

**IFCBC meeting 2010, 4 Feb**

**High Power Rechargeable  
Lithium Battery Market**

**Shmuel De-Leon  
shmuel33@gmail.com**



# Hybrid & Electric Vehicle – Growing Market For High Power Rechargeable Batteries



**E-Transportation is  
the most significant  
technological  
revolution after the  
cellular and the  
internet.**



# Energy Storage Systems – New Developing Market For High Power Lithium Batteries

- Manage fluctuations in electricity demand.
- MW reserve power plants.
- Manufacturers to take a part: A123, Altairnano, Enerdel, Electrovaya.



Semi trailer that houses one megawatt of lithium titanate batteries for grid storage



# How To Define High Power Rechargeable Lithium Cells?

	High Power Lithium Cells	Ultra High Power Lithium Cells
Max constant discharge current	>10C	>20C
Power weight density at max constant discharge current	>1000 W/kg	>2000 W/kg
Max pulse discharge current	>20C	>40C
Fast charging	$\geq 2C$	$\geq 2C$
Max constant discharge current capacity/ 1C constant discharge current capacity	>90%	>80%



# Differences From “Standard” Lithium Rechargeable Cells

- Higher power density - Lower internal impedance.
- Longer cycle life (LFP, LMO/LTO).
- Accept faster charging.
- Lower operation temperature range (- 40 c).

**But....**

- Safety problems.
- Lower energy density.
- Complicated battery design.
- Higher cost.





# Market Size

- **High power** - 84 manufacturers, > 1500 different cell models.
- **Ultra High power** - 19 manufacturers, >120 different cell models.

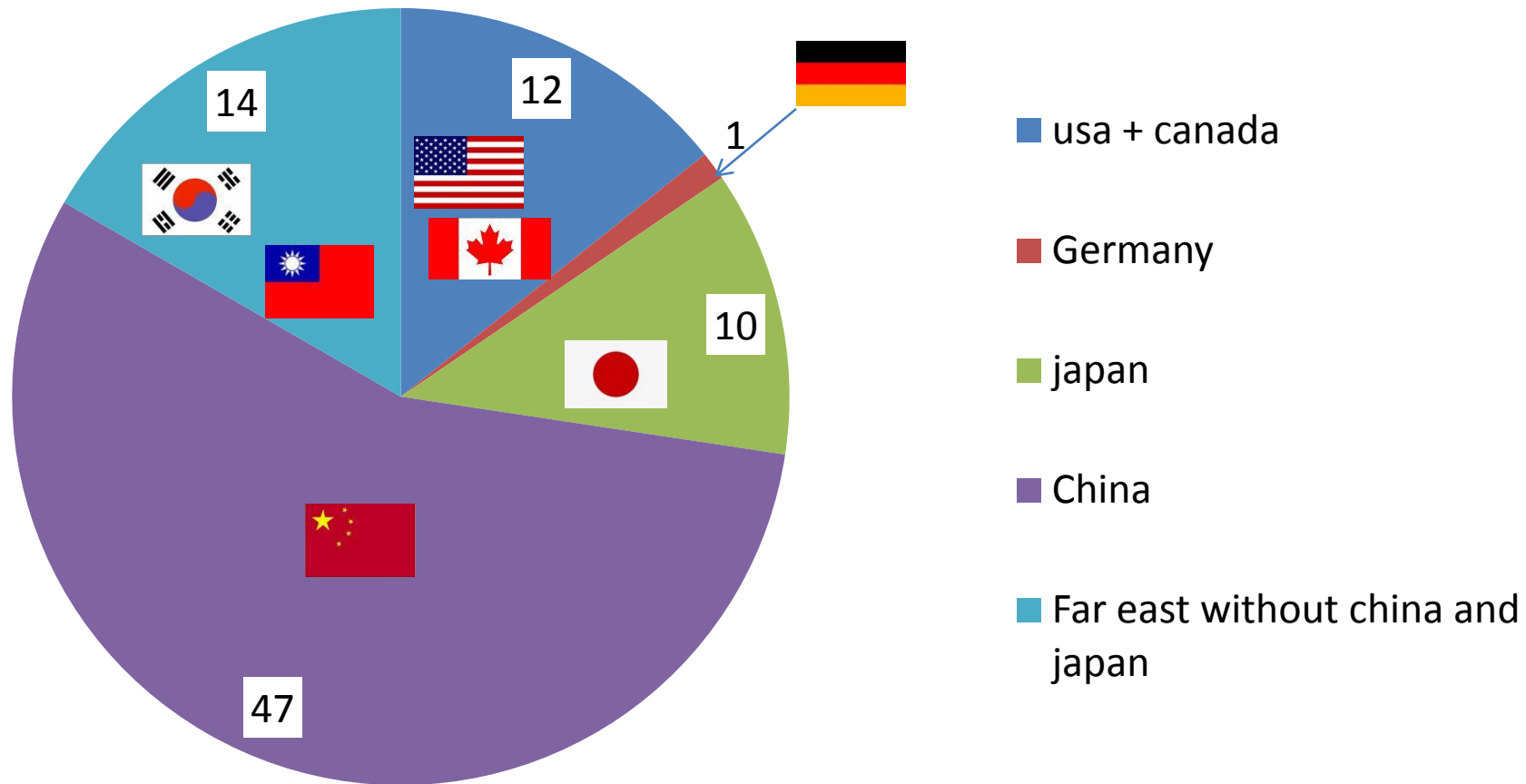
Market grow of 15% CAGR per year driven by the EV growing market, Cell costs are decreasing by 8% per year (Source: IIT).



[list of manufacturers at the presentation end.](#)

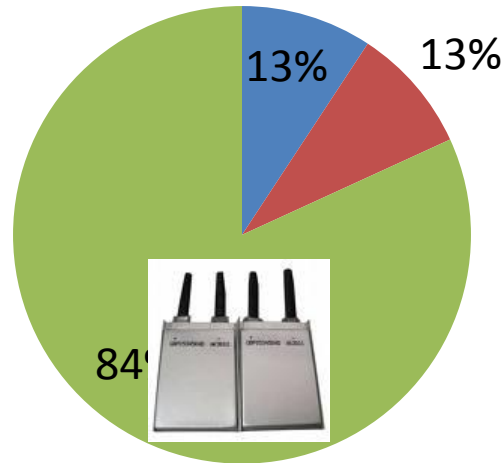
# Far-East manufacturers dominate the market

## 84 High power lithium cells Manufacturers



# High Power Lithium cells packaging

High power lithium pouch cells dominant the market, Higher weight energy density, Better heat transfer, Lower cost



- Cylindrical cells
- Prismatic cells
- Pouch cells



Pouch cells



Cylindrical cells



Prismatic cells

LI-P	LI-B	LI-FE
<b>207 Wh/Kg</b> PL093448HD	<b>167 Wh/Kg</b> LP1751AB	<b>140 Wh/Kg</b> IFR18650
<b>433 Wh/L</b> 646194FP	<b>420 Wh/L</b> LIP-173665	<b>389 Wh/L</b> 402045Fe

# Market Highest Constant Power Lithium Iron Phosphate New Cells

Cell	Size [mm]	Cap [Ah]	Cycle life	Temp range	Weight [gr]	Weight energy density [Wh/Kg]	Volume energy density [Wh/L]	Weight constant power density [W/Kg]	Volume power density [W/L]
<b>A123 -</b> AHR18700M1ULTRA	D=18 L=70	0.7	1000 to 90%	-10 to 100	38	60	129	<b>10855</b>	23169
<b>A123 -</b> AHR32157M1HD	D=32 L=157	10	1000 to 80%	-30 to 60	304	108	261	<b>10855</b>	26148
<b>Saft -</b> VL12V	D=47 L=173	12	500 to 80%	-30 to 60	640	67	144	<b>8437</b>	18000

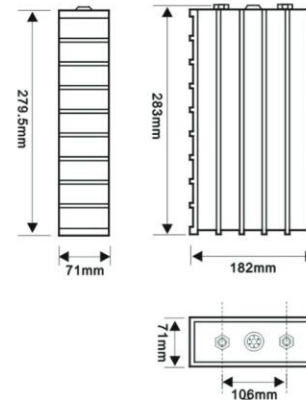


# Market Highest Capacity High power Cells

Cell	Size [mm]	Cap [Ah]	Cycle life	Temp range	Weight [gr]	Weight energy density [Wh/Kg]	Volume energy density [Wh/L]	Weight power density [W/Kg]	Volume power density [W/L]
<b>Beijing China Powerel</b> LI-P 3.6v Zrli-200	850 x 560 x 71	<b>200</b>	500 to 80%	?	7000	102	21	1028	213
<b>Lionik</b> LIP-55145255	255 x 145 x 55	<b>100</b>	500 to 80%	-20 to 60	3600	105	186	1055	1868

High capacity battery packs use high capacity cells to simplify battery design

*EV LiFePO4 Battery cell  
3.2V/180Ah*



# Market 18650 Size Highest power Cells

Cell	V	Cap [Ah]	Cycle life to 80%	Weight [gr]	Weight energy density [Wh/Kg]	Volume energy density [Wh/L]	Weight power density [W/Kg]	Volume power density [W/L]
<b>Advanced battery factory 1201007</b>	3.3	1.2	1000	43	92	239	<b>5525</b>	<b>14372</b>
<b>Q-Lite Industrial ICR18650HH</b>	3.7	1.3	500	40	120	275	3006	6885
<b>CENS Energy Tech Co 18650P</b>	3.2	1.1	<b>2000</b>	45	78	212	2844	7742
<b>American Lithium Inc No-P.N</b>	3.2	<b>1.5</b>	<b>2000</b>	34.3	<b>140</b>	290	2798	5806
<b>Henan Bideli Energy ICR18650P</b>	3.7	1.4	500	<b>38</b>	136	306	2726	6129
<b>Samsung INR18650-15R</b>	3.6	<b>1.5</b>	500	45	120	<b>326</b>	2000	5443

High competitive market with almost 50 different cell models



# Market Highest Operating temp. High Power Lithium Cells

Cell	V	Cap [Ah]	Cycle life to 80%	High oper. Temp. [c]	Weight energy density [Wh/Kg]	Volume energy density [Wh/L]	Weight power density [W/Kg]	Volume power density [W/L]
<b>Saft</b> VL32600-125	4.2	4	200	<b>125</b>	123	259	61	129
<b>Advanced Battery Factory</b> 3.2v/60ah	3.6	60	3000	<b>90</b>	80	127	666	1060
<b>Thunder sky</b> TS-LMP800AHA	3.7	800	1000	<b>75</b>	118	169	444	636



EV needs batteries with up to 80c high temperature operating range...

# How EV Makers Can Increase EV Driving Range?



I have no battery...

## Non oil dependent solution:

- Higher power energy density batteries with a weightless EV.
- Mechanically switch depleted batteries with a fully-charged ones.
- Fuel cell EV.

## • Fast charging...

## Oil dependent solution with a better fuel consumption:

- Hybrid or plug-in hybrid EV (ICE + Electric power train).
- EV batteries recharge by small ICE/Turbine/PV panels equipped on the vehicle.

# Ultra Fast Charging High Power Lithium Cells

Standard Charge	Quick Charge	Fast Charge	Ultra Fast Charge
<C/3	C/3<, <2C	>2C	>10C

Ultra Fast Charging batteries (up to 5 min, >80% capacity) are a less expansive way to increase EV driving range instead of EV battery expansive and complicated switch stations.

## Current Market Ultra fast charging cell

Cell I.D	Wh/Kg	Charge Rate	Cycle Life
GS Yuasa, LEV50, 50AH	108	10C	2000
GPL battery, GE-32AH-02, 32AH	93	9.38C	500
GAIA UHE-341440, 7.5AH	84	16C	500
Toshiba SCiB	65	11.9C	6000

Better Place Battery Switch Station



# Toshiba Super Charge Lithium Ion Battery - SCiB

- Lithium Manganese oxide Spinel cathode - **LMO**
- Lithium Titanate Oxide anode – **LTO**
- Recharge to 90% of full capacity in less than 5 minutes.
- Excellent safety because of high level anode stability.
- 6000 cycles of full D.O.D to 90% of initial capacity.
- Low temperature discharge from -30C.
- SCIB is currently available on the Schwinn Tailwind electric bike.

2.4Voc

**65 Wh/Kg**

131 wh/KG

650 W/Kg

1316 W/l

VW & Toshiba



SCiB Cell



# Ultra Fast Charging Should get more attention...


- There are very limited EV lithium ultra fast charging cell models in the market.
- Current cell models have a lower weight energy density - only 65-108 Wh/Kg in comparison to 130-170 Wh/Kg of standard high power cells.
- Ultra fast charging battery with 10% less energy density than standard high power cells are a better solution for EV driving range problem.

A small “payment” in Energy Density + Ultra fast Charging

=

EV Driving Range Solution

# Constant Power Density comparison – Primary to Rechargeable

	Primary Tadiran TLM Standard Family	Primary Tadiran New TLM- 1550UHP Cell	Rechargeable
Constant Current Discharge C-Rate	4-10	55	10-180
[W/Kg]	450-1300	<b>4500</b>	<b>5000-10800</b>
[W/l]	1900-2300	10800	10000 - 26200
Capacity [Ah]	0.47-0.8	0.45	10-200
[WH/Kg]	80-150	<b>81</b>	<b>100-200</b>

- **Rechargeable lithium constant power density is much higher than the best primary lithium power cells.**
- **Tadiran Batteries TLM cell family are the highest primary constant power density cells in the market.**

# High Power Li-Ion Safety Issues

- **Overcharging**
  - Explosive hydrogen out gassing
  - Thermal runaway resulting in melting, vent opening, explosion, fire
- **Short Circuit**
  - Internal or external may lead to thermal runaway
- **Leaks**
  - Liquid electrolyte leaks



**If it is not safe it will not survive...**

# E.V. makers & Battery Makers Joint ventures

- EV makers need an high power batteries for their Vehicles.
- Some build their own battery plants – BYD, Toyota, GM.
- Others sign a joint venture agreements with battery makers – NEC, Hitachi, Sanyo.
- [list of joint ventures at the presentation end.](#)



**Together we  
are stronger...**

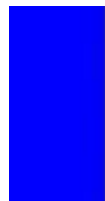


# Government Funds and Tax Subsidies Push Battery Development & Production

- U.S - 2.4 billion \$ fund program.
- France - 2.2 billion \$ fund program.
- China – 863 program.
- Germany – 500 million Euro.



Government funds push the battery development and production capability forward.



[list of programs at the presentation end.](#)

# Lithium Ion Technology Forecast

- **1<sup>st</sup> Generation Li-Ion Chemistries**

- Will dominate the rechargeable market for the near and mid future.

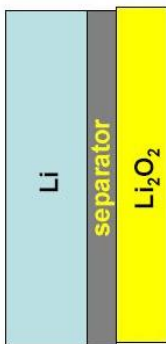


- **2<sup>nd</sup> Generation Li-Ion Chemistries**

- Better performance
  - Up to 300 Wh/kg with fast recharge.
  - Wider operating temperature range.
  - Fast Charging.
- Improved safety.
- Reduced cost.



- [list of Li-Ion chemistries at the presentation end.](#)



# What in the Future (7-10 years) ?



- **The promise of recharge/Primary Li-Air Batteries**
- **Potential store 5-10 times as much energy as today best systems.**
- **React with oxygen in the air.**
- **Sensitive to humidity, very low rate discharge.**
- **Developing companies: IBM, Excellatron, Liox Power, Lithion-Yardney, Poly plus, Rayovac.**
- **Research: AIST Japan, St Andrews UK, Michigan State University, Brookhaven National Laboratory, *Pacific Northwest National Laboratory*, University of Dayton Research Institute, Technion Israel.**

**Still a long way to go... but “the holy grail of batteries!”**

# Thank you for your attention

**Shmuel De-Leon**  
**[shmued33@gmail.com](mailto:shmued33@gmail.com)**

**Information in that presentation obtained by:**

- 1. Public web sources.**
- 2. Shmuel de-leon Battery /Energy Sources DataBase<sup>®</sup> (Includes 28000 cells PDF data sheets ).**
- 3. Shmuel De-Leon Battery Seminar<sup>®</sup> presentations.**

# Free Battery Industry News E-Mailing service

Any one wants to receive a free updated battery industry news + free monthly updated industry events is welcome to send me his contact details.

**Shmuel De-Leon**

**[shmued33@gmail.com](mailto:shmued33@gmail.com)**

# EV Battery – EV Makers

Battery Manufacturer	E.V & Power Tool Manufacturers
Altairnano - ATL	Phoenix Motorcars, The Lightning Car Company
A123 - BAK	GM, Chrysler, Nissan – Renault, Think, SAIC, BMW, Daimler, Fisker
A123 - Shanghai Advanced Traction Battery Systems	SAIC
BYD	BYD Auto, VW, SAIC
Atomic Energy Commission (CEA), French Strategic Investment Fund (FSI), Renault	Renault
<i>CITIC Guoan Menguli (MGL)</i>	Chinese EV buses
Cobasys	GM
Electrovaya	TATA, Miljobil Greenland
ENAX - Continental	Daimler
Ener1 - Enerdel	Volvo, Think, Mazda
E-One/ Moli	BMW, Fisker
FAAM	Fiat
GS –Yuasa (GSY)/ Lithium Energy Japan	PSA, Mitsubishi
,GS – Yuasa (GSY) - Blue Energy Co	Honda
Hitachi Vehicle Energy, Ltd	GM, Mitsubishi, Isuzu, Hyundai, Pininfarina
Johnson Control - Saft (JCS)	Daimler, Ford, BMW, Chery, Shanghai Motor , Azure Dynamics, SAIC Motor, Fisker, jaguar, land rover, VW
Kokam	Groupe Industriel Marcel Dassault (Dassault)
LG Chem	GM, Hyundai, Ford, VW

# EV Battery – EV Makers

Battery Manufacturer	E.V & Power Tool Manufacturers
Lishen	Miles (Hafei electric vehicles ) , Coda (Tianjin Qingyuan Electric Vehicle), Hengtong, Zhong Tong Bus, Ford, GM, Audi, Porsche, BMW, VW, Chana, Foton
Li-Tec Battery GmbH – Evonik Degussa – Deutsche Accumotive	Daimler, VW
Lithium Technology Corp/GAIA	VW, Mitsubishi
Matsushita Battery Industry (MBI)	GM, Honda, Toyota
Magna International Inc	Ford
NEC - Automotive Energy Supply Co (AESC)	Nissan – Renault, Subaru, Mazda, Suzuki
Panasonic EV Energy co (PEVE)	Toyota, Nissan – Renault, GM, Chrysler, PSA
Samsung SDI – SB LiMotive	Bosch, BMW, VW, PSA, Hyundai, Tesla, Delphi Corp
Sanyo	Toyota, Ford, Honda, GM, Daimler, VW, Tesla, PSA
Sony	Tesla
SK	Hyundai, Mitsubishi Fuso, CT&T, Daimler
Tianjin Lantian Technologies	Tianjin Qingyuan Electric Vehicle
Toshiba	VW
<i>Thunder Sky Battery</i>	China FAW Group Co
Varta	VW
Valence	EVI Electric Trucks, Smith electric vehicles
VK EIG Ltd (SOUTH KOREA)	TATA
Yardney - Lishen	Coda, Hafei China
<i>Wanxiang Electrical Vehicle Co</i>	<i>Wanxiang Electrical Vehicle Co, Chery, Zotye</i>

# EV Battery – EV Makers

Battery Manufacturer	E.V & Power Tool Manufacturers
EEStor (Ultra capacitors unit)	Zenn Motor Co
CENS ENERGY-TECH Co	Pihsiang Machinery Manufacturing Co., Ltd (TAIWAN)
Hyundai Mobis + LG Chem (company has no name yet)	Hyundai
EIG	TATA
K2 Energy	Fiat
?	REVA, MIDSET AG, LUMENEO, LOREMO, HEULIEZ, COMMUTER CARS, CHERY AUTOMOBILE, Beijing Auto, Brilliance Auto, Changan Auto, Dongfeng Auto, Guangzhou Auto, Jianghuai Auto, Sinotruk Group, Guangzhou Langging Electric Vehicle Co, great wall motor co, Geely
BAK International (Tianjin) Limited, Suzhou Phyllion Battery Co, YOKU Energy Technology Limited, Zhejiang Xinghai Energy Technology Co, Electric Vehicle Power System Technology Co., ELIY Power Co (JAPAN), EVB Technology (GP), OSN Power Tech Co, Sawtry Technology Limited, Sky Energy (Luoyang) Co, Shin Kobe Machinery Co – Japan, Zhejiang GBS Energy Co., Ltd., Microvast Power Systems Co. – China, Jiangsu Eastdye Battery Co	?

Cooperation between the companies in red is still missing – I will appreciate sending me relevant information – **Shmuel de-leon – [shmuel33@gmail.com](mailto:shmuel33@gmail.com)**

# Common Li-Ion Chemistries

Cathode Main	Cathode Sub	Anode	Manufacturers/ Developers	C.C. V	Weight energy density	Weight power density	Cycle life	Safety	cost
Lithium Cobalt oxide – <b>LCO</b>		Graphite	E-one moli, Sony, Samsung	3.7	High	Fair	Fair	Fair	High
Lithium Manganese Oxide Spinel - <b>LMO</b>		Graphite	LG chem, SK	3.8	High	High	Fair	Good	Low
Lithium Manganese Oxide Spinel Polymer - <b>LMO</b>		Graphite	Sony, Sanyo, GS - Yuasa	3.8	High	High	Fair	Good	Low
Lithium Manganese Oxide Spinel - <b>LMO</b>	Lithium Nickel cobalt Aluminum - – <b>NCA</b>	Graphite	Sony, Sanyo, GS – Yuasa, NEC	?	High	Fair	Good	Low	High
Lithium Manganese Oxide Spinel - <b>LMO</b>	Manganese Nickel Cobalt oxide <b>MNC</b>		Sony, Sanyo, Hitachi – Maxell, NEC, Samsung	3.7	High	High	Fair	Good	Low
Lithium Iron phosphate – <b>LFP</b>		Graphite	A123, Saft, Valence, Samsung, Sony, BYD, GS-Yuasa, Lithium technology, Lishen, LG Chem, Valence	3.3	80-120 Low	High	2000 High	Very good	Fair
Manganese Nickel Cobalt oxide – <b>MNC</b>		Graphite	Panasonic, Enerdel, Mitsubishi, Kokam, NEC, Samsung	3.2 – 4.2	High	Fair	Low	Fair	High

# Common Li-Ion Chemistries

Cathode Main	Cathode Sub	Anode	Manufacturers/ Developers	C.C. V	Weight energy density	Weight power density	Cycle life	Safety	cost
Nickel cobalt Aluminum Oxide – <b>NCA</b>		Graphite	Soft, Panasonic EV Energy, Lithium technology, Matsushita	3.7	160 High	High	Fair	Fair	High
Lithium Manganese oxide Spinel - <b>LMO</b>		Lithium Titanate Oxide - <b>LTO</b>	Enerdel, Toshiba, Altairnano, SK	2.5	90 Low	Low	4000 High	Good	High
Lithium Manganese Oxide – <b>LMO</b>	Manganese Nickel Cobalt oxide – <b>MNC</b>	Graphite	(Argonne Lab)	3.9	High	High	?	Very good	Fair
Lithium Nickel Oxide – <b>LNO</b>		Graphite	Johanson Control – Soft	4.2 – 3.2	High	Fair	Fair	Fair	Fair
Lithium Nickel Oxide – <b>LNO</b>		<b>SC</b>	Panasonic, American Lithium, Samsung Sdi						
Lithium Manganese Nickel Oxide Spinal - <b>LMNS</b>		Graphite	ETV Motors - research	4.8	High	High	Fair	Fair	Low
Lithium Manganese Nickel Oxide Spinal - <b>LMNS</b>		Lithium Titanate Oxide – <b>LTO</b>	ETV Motors – research	3.2	Fair	High	High	Good	Low

# Common Li-Ion Chemistries

Cathode Main	Cathode Sub	Anode	Manufacturers/ Developers	C.C. V	Weight energy density	Weight power density	Cycle life	Safety	cost
Lithium Manganese Nickel Oxide Spinal - <b>LMNS</b>		Lithium Titanate Oxide – <b>LTO</b>	<b>ETV Motors – research</b>	3.2	Fair	High	High	Good	Low
Lithium Nickel cobalt manganese oxide $\text{LiNi}_{0.5}\text{Mn}_{1.5}\text{O}_4$		Graphite	<b>Yardney</b>	4.7	High				
<b>LiCoPO4</b> <b>LiMn1.5 (Co, Fe, Cr)0.5O4</b>			<b>?</b>	4.8 – 5	high				
<b>Li2MnO3/1- xMO2</b>			<b>?</b>	4.7					
<b>LiNi0.5Mn0.5O2</b>			<b>?</b>						
<b>LiMn1.5Ni0.5O4</b>			<b>?</b>						
<b>LiCo1/3Ni1/3 Mn1/3O2</b>			<b>?</b>						
<b>Li[Ni1/3Mn1/3 Co0.233Al0.1] O2</b>			<b>?</b>	3.75					

# Common Li-Ion Chemistries

Cathode Main	Cathode Sub	Anode	Manufacturers/ Developers	C.C. V	Weight energy density	Weight power density	Cycle life	Safety	cost
Li-Metal		Sulfur	Sion	2.3	High	High	Poor	Poor	High
NCH; lithiated mixed oxide of nickel, cobalt, and aluminium $\text{Li}(\text{Ni}_{0.85}\text{Co}_{0.1}\text{Al}_{0.05})\text{O}_2$			?						
Lithium Vanadium Silicon Oxide $\text{LiVSi}_2\text{O}_6$			GS Yuasa						
Li-Metal		Sulfur	Sion	2.3	High	High	Poor	Poor	High
Li or Lithiated carbon		Electrode posited CuS	Tel-Aviv University (High power thin film 3D-MB)	2.1			Good		

# World Wide High Power Lithium Rechargeable Manufacturers

Battery Manufacturer	Web Site	Country
A123systems	<a href="http://www.a123systems.com">http://www.a123systems.com</a>	USA
Advanced Battery Factory	<a href="http://www.advancedbatteryfactory.com">http://www.advancedbatteryfactory.com</a>	China
Advanced Electronics Energy	<a href="http://www.aeenergy.com.hk">http://www.aeenergy.com.hk</a>	China
Advanced Lithium Electrochemistry Co., Ltd	<a href="http://www.aleees.com">http://www.aleees.com</a>	Taiwan
Apl Tech Battery Industry	<a href="http://www.aplbattery.com">http://www.aplbattery.com</a>	Malaysia
ATL - Amperex Technology	<a href="http://www.atlbattery.com/">http://www.atlbattery.com/</a>	China
Baoding Fengfan New Energy Co	<a href="http://www.sailli.com.cn">http://www.sailli.com.cn</a>	China
Baojia Battery Technology Co., Ltd	<a href="http://www.baojiabattery.com/">http://www.baojiabattery.com/</a>	China
Toshiba	<a href="http://www.toshiba-denchi.jp">http://www.toshiba-denchi.jp</a>	Japan
CENS Energy Tech Co	<a href="http://www.censli.com/">http://www.censli.com/</a>	China
Creup Technologies Ltd	<a href="http://www.creup.com/">http://www.creup.com/</a>	China
DLG Battery Co Ltd + K2 Energy Solutions	<a href="http://www.dlgbattery.com">http://www.dlgbattery.com</a>	China
E Square Technologies	<a href="http://www.e2-tek.com/">http://www.e2-tek.com/</a>	South Korea
Ecipy Power Co., Ltd	<a href="http://www.ecitypower.com">http://www.ecitypower.com</a>	China
Eemb Co	<a href="http://www.eemb.com">http://www.eemb.com</a>	China
Electric Vehicle Power System Technology Co	<a href="http://www.evpst.com/">http://www.evpst.com/</a>	China

# World Wide High Power Lithium Rechargeable Manufacturers

Battery Manufacturer	Web Site	Country
ELIYY Power Co	<a href="http://eliyypower.co.jp/">http://eliyypower.co.jp/</a>	Japan
Enerland Co	<a href="http://www.enerland.com/">http://www.enerland.com/</a>	South Korea
E-One Moli Energy (Canada) Limited	<a href="http://www.molicel.com">http://www.molicel.com</a>	Taiwan
ETI Tech	<a href="http://www.etitech.com.my/">http://www.etitech.com.my/</a>	Malaysia
EXA Energy Technology Co	<a href="http://www.exa.com.tw">http://www.exa.com.tw</a>	Taiwan
Excellatron	<a href="http://www.excellatron.com/">http://www.excellatron.com/</a>	USA
Panasonic EV - Energy	<a href="http://www.peve.jp/">http://www.peve.jp/</a>	Japan
Foshan U&T battery Co., Ltd	<a href="http://www.utbattery.com">http://www.utbattery.com</a>	China
Front Edge Technology	<a href="http://www.frontedgetechnology.com/">http://www.frontedgetechnology.com/</a>	USA
Future synergy power source co., ltd .	<a href="http://www.synergy-power.com">http://www.synergy-power.com</a>	China
Mitsubishi Batteries industrial	<a href="http://www.mhi.co.jp/en/index.html">http://www.mhi.co.jp/en/index.html</a>	Japan
GBP Battery	<a href="http://www.gbp-battery.com">http://www.gbp-battery.com</a>	China
General Electronics Battery Co	<a href="http://www.gbattery.com.cn">http://www.gbattery.com.cn</a>	China
GP Batteries	<a href="http://www.gpbatteries.com">http://www.gpbatteries.com</a>	China
Guangzhou FULLRIVER Battery New Technology Co	<a href="http://www.fentbattery.com">http://www.fentbattery.com</a>	China

# World Wide High Power Lithium Rechargeable Manufacturers

Battery Manufacturer	Web Site	Country
Henan Bideli Energy Source Science & Technology	<a href="http://www.bideli.com.cn">http://www.bideli.com.cn</a>	China
Hitachi Maxell Ltd - Hitachi Vehicle Energy, Ltd	<a href="http://www.hitachi-ve.co.jp">http://www.hitachi-ve.co.jp</a> <a href="http://www.maxell.co.jp">http://www.maxell.co.jp</a>	Japan
Huanyu Power Source Co	<a href="http://www.huanyubattery.com">http://www.huanyubattery.com</a>	China
Altairnano	<a href="http://www.altairnano.com">http://www.altairnano.com</a>	USA
Jiangsu Eastdye Battery Co	<a href="http://www.eastdye.com/">http://www.eastdye.com/</a>	China
Jiangxi Jingang Energy Technology Co., Ltd	<a href="http://www.kingcell.com.cn">http://www.kingcell.com.cn</a>	China
Kayo battery co., ltd	<a href="http://www.kayobattery.com">http://www.kayobattery.com</a>	China
Kingsfield Battery Tech Co. Ltd	<a href="http://www.kingsfieldhk.com">http://www.kingsfieldhk.com</a>	China
Kokam Co	<a href="http://kokamamerica.com/">http://kokamamerica.com/</a>	South Korea
ENER1 - ENERDEL	<a href="http://www.ener1.com/">http://www.ener1.com/</a>	USA
Lionik Battery	<a href="http://www.lionikbattery.com">http://www.lionikbattery.com</a>	China
Lithion	<a href="http://www.yardney.com/">http://www.yardney.com/</a>	USA
Lithium Technology Corp	<a href="http://www.gaia-akku.com/">http://www.gaia-akku.com/</a>	USA
Nanoexa	<a href="http://www.nanoexa.com">http://www.nanoexa.com</a>	USA
Narada Licom Power	<a href="http://www.naradalicom.com/">http://www.naradalicom.com/</a>	China

# World Wide High Power Lithium Rechargeable Manufacturers

Battery Manufacturer	Web Site	Country
Neosonic Li-Polymer Energy	<a href="http://www.neosonic.com.cn">http://www.neosonic.com.cn</a>	China
Ningbo Veken Battery Co Ltd	<a href="http://www.vekenbattery.com/">http://www.vekenbattery.com/</a>	China
Nuricell Inc	<a href="http://nuricell.com/?z=contents.e_sub02_01">http://nuricell.com/?z=contents.e_sub02_01</a>	South Korea
Phoenix Silicon International Co	<a href="http://mvp090-1.104web.com.tw/">http://mvp090-1.104web.com.tw/</a>	Taiwan
Phylion Battery (Suzhou)	<a href="http://www.xingheng.com.cn">http://www.xingheng.com.cn</a>	China
Q - Lite Industrial	<a href="http://www.q-liteindustrial.com">http://www.q-liteindustrial.com</a>	China
Quallion L L C	<a href="http://www.quallion.com">http://www.quallion.com</a>	USA
Rexpower Industrial Co	<a href="http://www.rex-cell.com/">http://www.rex-cell.com/</a>	China
Saft	<a href="http://www.saftbatteries.com/">http://www.saftbatteries.com/</a>	France - USA
Samsung SDI Co Ltd, SB Limotive	<a href="http://www.samsungsdi.com">http://www.samsungsdi.com</a> <a href="http://sblimotive.co.kr">http://sblimotive.co.kr</a>	South Korea
Sanyo	<a href="http://batteries.sanyo-component.com/">http://batteries.sanyo-component.com/</a>	Japan
Shenzhen B&K Technology Co	<a href="http://www.bkbattery.com">http://www.bkbattery.com</a>	China
Shenzhen Cham Battery Technology Co	<a href="http://www.cham.com.cn/">http://www.cham.com.cn/</a>	China
Shenzhen Eastar Battery Co	<a href="http://www.eastbattery.com">www.eastbattery.com</a>	China
Shenzhen Free Technology Co	<a href="http://www.chinafreepower.com">http://www.chinafreepower.com</a>	China

# World Wide High Power Lithium Rechargeable Manufacturers

Battery Manufacturer	Web Site	Country
Shenzhen Saibn Power Co	<a href="http://www.saibnpower.com">http://www.saibnpower.com</a>	China
Shenzhen Yiklik Energy Ltd	<a href="http://www.yiklik.com/">http://www.yiklik.com/</a>	China
Sony Energy Devices	<a href="http://products.sel.sony.com">http://products.sel.sony.com</a>	Japan
SouthRiver Products Ltd	<a href="http://www.southeriverproducts.com">http://www.southeriverproducts.com</a>	China
TCL Hyperpower Batteries	<a href="http://www.tclbattery.com">http://www.tclbattery.com</a>	China
Tianjin Lishen Battery Joint-Stock Co	<a href="http://en.lishen.com.cn">http://en.lishen.com.cn</a>	China
Universal Power Technology Company	<a href="http://www.universal-power.com.cn">http://www.universal-power.com.cn</a>	China
Valence Technology	<a href="http://www.valence.com/">http://www.valence.com/</a>	USA
VK EIG Ltd	<a href="http://www.eigbattery.com/">http://www.eigbattery.com/</a>	South Korea
Yoku Energy (Shenzhen) Co	<a href="http://www.yokuenergy.com">http://www.yokuenergy.com</a>	China
Yuntong Power Co	<a href="http://www.yuntong-batt.com">http://www.yuntong-batt.com</a>	China
Zhejiang Xinghai Energy Technology Co	<a href="http://www.xhnykj.com/">http://www.xhnykj.com/</a>	China
LG Chem	<a href="http://www.lgchem.com/">http://www.lgchem.com/</a>	South Korea
SK	<a href="http://www.skme.co.kr/">http://www.skme.co.kr/</a>	South Korea
Electrovaya	<a href="http://www.electrovaya.com/">http://www.electrovaya.com/</a>	Canada
GS-Yuasa – Lithium Energy Japan	<a href="http://www.gs-yuasa.com/">http://www.gs-yuasa.com/</a> <a href="http://lithiumenergy.jp">http://lithiumenergy.jp</a>	Japan

# World Wide High Power Lithium Rechargeable Manufacturers

Battery Manufacturer	Web Site	Country
JND Battery	<a href="http://www.jnd-battery.com">http://www.jnd-battery.com</a>	China
BYD	<a href="http://www.byd.com.cn/">http://www.byd.com.cn/</a>	China
Panasonic	<a href="http://industrial.panasonic.com/">http://industrial.panasonic.com/</a>	Japan
NEC Tokin Corp – Automatic Energy Supply Co	<a href="Http://www.nec.co.jp">Http://www.nec.co.jp</a> <a href="http://www.eco-aesc.com">http://www.eco-aesc.com</a>	Japan
Leclanché Lithium GmbH	<a href="http://leclanche.coeno.com">http://leclanche.coeno.com</a>	Germany
Hangzhou Future Power Technology Co	<a href="http://www.ftbattery.com/">http://www.ftbattery.com/</a>	China
Tianjin Lishen Battery Joint Stock Co	<a href="http://www.lishen.com.cn/">http://www.lishen.com.cn/</a>	China

# U.S Department of Energy Support The Battery Industry

- **\$2.4 billion in funding through the American Recovery and Reinvestment Act for 48 advanced battery and electric vehicle projects.**
- **Accelerate the development of U.S. manufacturing capacity for batteries and electric drive components.**
- **Accelerate the deployment of electric drive vehicles.**
- **\$1.5 billion in grants to U.S. based manufacturers to produce batteries and their components and to expand battery recycling capacity.**
- **\$500 million in grants to U.S. based manufacturers to produce electric drive components for vehicles, including electric motors, power electronics, and other drive train components.**
- **\$400 million in grants to purchase thousands of plug-in hybrid and all-electric vehicles for test demonstrations.**

Applicant	DOE Award (Dollars in Millions)	Project Locations	Technology
Johnson Controls, Inc.	\$299.2	Holland, MI Lebanon, OR (Entek)	Production of nickel-cobalt-metal battery cells and packs, as well as production of battery separators (by partner Entek) for hybrid and electric vehicles.
A123 Systems, Inc.	\$249.1	Romulus, MI Brownstown, MI	Manufacturing of nano-iron phosphate cathode powder and electrode coatings; fabrication of battery cells and modules; and assembly of complete battery pack systems for hybrid and electric vehicles.
KD ABG MI, LLC (Dow Kokam)	\$161	Midland, MI	Production of manganese oxide cathode / graphite lithium-ion batteries for hybrid and electric vehicles.
Compact Power, Inc. (on behalf of LG Chem, Ltd.)	\$151.4	Indianapolis, IN	Production of lithium-ion cells and packs for hybrid and electric vehicles. Primary lithium chemistries include: manganese spinel cathode and lithium titanate anode for high power applications, as well as manganese spinel cathode and amorphous carbon for high energy applications.
Saft America, Inc.	\$95.5	Jacksonville, FL	Production of lithium-ion cells, modules, and battery packs for industrial and agricultural vehicles and defense application markets. Primary lithium chemistries include nickel-cobalt-metal and iron phosphate.

Applicant	DOE Award (Dollars in Millions)	Project Locations	Technology
Exide Technologies with Axion Power International	\$34.3	Bristol, TN Columbus, GA	Production of advanced lead-acid batteries, using lead-carbon electrodes for micro and mild hybrid applications.
East Penn Manufacturing Co.	\$32.5	Lyon Station, PA	Production of the UltraBattery (lead-acid battery with a carbon supercapacitor combination) for micro and mild hybrid applications.
Seeo, Inc	\$6.2	Berkeley, CA	Solid State Batteries for Grid-Scale Energy Storage - Develop and deploy a 25kWh prototype battery system based on Seeo's proprietary nano structured polymer electrolytes. This new class of advanced lithium-ion rechargeable battery will demonstrate the substantial improvements offered by solid state lithium-ion technologies for energy density, battery life, safety, and cost. These batteries would be targeted for utility-scale operations, particularly Community Energy Storage projects.

# France Energy Ministry – EV Development Plan, 2.2 billion US\$

- a public investment of €1.5 billion (US\$2.2 billion) to establish a network of 1 million charging points by 2015 and the building of a €625 million (US\$910 million) lithium-ion battery plant at a plant owned by Renault with a public contribution of €125 million (US\$182 million) toward the total.
- Renault will establish a Li-ion battery factory in Flins, in partnership with CEA (France's Atomic Energy Commission), at an investment of €625 million. This site may produce more than 100,000 batteries per year. Bolloré, Dassault and Saft are also conducting parallel projects.