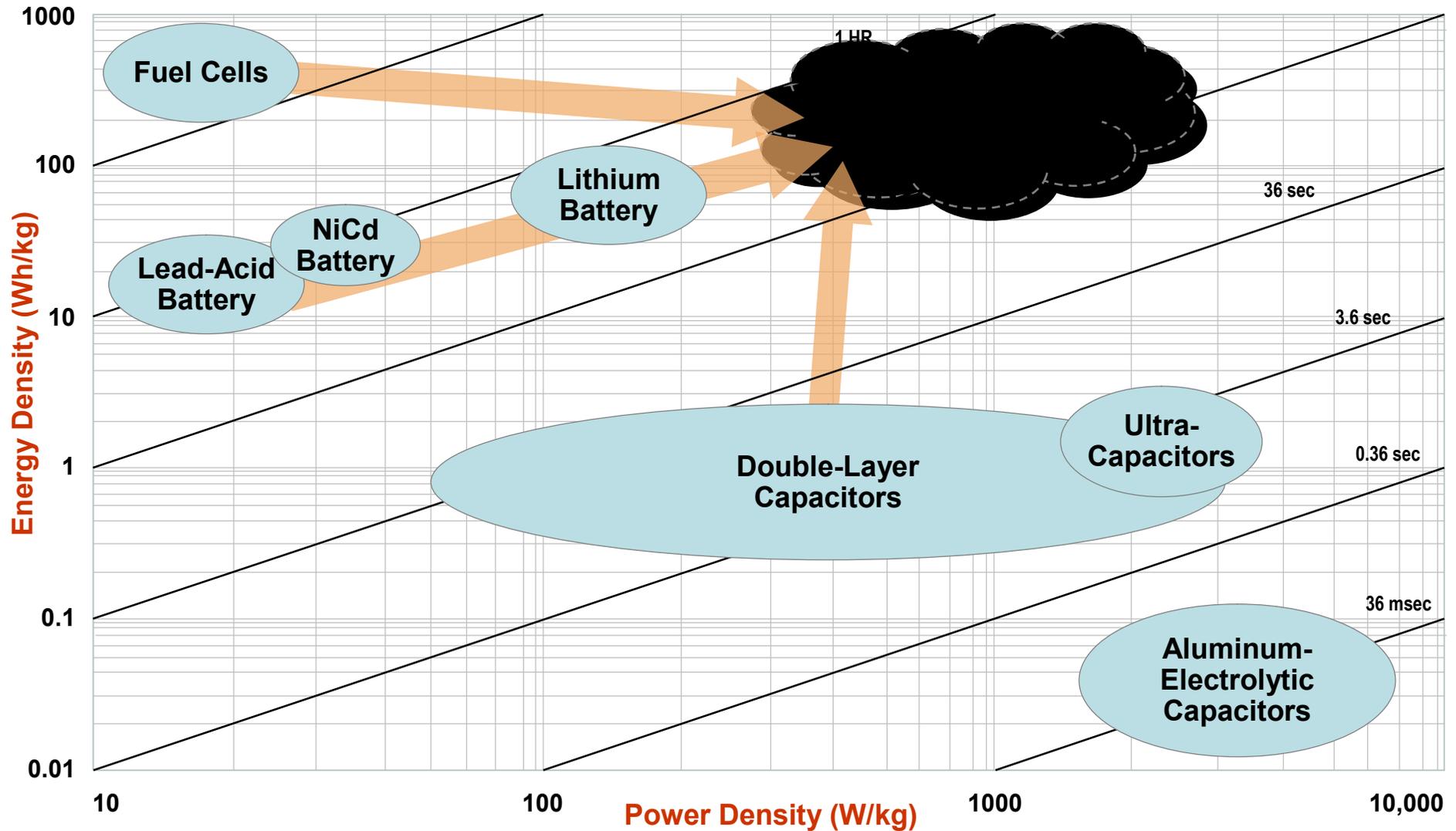
# Portable fuel cells – reaching commercial phase

First commercial fuel cells in the market are power packs for charging Li-Ion batteries



- Single use Fuel cell Power Pack from Medis Israeli company.
- Cartridge replaceable Fuel cell Power Pack from Ultracell USA company.

# Hybrid Systems -Why Hybrids?



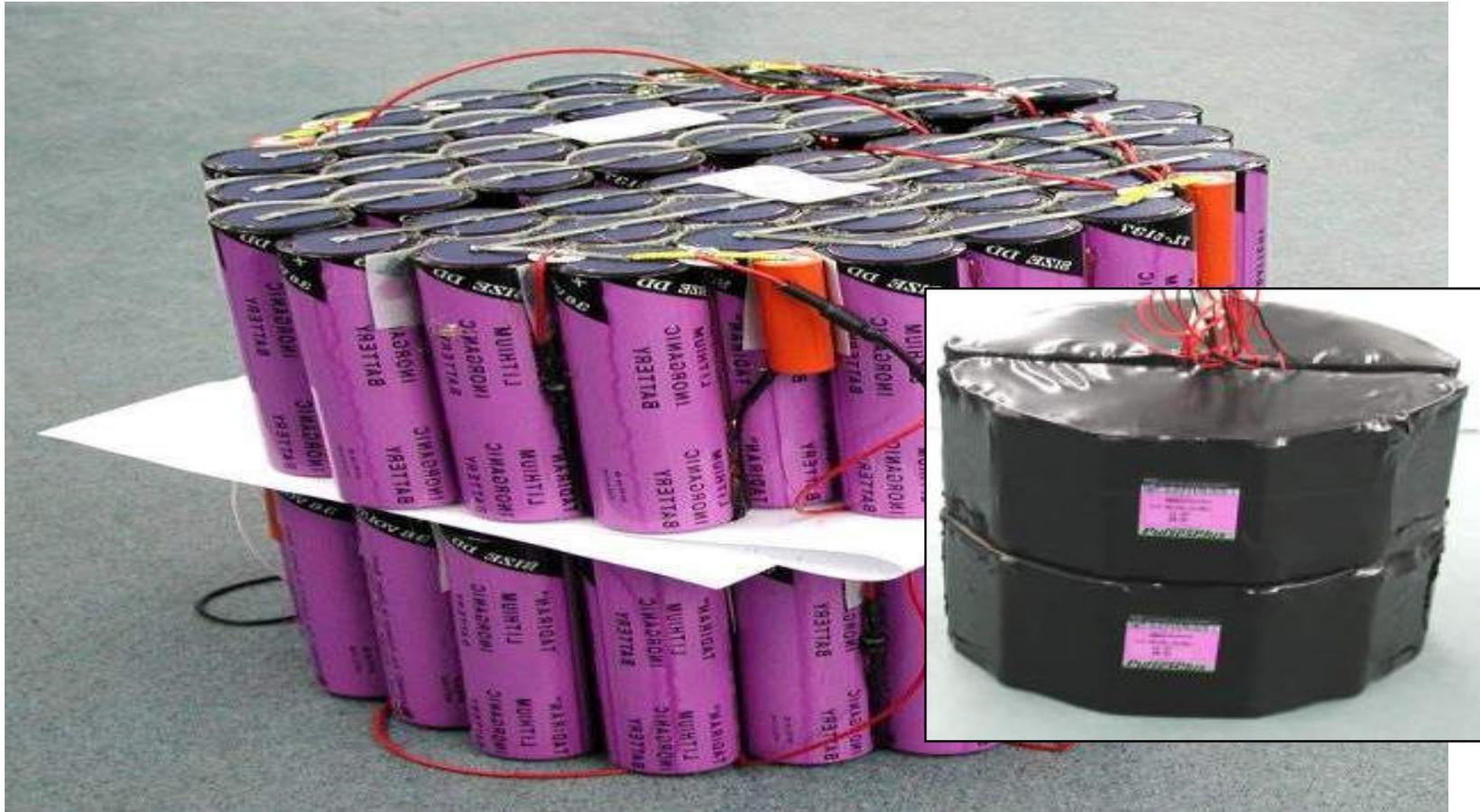
# Hybrid Systems

## Different technologies integrate basic idea

- Primary Lithium cells in parallel to capacitors – capacity, no passivation, pulses.
- Rechargeable Lithium cells in parallel to capacitors – power and pulses.
- Primary Lithium cells in parallel to rechargeable Li-Ion – capacity and power pulses, no passivation.
- Rechargeable Lithium cells in parallel to Fuel Cells – capacity and power pulses, no passivation.
- Capacitors in parallel to Fuel Cells – energy and pulses



**Tadiran Oceanographic Hybrid Battery:  
14KWh , 960Ah, 14.4 Volt, 19.5 Kg  
96 DD Lithium Thionyl Chloride Cells +12  
HLC1550 Super capacitor,**



# THANK YOU

**Samuel De-Leon**  
**shmued3@bezeqint.net**