«Il mercato dei sistemi di accumulo per i veicoli elettrici per il trasporto merci e per i servizi di potenza: il punto di vista di un costruttore»

MIDAC BATTERIES

Power Passion

www.midacbatteries.com

Roberto Isidori

Lucca, 10/07/2015


gruppo
mastrotto
Fatturato 2014: 520 Mil€
dipendenti : 2600
Power Passion
MIDAC
Headquarters Soave (VR)
150mil€ Fatturato 2014
530 dipendenti negli stabilimenti Italiani
MIDAC
BATTERIES

Our Battery Range

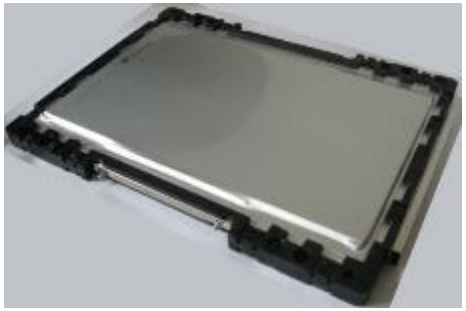
ELECTRIC & HYBRID VEHICLES BATTERIES

Electrochemical Battery for Automotive & Motive Power Applications

Type		Voltage	Energy density	Energy density	Power density	Effi.	Cycles (DoD 80% @RT)	Calendar Life
		(V)	(Wh/kg)	(Wh/L)	(W/kg)	(%)	(#)	Years
Lead-VLA		2.0	40	90	180	85%	1800	@15
Lead-VRLA		2.0	30	75	180	85%	600	@12
Ni-cadmium		1.2	@60	@150	150	70%-90%	1500	5
NiMH		1.2	@80	@300	@1000	66%	1000	5
Li-ion	LCO	3.6	160	270	1800	99 %	1200	5
	NCA	3,6	240	600	1000	98%	3000	+15
	LMS	4,0	140	250	2000	98%	2000	@10
	NMC	3.7	215	500	@4000	98 %	@8000	+15
	LFP	3.2	135	220	@4000	98 %	@8000	+15
	LTO	2.3	90	160	10000	87-95%	@25000	+20
Ni-NaCl		2,6	90	150	170	75%	@800	+10

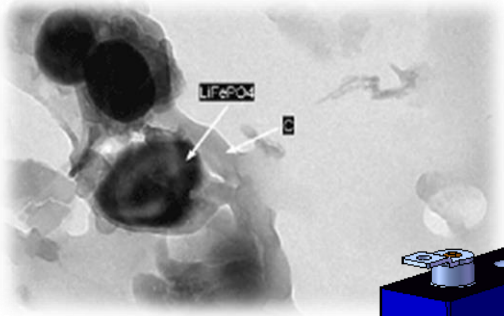
Different Selected Chemistry for different application

New NMC Lithium Polymer Cell



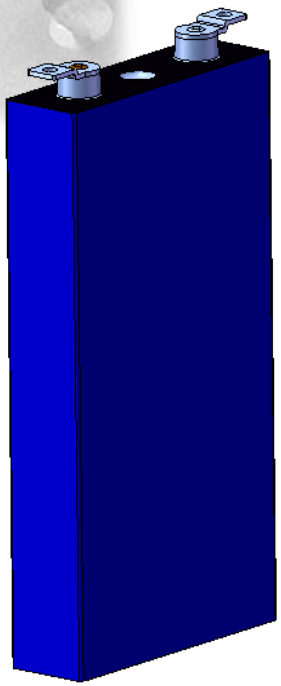
- Coating cathode protection
- Long Life: 1500-5000 cycles
- Long calendar life: >15y
- High energy density

www.midacbatteries.com



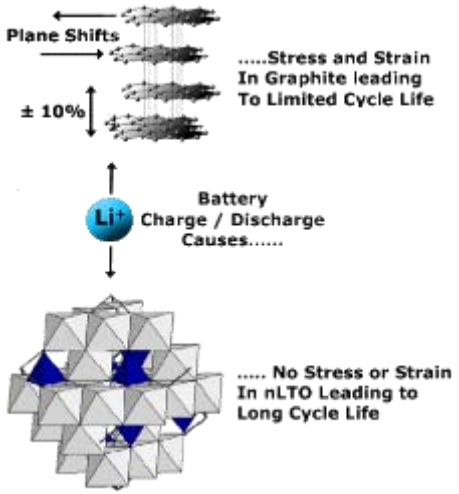
LiFePO4

Lithium Iron Phosphate



- More Safety
- High Power Density: 4000 W/kg
- Long Life 2000 - 8000 cycles

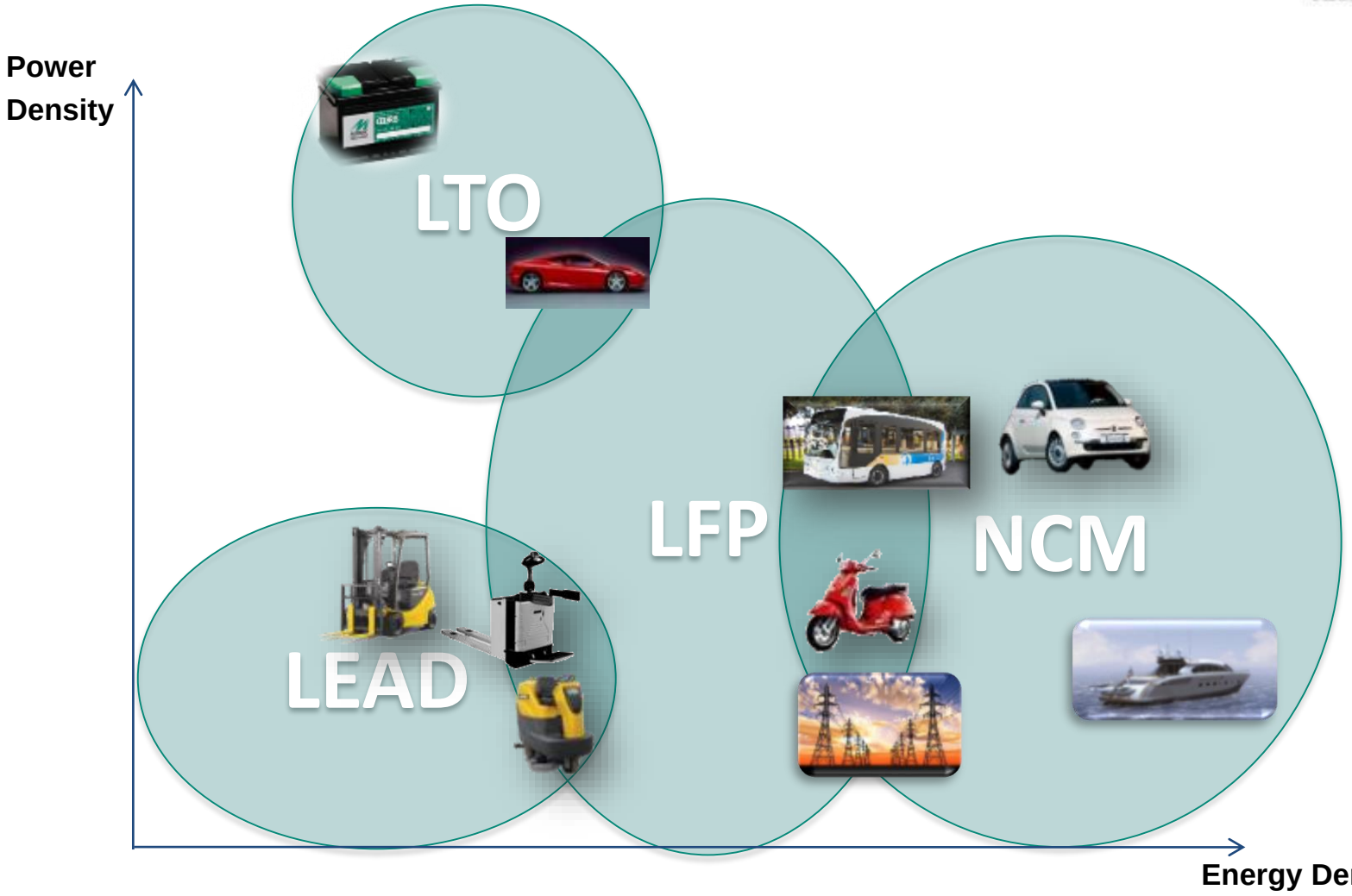
Lithium Titan Oxide



- **Cycle life (HEV) : >15.000**
- **Power density: > 6000W/kg**
- **Fast Charger : 60C**
  continues: 60C peak
- **Temperature : -30; +55 °C**

Power Passion

Chemistry and application



Selected Chemistry for Different Application

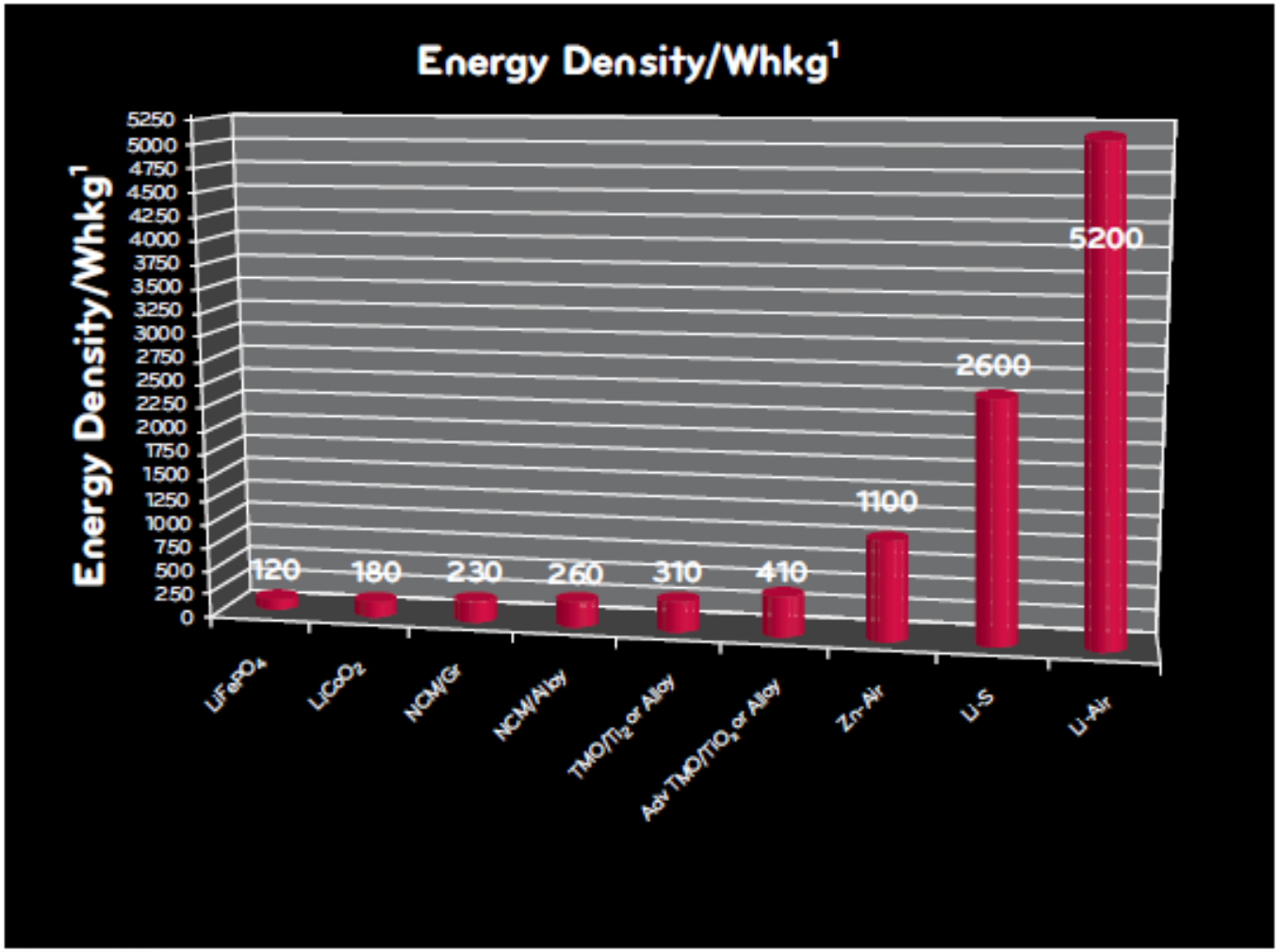
Selected Chemistry for MIDAC Battery Production				
Cathode	Advanced **NMC**	Advanced **LFP**	NMC	**LMS**
Anode	Graphite	Graphite	**LTO**	Graphite
Electrolyte	Poly	Poly	Poly	Ion
Nominal Voltage	3,7	3.2	2.3	3,7
Specific Density (Wh/kg)	210	135	90	150
Energy Density (Wh/l)	560	245	180	280
Specific Power(W/kg)	3000	4000	6000 CH	2000
Min Charge Time	30 min	30 min	2 min.	4h
Cycling Life	8000	8000	25000	2000
Calendar Life	15	15	25	10
Security	media	Molto alta	altissima	alta
Cost	medio	Medio	altissimo	basso
Uses	Alta densità di energia: uso dove peso e volume contano molto. Veicoli, Militare, UPS	Dove occorre sicurezza e alta potenza Automotive: SLI HEV, PHEV, BEV. Stand-by: UPS e peak sharing,	Automotive HEV ,mild hybrid SLI	applicazione a basso costo applicazioni industriali non esigenti, traspallet, barche, ecc ecc

NEXT LITHIUM TECHNOLOGY

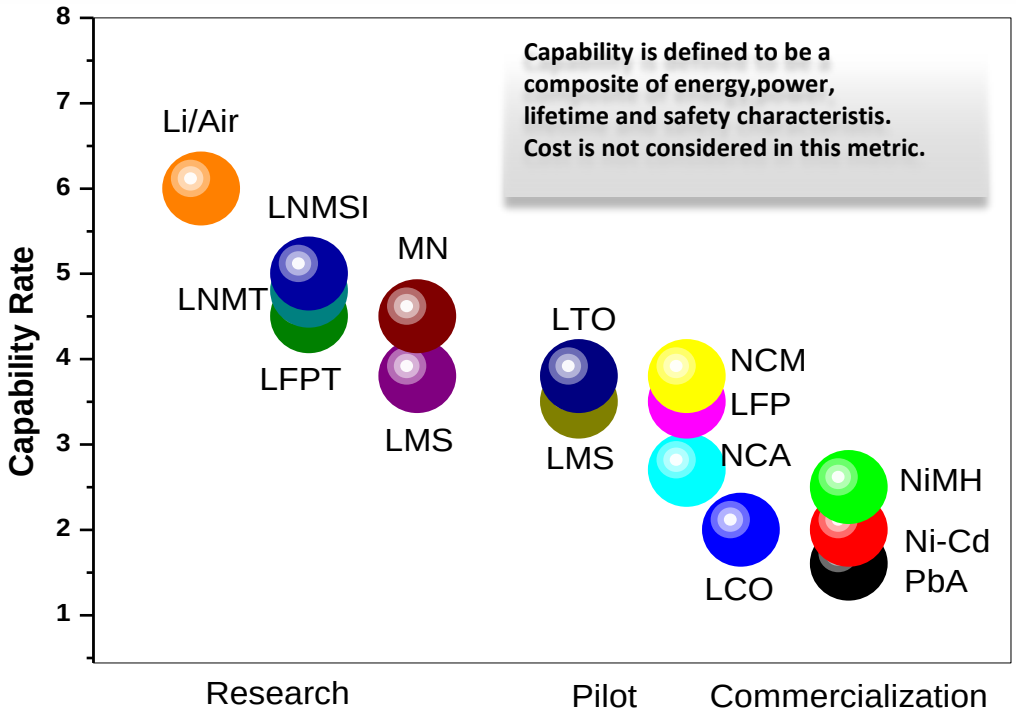
Why Lithium?: Battery of the Future

MIDAC BATTERIES

Theoretical maximum energy density of different cell chemistries

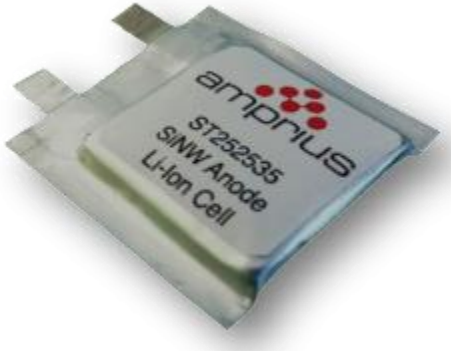


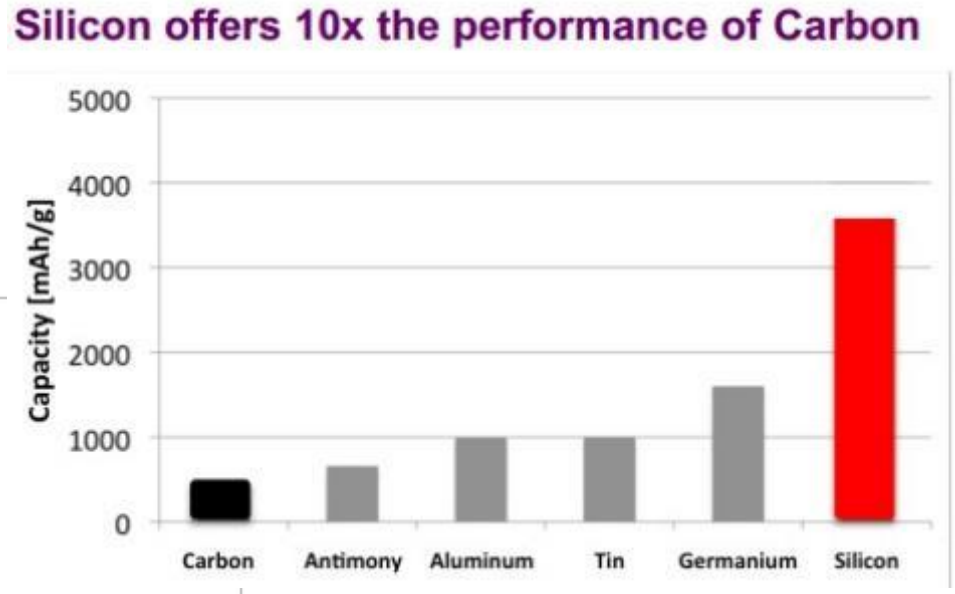
Why Lithium?: Battery of the Future

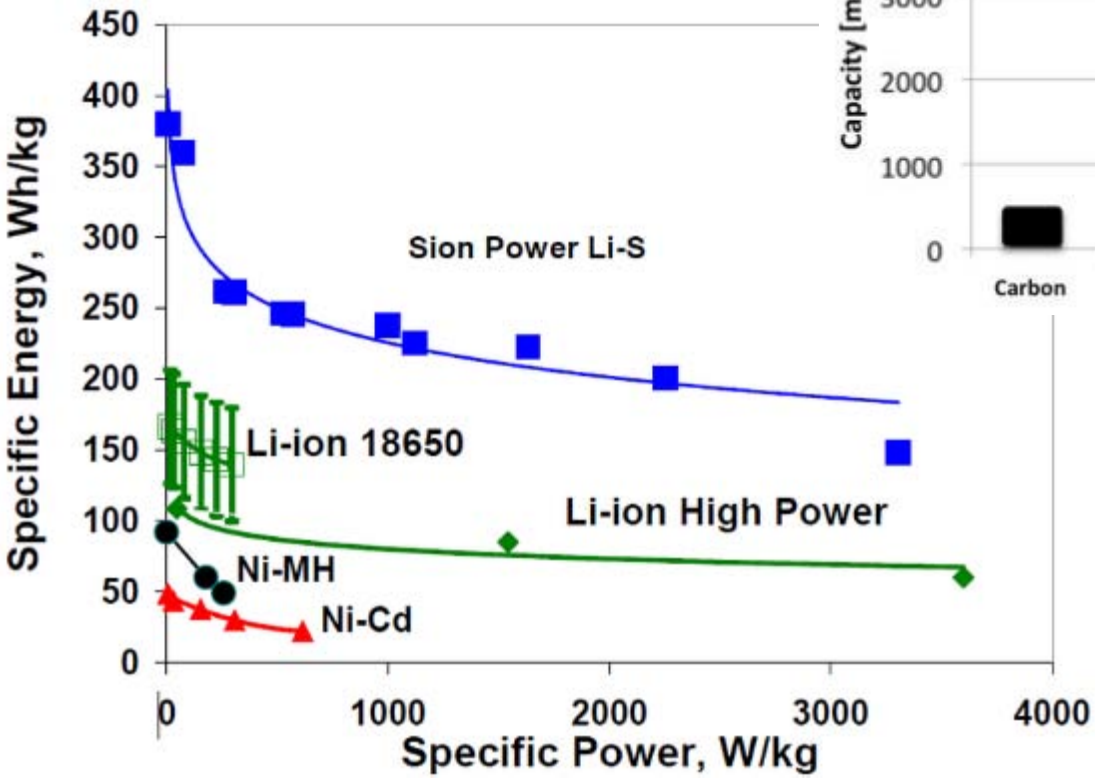


- Pb-Acid
- Ni-Cd
- NiMH
- LiCoO2/Graphite (LCO)
- Li(Ni0.85Co0.1Al0.05)O2/Graphite (NCA)
- LiFePO4/Graphite (LFP)
- Li(Ni1/3Co1/3Mn1/3)O2/Graphite (NCM)
- LiMn2O4/Graphite (LMS)
- LiMn2O4/Li4Ti5O12 (LTO)
- LiMn21.5Ni0.5O4/Li4Ti5O12 (MNS)
- Li1.2Mn0.6Ni0.2O2/Graphite (MN)
- LiFePO4/TiO2 (LFPT)
- LiNi0.5Mn1.5O4/TiO2 (LNMT)
- LiNi0.5Mn1.5O4/Si (LNMSI)
- Li/Air

Next Future: Silicon Lithium Cells





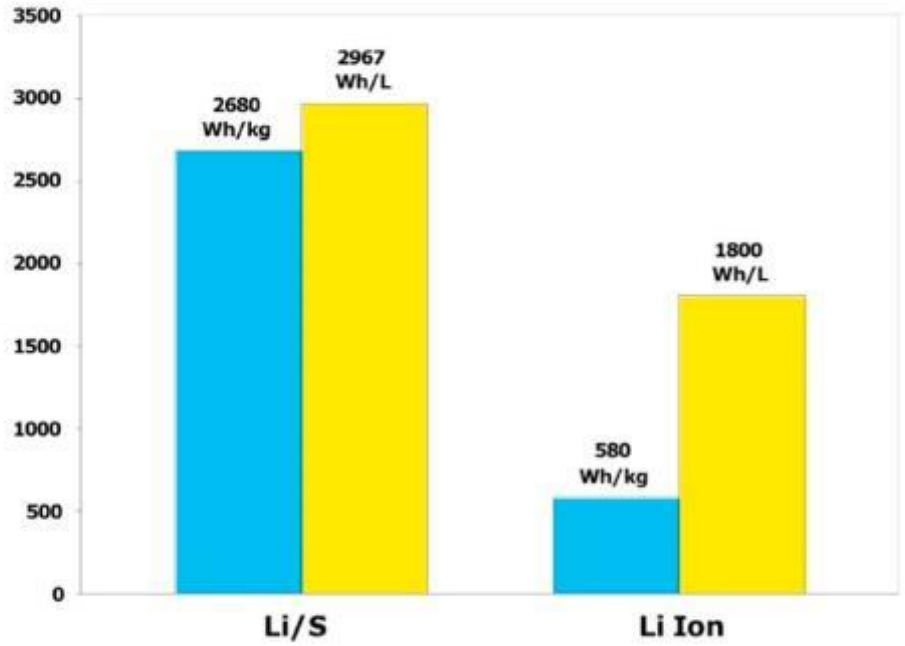


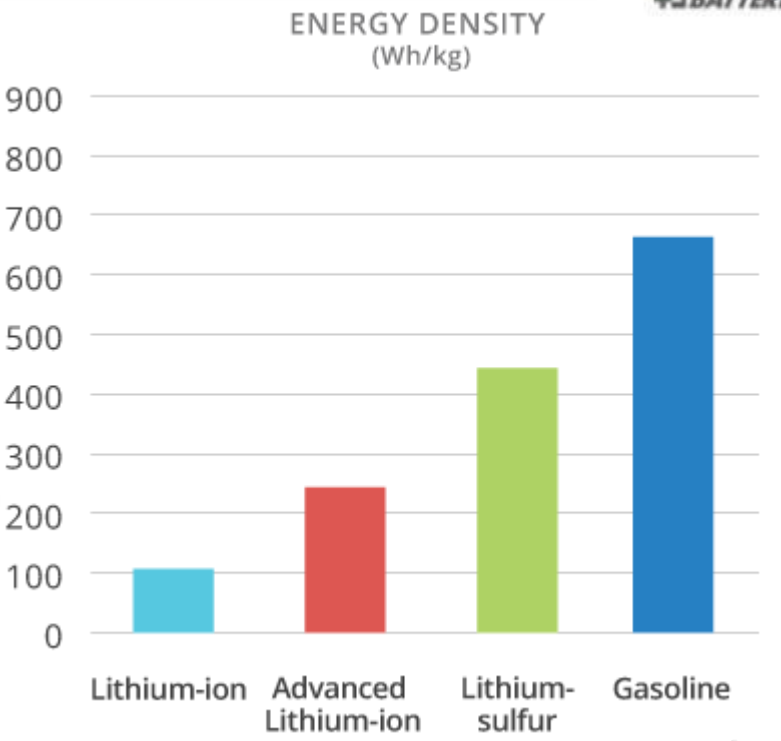
Amprius, Panasonic,
ALEC, LG, Samsung

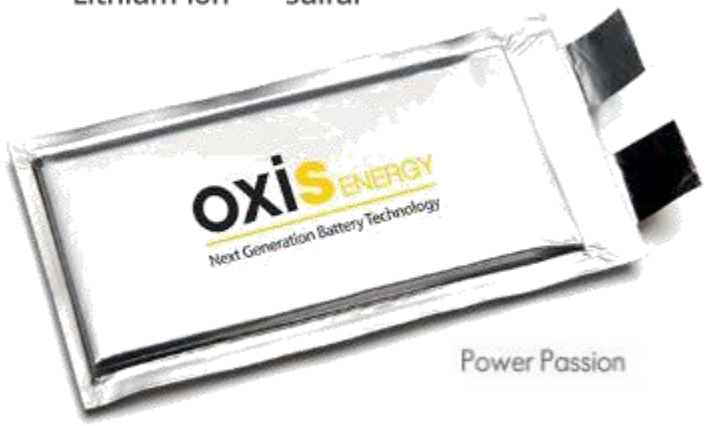
Power Passion

Next Future: Lithium Sulphur

- 600Wh/kg Practical Energy Density
- Cheap raw material
- Oxis, Eagle Picter, Sion, Batscap ..

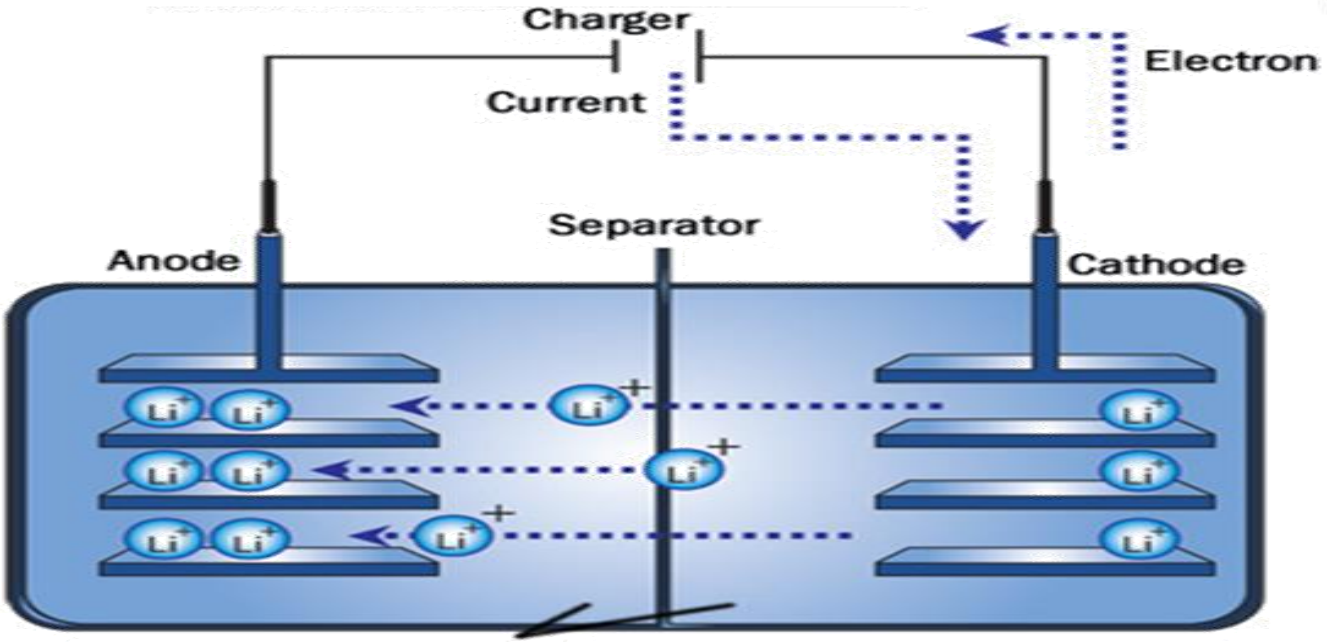






LITHIUM BATTERY: HOW IS MADE?

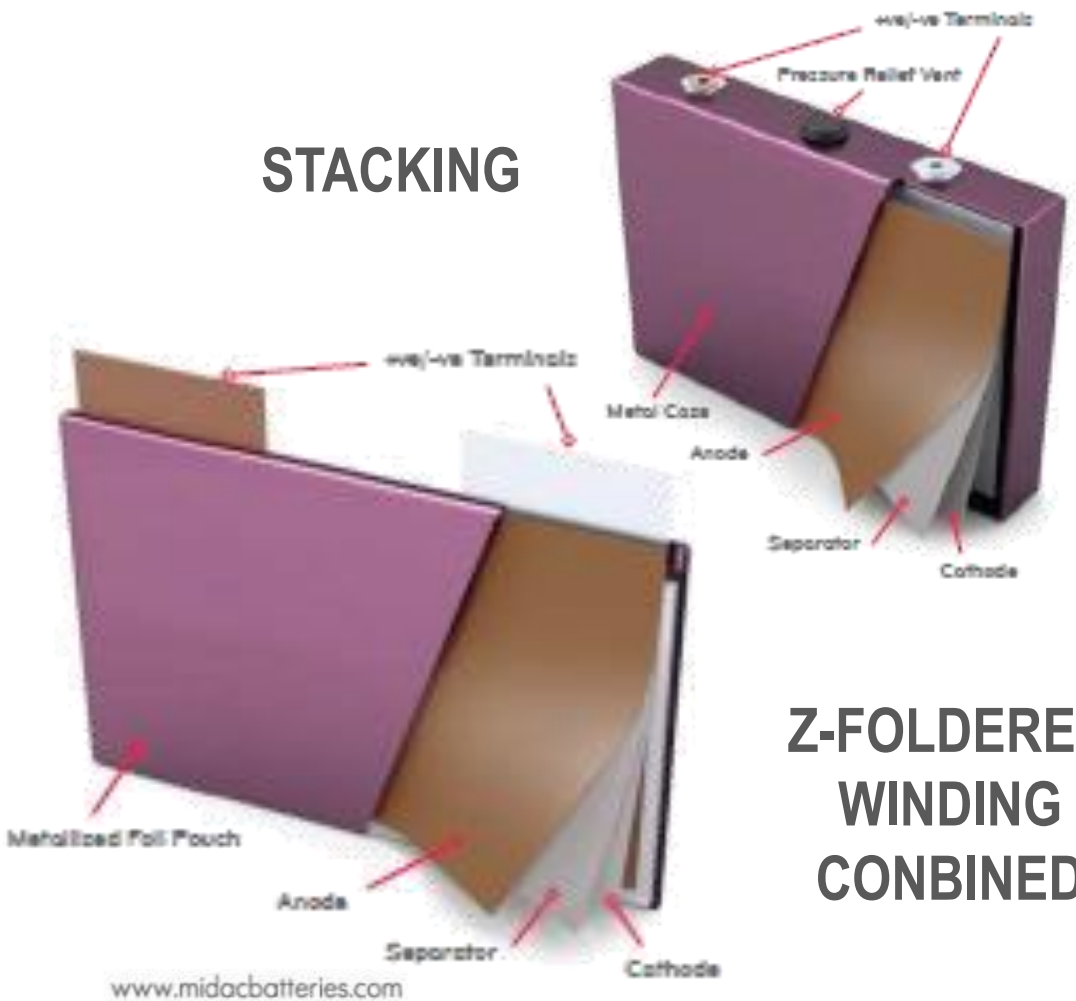
How is made: Materials



Collettore Anodo	Materiali Anodici	Sepatatore	Tipi di Elettrolito	Materiali catodici	Collettore Catodo
Rame	Grafite (C)	Mono-layer	Liquido	Litio Cobalto Ossido(LCO)	Allumino
		Tri-layer		Litio manganese Ossido(LMO)	
				Litio Nichel Ossido(LNO)	
	Litio Titanato (LTO)	Ceramico	Polimerico (Li-Po)	Litio Nichel Cobalto Alluminio (NCA)	
		Self-repair		Nichel Manganese Cobalto (NMC)	
				Litio ferro fosfato (LFP)	

How is made: Formats

STACKING



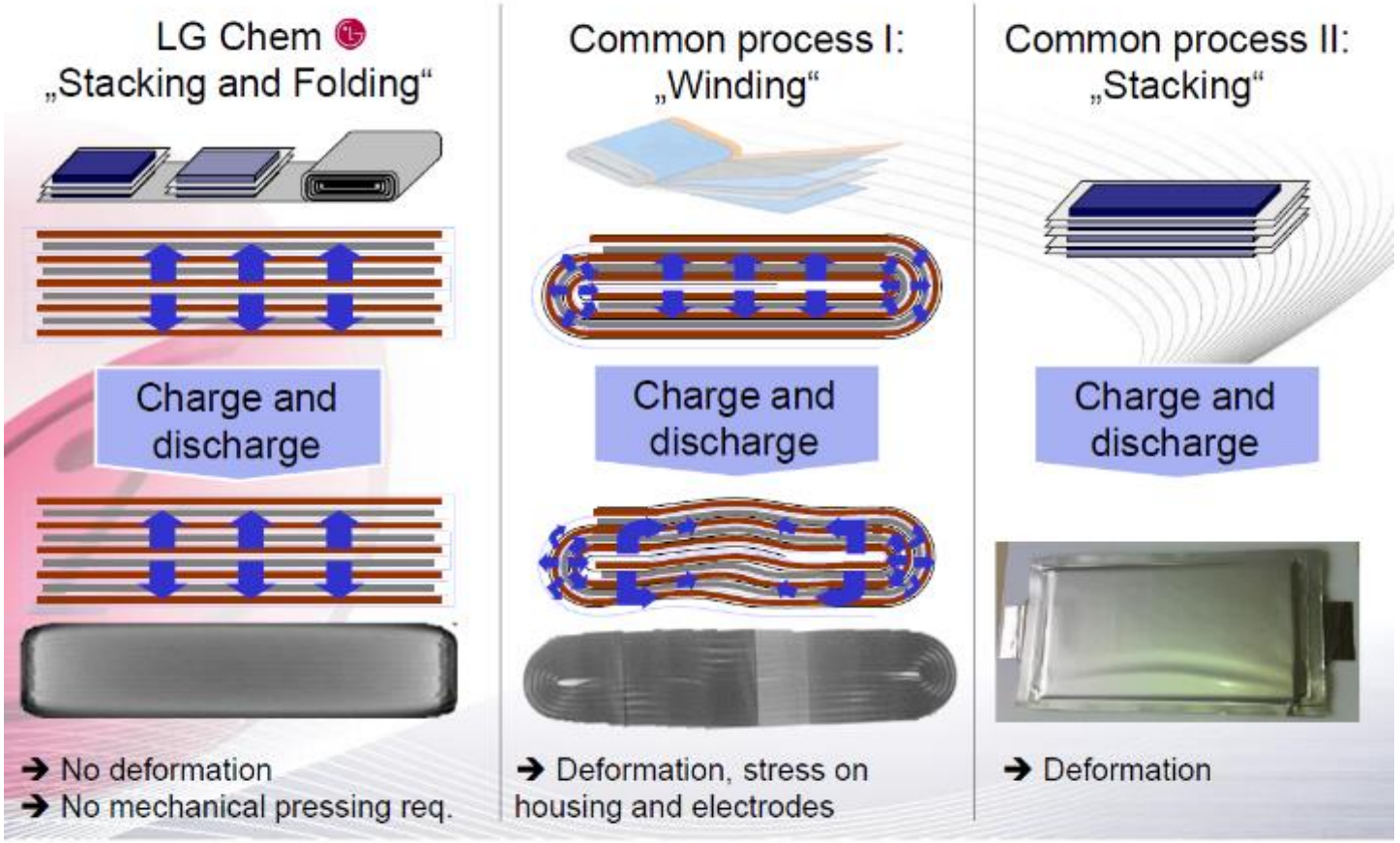
Z-FOLDERED
WINDING
CONBINED

WINDING

How is made: Production Process

How is made: Assembly Technologies

Structure of a Lithium-Ion Polymer cell



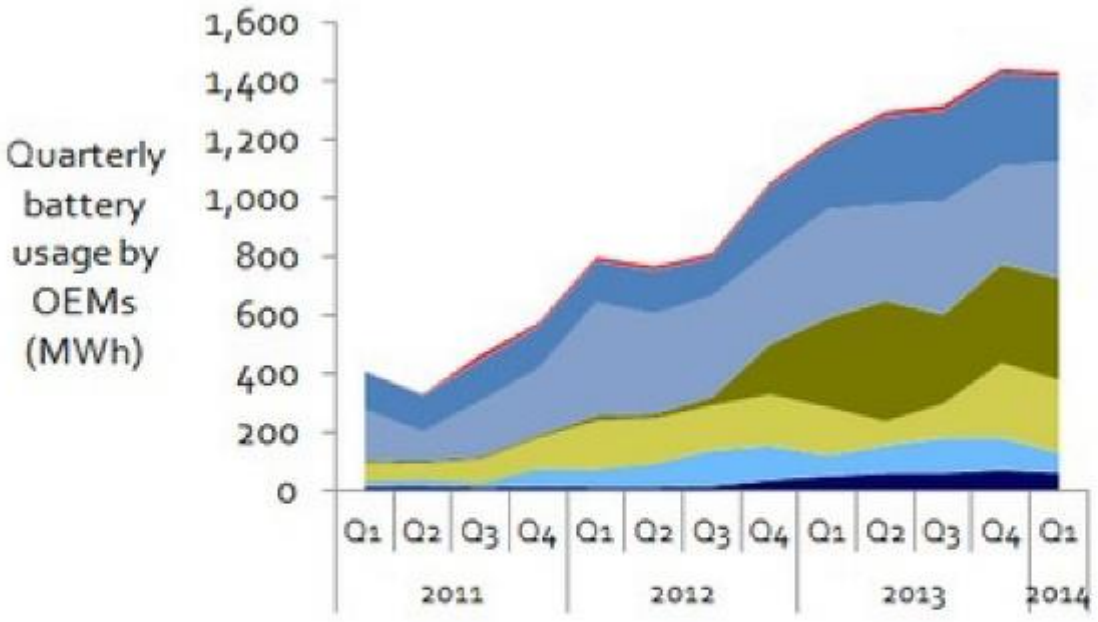
How is made: Battery Pack Components

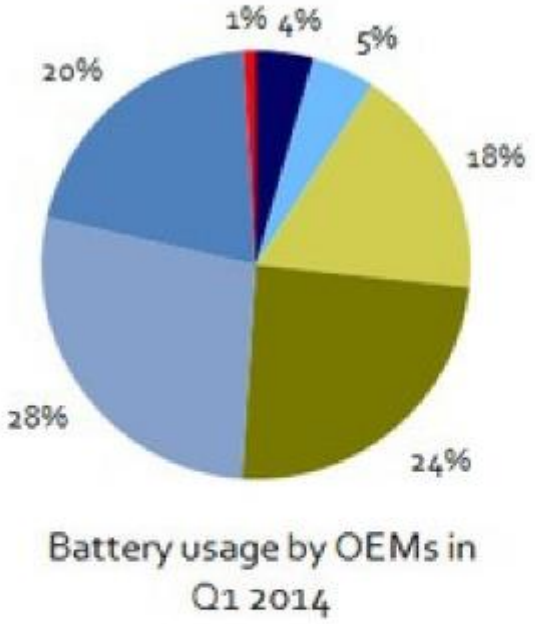
Battery Pack
Cells
BMS (master /slave)
Thermal Management System
Breakers
Connectors
Cables
Case
Fuses

1. Scegliere la chimica il formato più appropriati
2. Selezionare correttamente le celle per realizzare moduli uniformi
3. BMS affidabile sicuro ed evoluto (sicurezza Asil3-4, hardware secondary protection)
4. Progettazione Thermal Management System
5. Ingegneria di sistema (materiali, requisiti normativi, validazione
6. Certificazioni (CE, UN38.3…)

LITHIUM BATTERY MARKET, COSTS & PROSPECTIVE

Automotive Lithium Battery per OEM

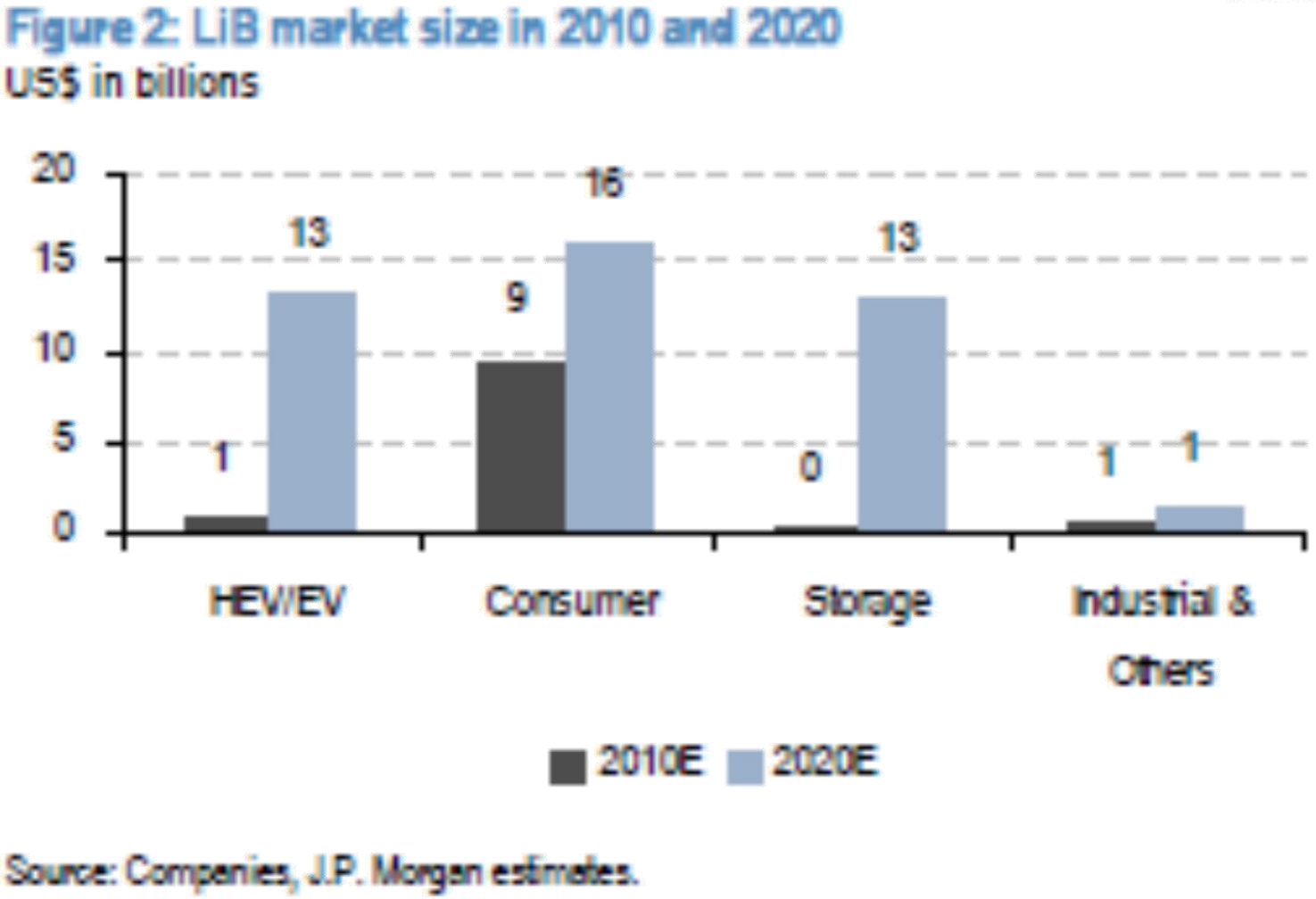




Ford Motor Company
General Motors
Toyota Motor Corporation
Renault-Nissan Alliance
Other
Tesla Motors
Hyundai Motor Company

Source: Lux Research, Inc.
www.luxresearchinc.com

Battery Market per Application

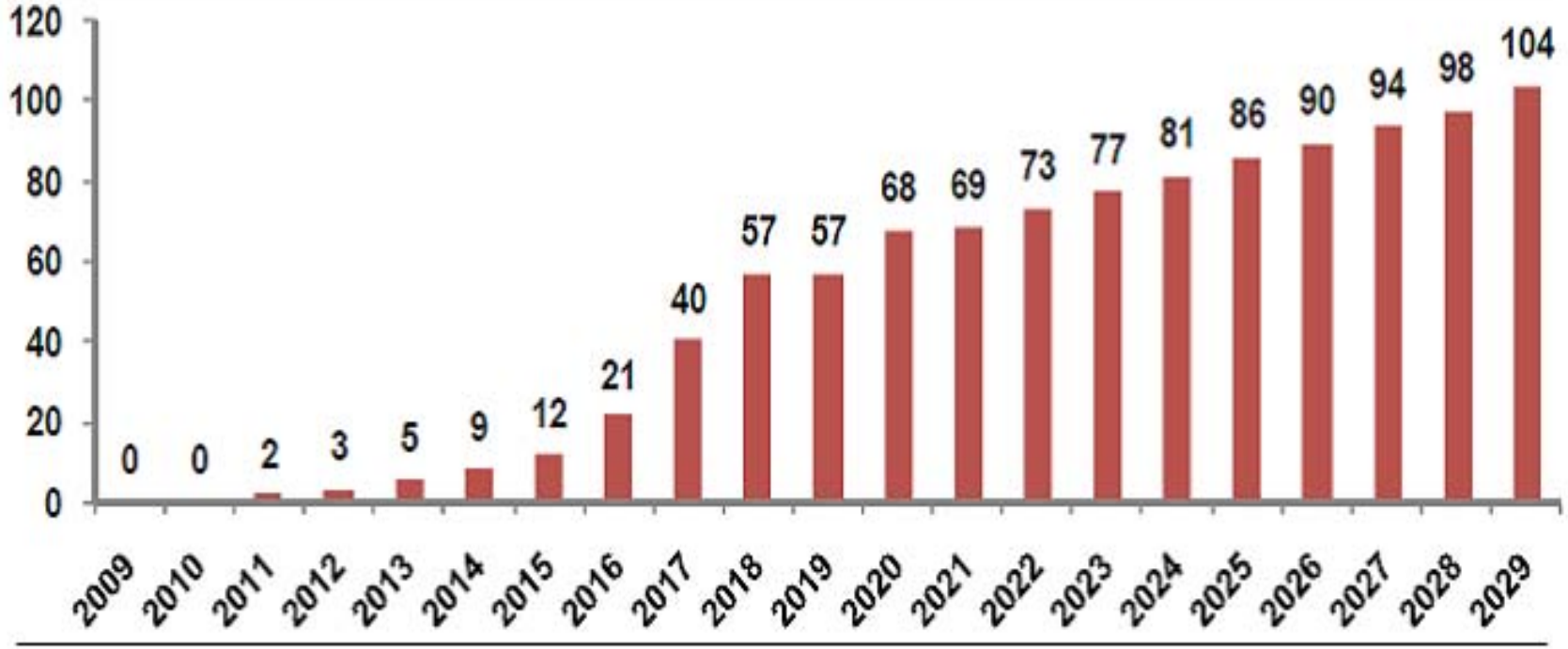


Source: Companies, J.P. Morgan estimates.

2009-2029 Lithium Battery Market scenario

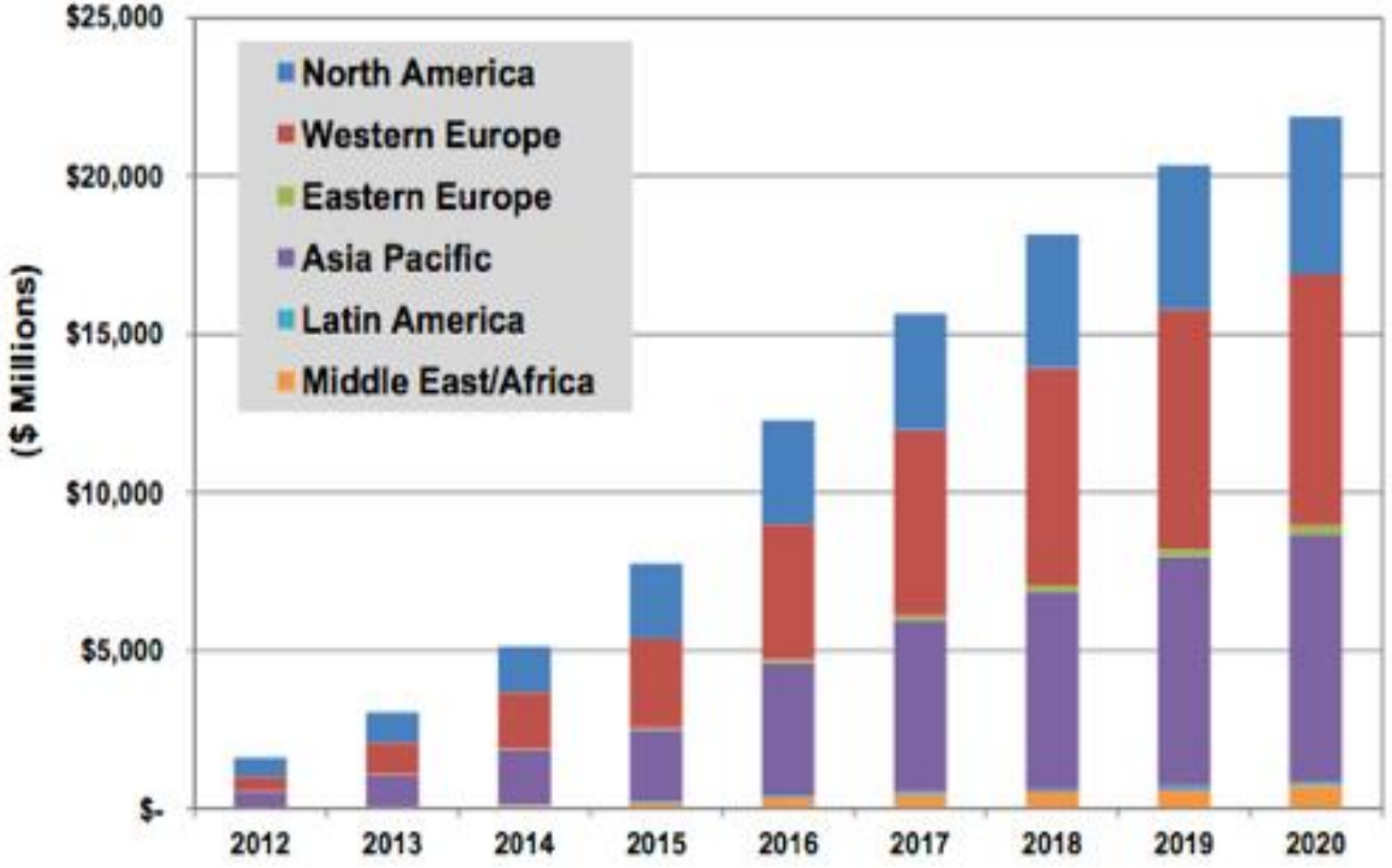
MIDAC BATTERIES

Exhibit 18 – Estimated Market for Large Format Lithium-Ion Batteries ($bn)



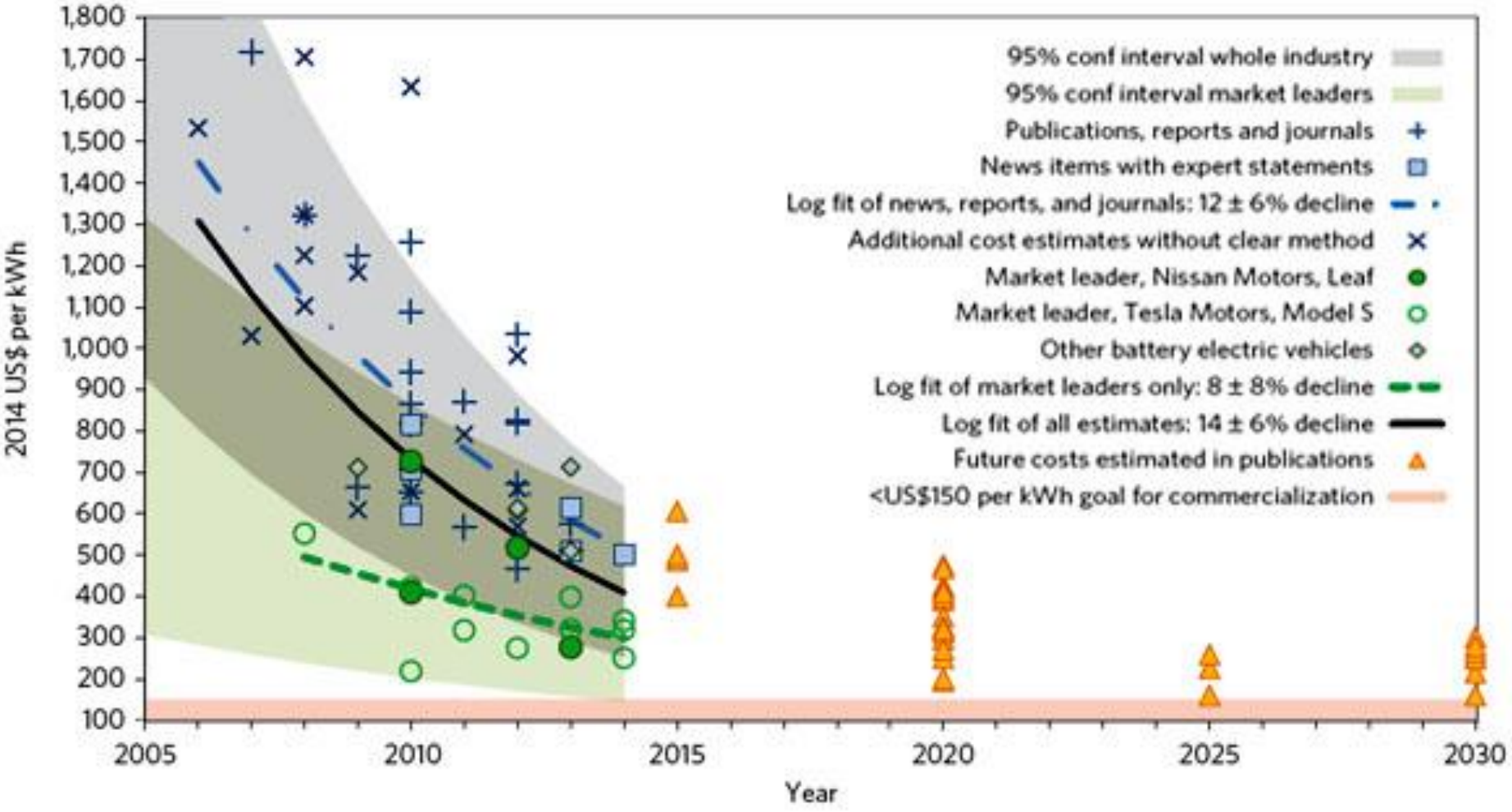
Source: Credit Suisse

Chart 1.1 *Total Lithium Ion Transportation Battery Revenue by Region, World Markets: 2012-2020*



(Source: Pike Research)

Cost of Li-ion battery packs in battery electric vehicles



"Rapidly Falling Costs of Battery Packs for Electric Vehicles," *Nature Climate Change*, 2015

TOTAL RETURN OF OWNERSHIP

Pb VLA			
Battery Cost [€/kWh]	Life Cycle	Round Trip Efficiency [%]	Exchanged energy cost [€/kWh]
100	1500	72%	0,12
Pb VRLA			
Battery Cost [€/kWh]	Life Cycle	Round Trip Efficiency [%]	Exchanged energy cost [€/kWh]
200	800	72%	0,31
Lithium			
Battery Cost [€/kWh]	Life Cycle	Round Trip Efficiency [%]	Exchanged energy cost [€/kWh]
600	3000	96%	0,21

Exchange Energy Cost (E. E. C.) [€/kWh] = 1 kWh Battery cost/n° cycles + (1-h) * energy cost

Average EU Electrical Energy Cost 2014 = 0,2 [€/kWh]

Thanks

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