EGVIA meeting

Research challenges for post Li-Ion batteries : expectations and opinions from the industry

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January 21rst, 2014

RECHARGE

Post Li-ion technology requires ambitious objectives

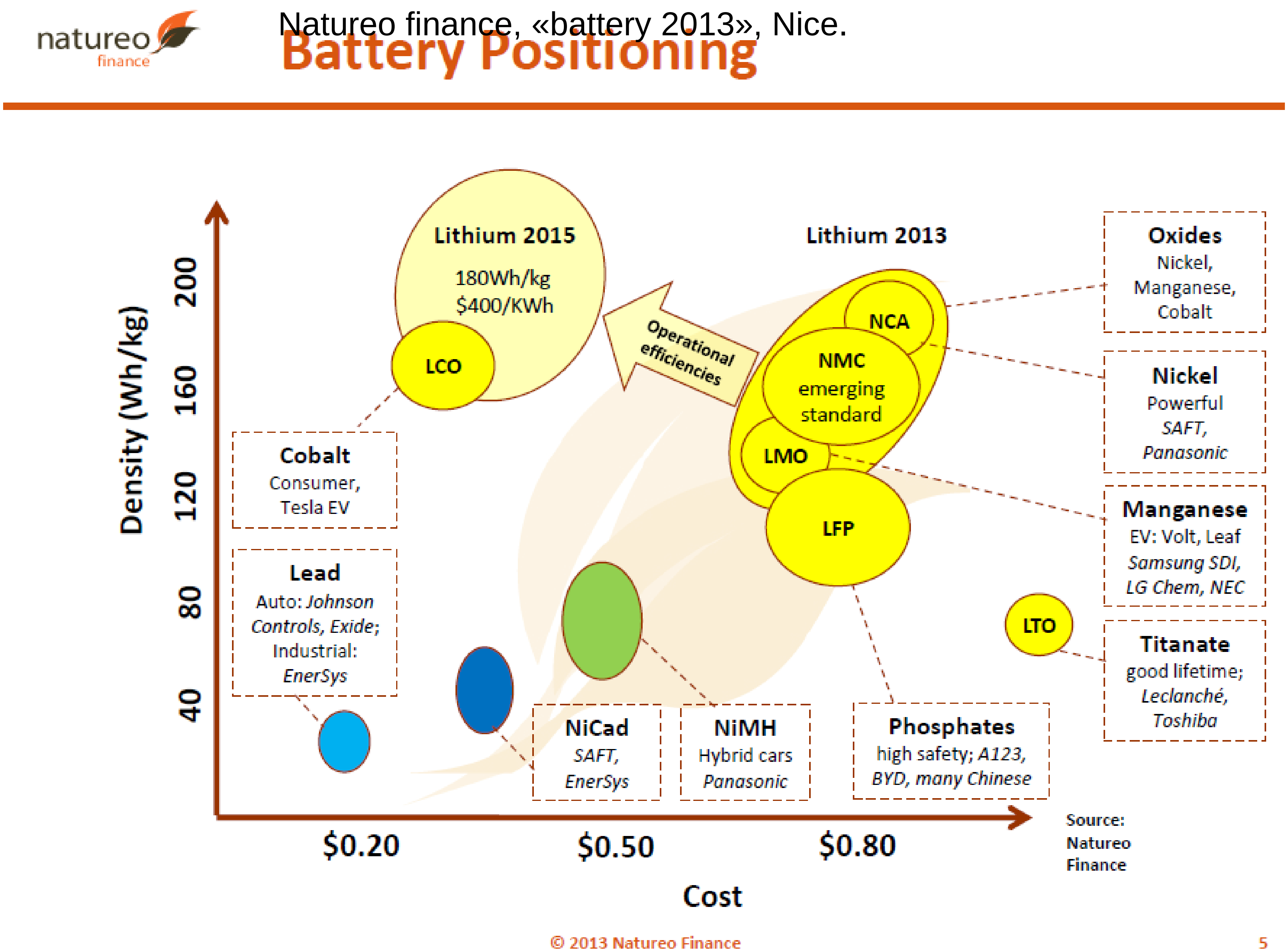
- ✓ **Successful new technologies are rare in the Battery industry**
  -> few major rechargeable technologies are surviving:
  Lead acid, Ni-Cd and Ni-MH, Li-ion = 99% of the 360 GWh placed on the market in 2012.

- ✓ **For a new «post Li-ion» technology will be expected excellent performances and low cost (see battery positioning next slide)**

- ✓ **The e-mobility market will require high volume manufacturing, based on a well qualified technology: maturity timing is key.**

Background: ambitious objectives

Natureo finance, «battery 2013», Nice.



NEDO Battery Roadmap

NEDO New Energy and Industrial Technology Development Organization

type		characteristic	2010	2015	2020	2030	> 2030	applications
focus on energy density	**Type 1** ▪ improve energy density ▪ improve power density ▪ improve calendar life ▪ decrease cost	volumetric energy	250 Wh/l	400 Wh/l	600 Wh/l	1000 Wh/l	1500 Wh/l	EV (electric vehicle) / electric bicycle (main application) other applications: fork lift / USV backup ATM / lift / golf caddy ...
		gravimetric energy	100 Wh/kg	150 Wh/kg	250 Wh/kg	500 Wh/kg	700 Wh/kg	
		gravimetric power	1000 W/kg	1200 W/kg	1500 W/kg	1000 W/kg	1000 W/kg	
		cycle life	act. value*				act. value*	
		calender life	5-8 years	5-8 years	10-15 years		10-15 years	
		cost	1000-2000 €/kWh	300 €/kWh	200 €/kWh	100 €/kWh	50 € /kWh	
						innovative batteries	production 1 440 000 MWh if 6 Mio EV	

Legend:
- (dashed box) mid-term goal of development
- (red box) necessary improvements
- (blue box) in particular to improve

* state of the art: cycle life = ca. 1000 cycles: DOD = 100 %, 1C, remaining capacity 85 %
** 1 € ≈100 ¥

Background: challenges for a research breakthrough

- ✓ By definition, «post Li-ion» technology will require a technology breakthrough: such a program cannot rely on a step by step methodology and associated reliability.
- ✓ Research leading to breakthrough is by nature unpredictable.
- ✓ The selection of competitive systems is difficult in an early stage: all have weaknesses, solutions to overcome them are not known.

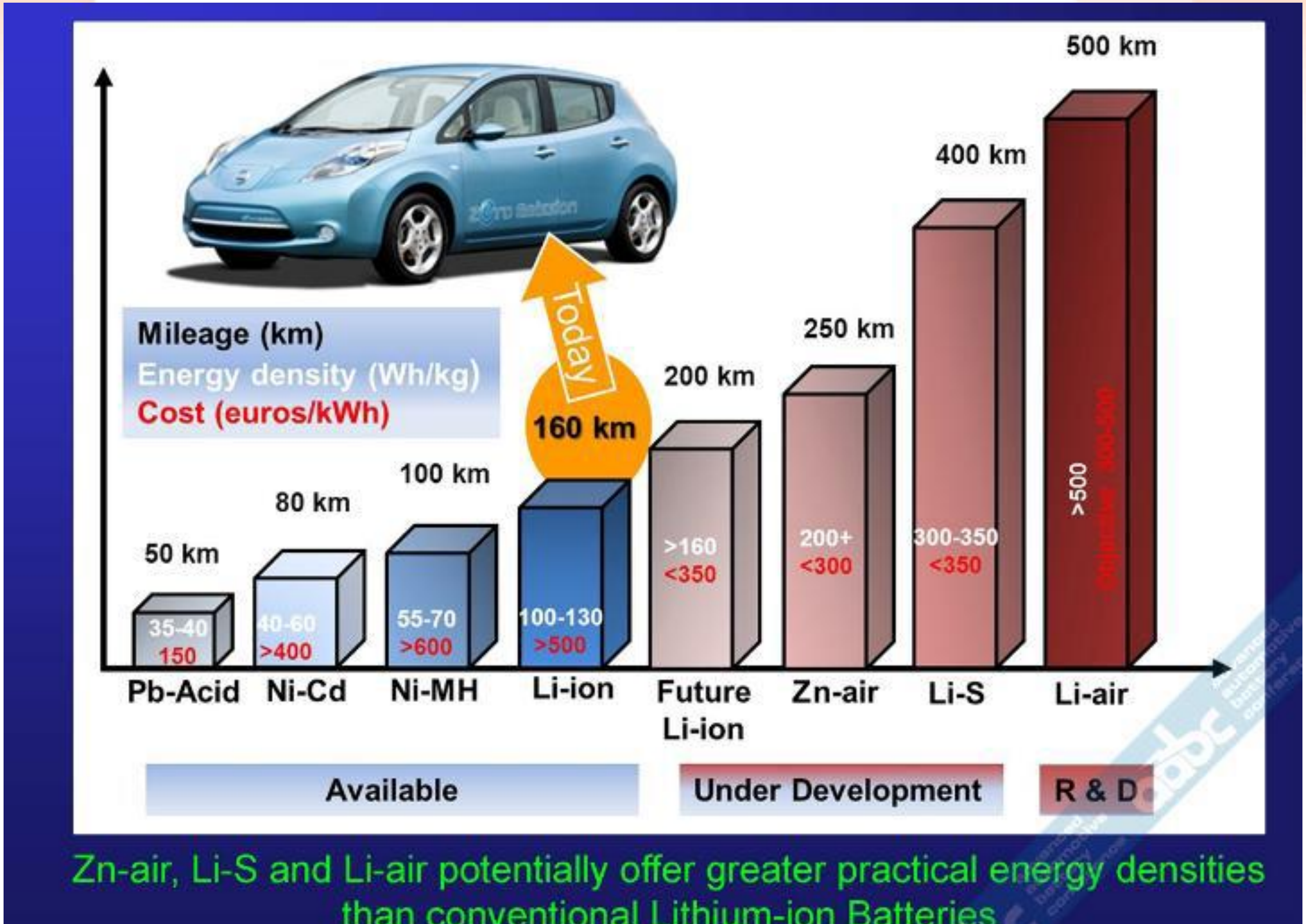
Industry expectation: consolidated research approach

1. Selection of several technologies with the required potential performance and cost (after large industrialization) is necessary to reduce the risk.

2. Concentrate research efforts on solving identified weaknesses of these technologies in order to assess their chances of success.

3. Explore in early stage the possible processes for large scale industrial manufacturing and recycling associated with these technologies.

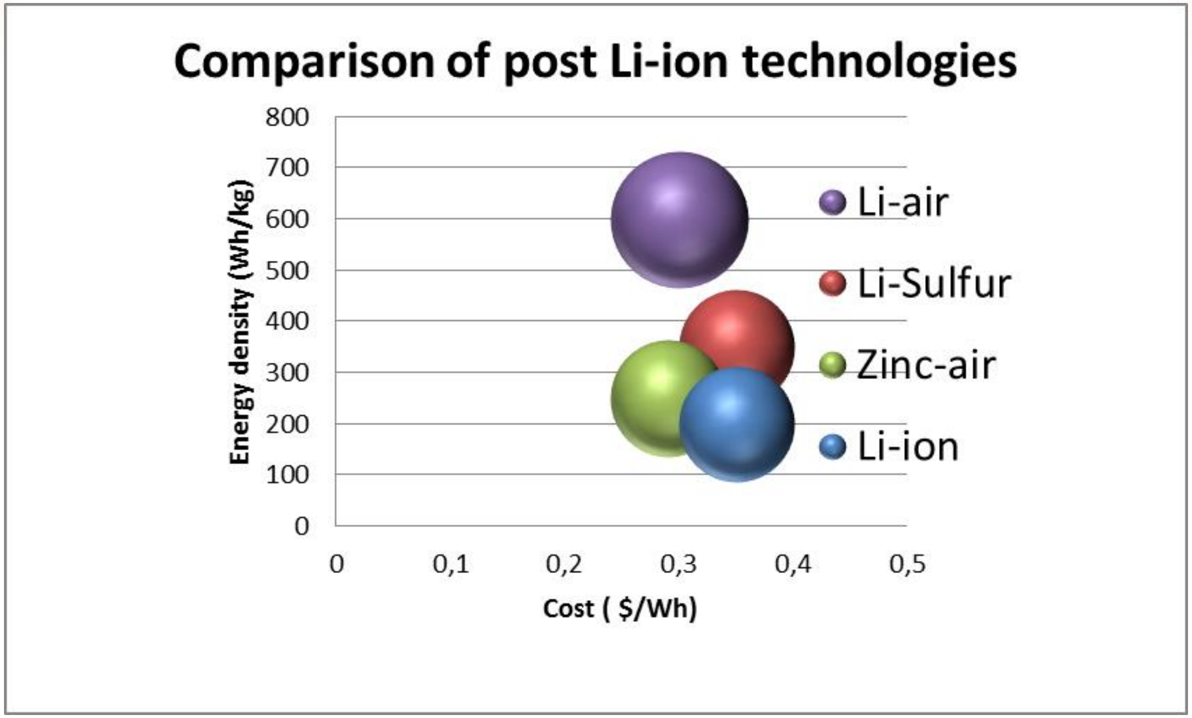
Field of interest for the industry: new technologies



M. Armand, J. M. Tarascon, *Nature* **2008**, 451, 652.

Courtesy of J-M. Tarascon www.college-de-france.fr

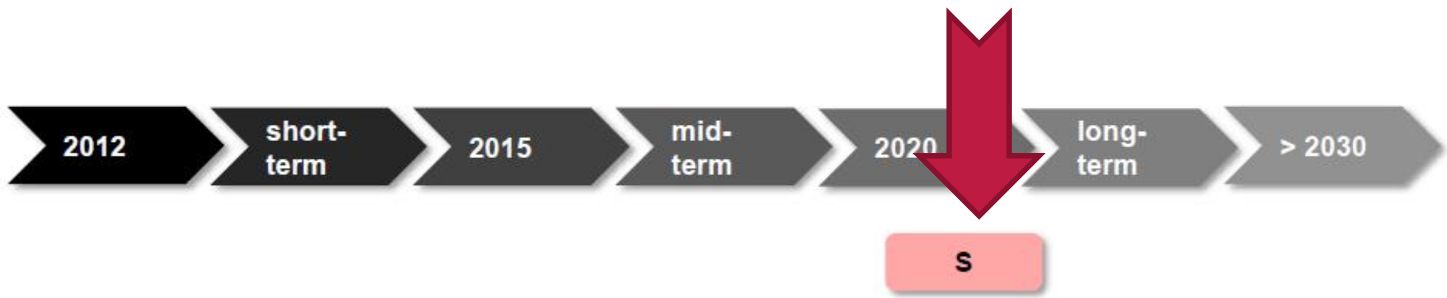
Field of interest for the industry: new technologies

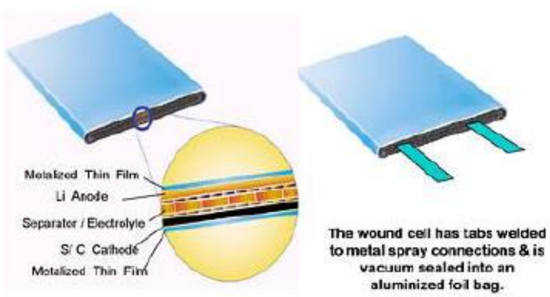


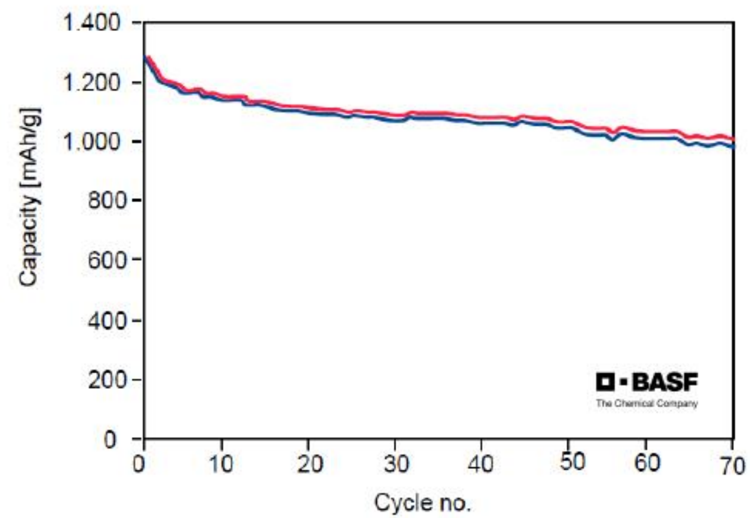
Is the Zinc-air technology worth the development effort?

Exemple of new technology: Li-Sulfur

Lithium Sulfur Battery







Fraunhoffer, Nice 'Batteries 2013'

Exemple of new technology: Li-Sulfur

B. Scrosatti (Batteries 2013, Nice)

The lithium- sulfur battery, remaining issues:

- ***Cycle life***, still a limited number of charge-discharge cycles

- **Rate capability**, still too low

- ***Solubility***, no definite proof of full control achievement

- ***Sulfur electrode morphology***, not yet optimized

Practical development : still far away (expected 2020)

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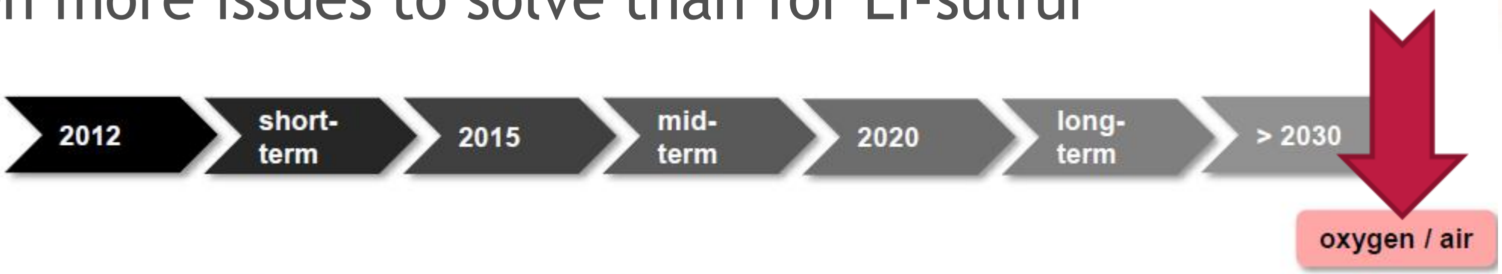
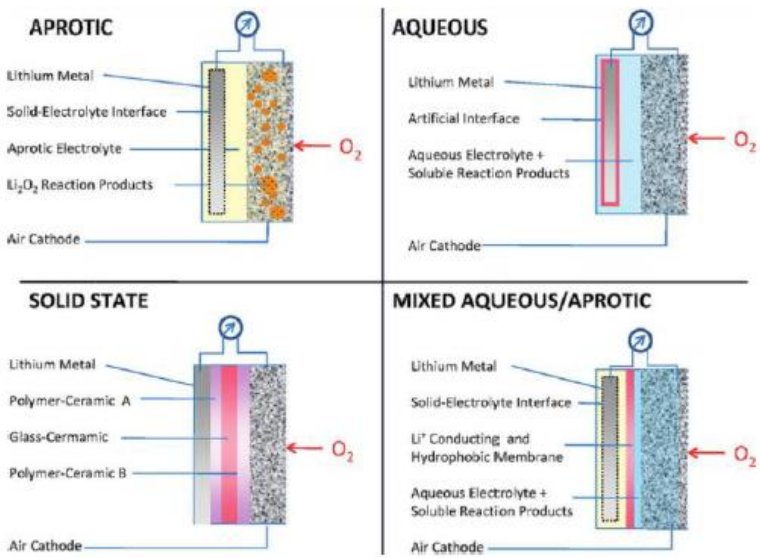
Exemple of new technology: Li-air, longer term.

Lithium Air Battery

Even more issues to solve than for Li-sulfur





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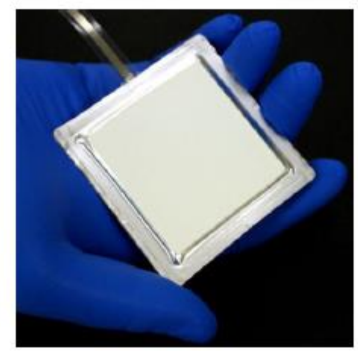

PolyPlus, Berkeley, CA

Fraunhoffer institute (batteries 2013, Nice)

Conclusion

The research programs should include the following aspects:

- ✓ Preliminary research work has identified new technologies: validation of their potential performance and cost (including recycling) would be necessary.
- ✓ Multi-technology research approach should be supported to maximize the chances of success for identifying a good candidate.
- ✓ Industrial processes should be evaluated at early stage to assess the technology feasibility.