MAT4BAT summer school

Battery industry prospective in Europe and new technologies

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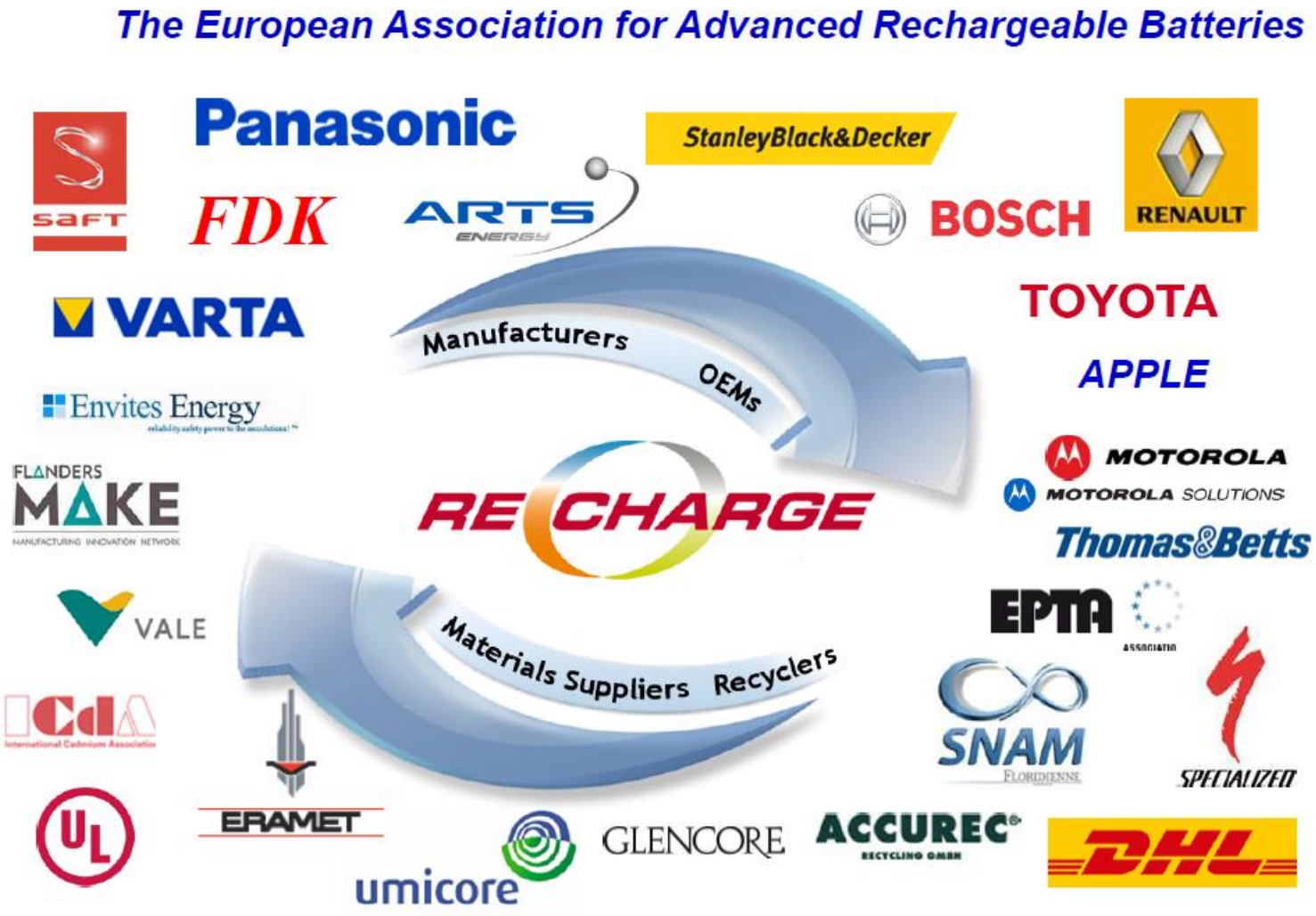
June 4, 2015

RECHARGE Membership throughout the Value Chain



RECHARGE Mission

RECHARGE's mission is to promote Advanced Rechargeable Batteries as a technology that will contribute to a Sustainable Society, a Resource and Energy Efficient policy and to **achieve a Green Circular Economy** in Europe

- ✓ RECHARGE anticipates an **increasing market for rechargeable batteries** in the electric mobility and power tool industries, the communications world, and in new renewable energy storage applications.

- ✓ RECHARGE acts to improve the advanced rechargeable batteries acceptance in Europe: **high level communication** supporting **continued market access for new and existing products**, in a fair international competition field, promoting:

  - ➢ **An environmental friendly image of the Battery.**
    PEF communication**,** ECODESIGN, Ecolabel,..

  - ➢ **A sustainable Battery Industry.**
    Industry involvement in waste management, recycling targets, CRM..

  - ➢ **A safe manufacturing, usage and transport of the Battery.**
    Industry involvement in REACH, CLP, UN transport regulation, Safety guidances,…

Agenda

1. Batteries Materials and technologies trends

2. Batteries market trends in e-mobility

3. Batteries industry prospective in Europe

1. Batteries technologies trends

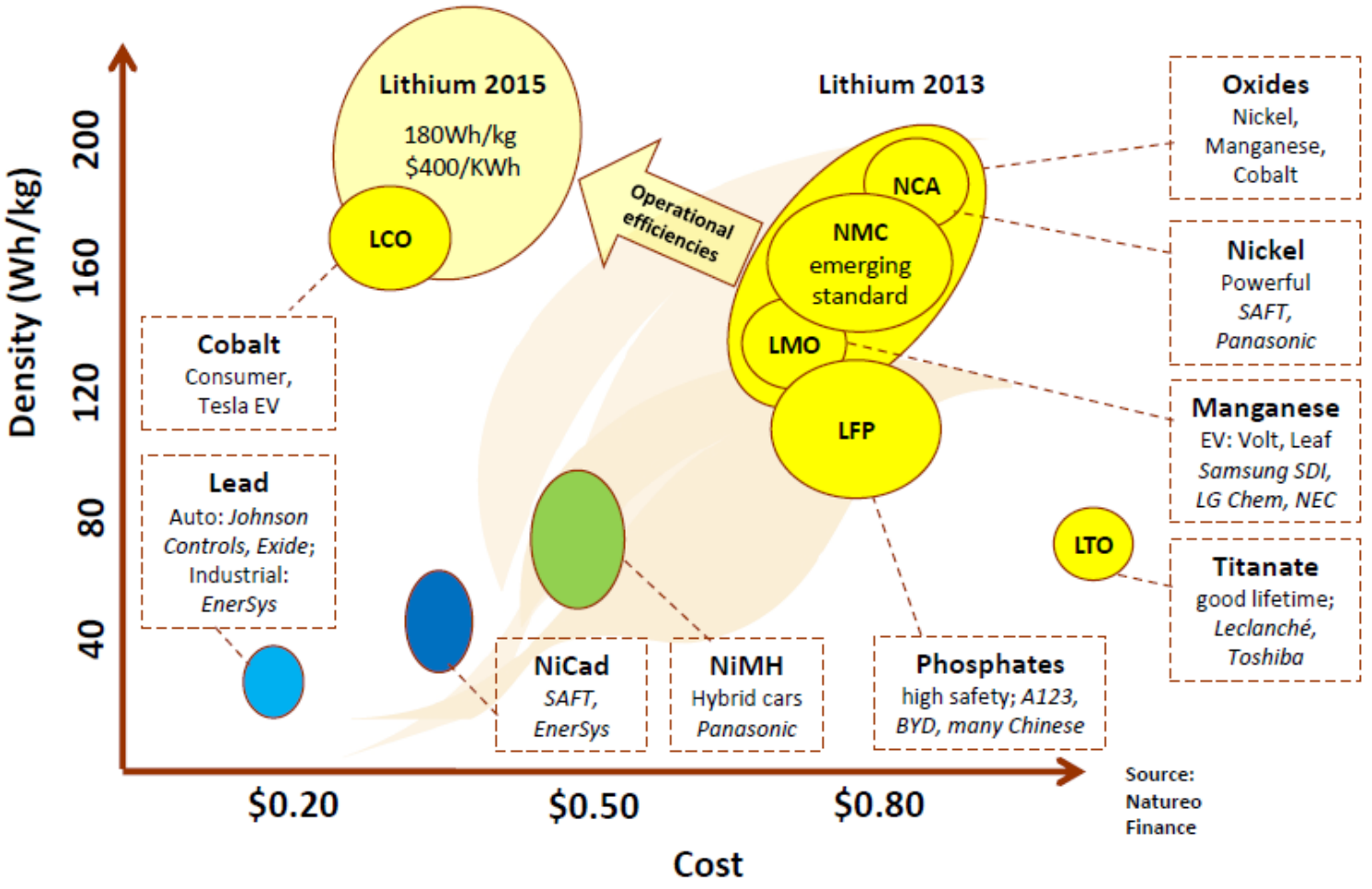
Li-ion Batteries technologies per application

1. For small portable batteries:
   - The existing market is still dominated by the LiCoO2 type.
   - The dominant Li-ion chemistry progressively becomes of NMC type. The LFP usage doesn't seems to develop as well, the energy density being too low.
2. For the automotive market:
   - The HEV batteries will move from Ni-MH (used in hybrids) to Li-ion, possibly technology NMC.
   - In the EV, several chemistries still competing, often Mn based.
3. From the Grid and Energy strorage market:
   - Li FePO4 type has already gained some market share, but NMC/NCA is also used.

Li-ion technology improvement on going

Natureo finance, «battery 2013», Nice.

Battery Positioning



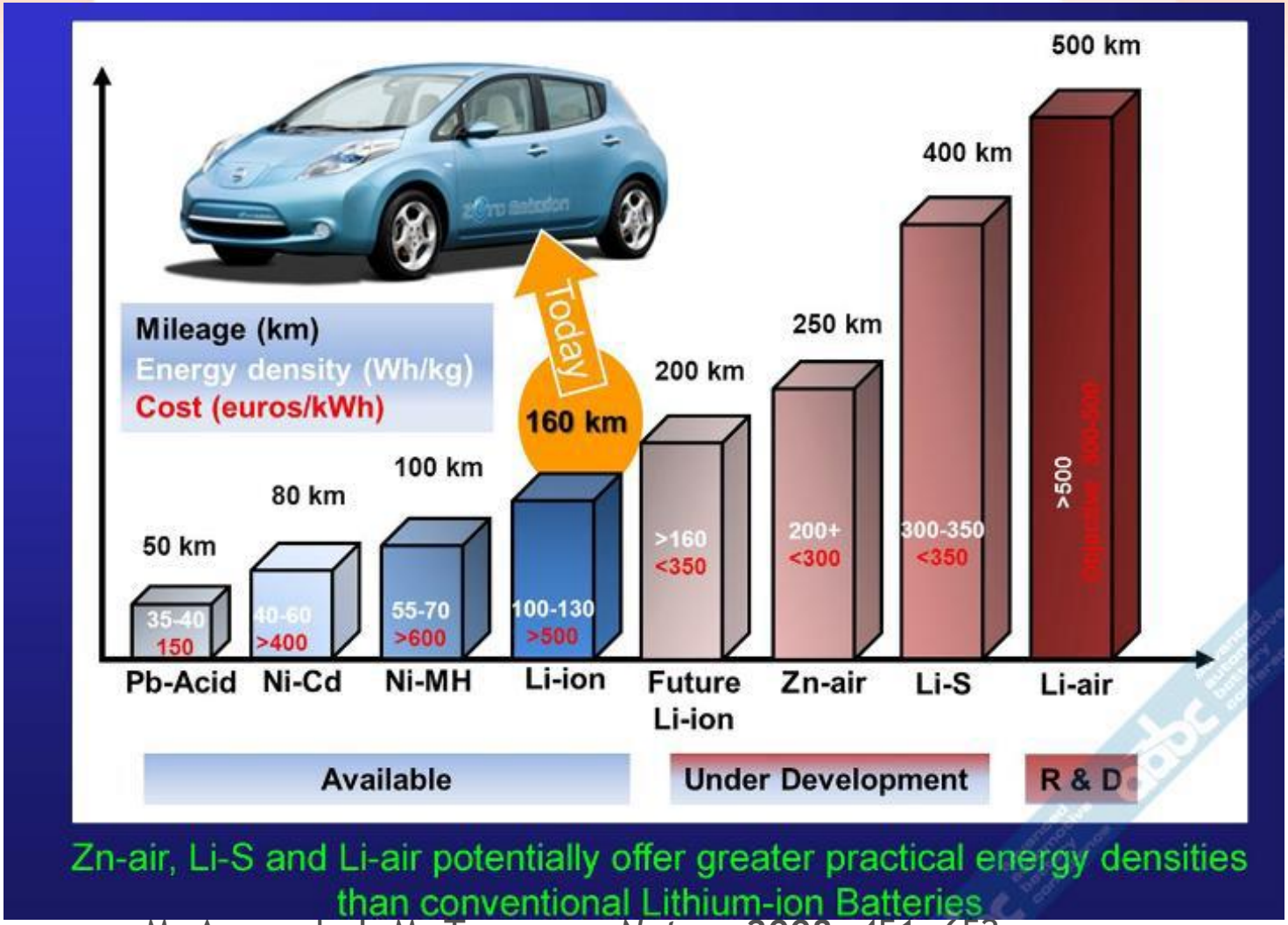
Post Li-ion technology requires ambitious objectives

- ✓ **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.**

New technologies: 2008 road map still applicable!



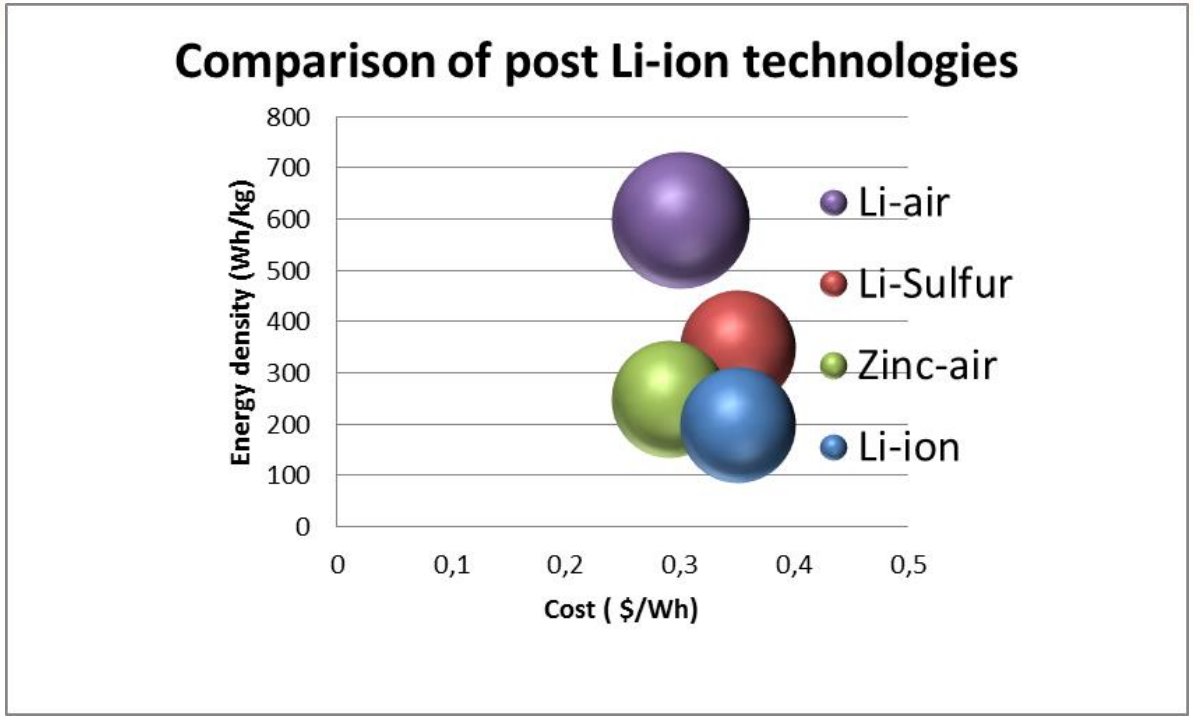
M. Armand, J. M. Tarascon, *Nature* **2008**, 451, 652.

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

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.

Promising new technologies



Is the Zinc-air technology worth the development effort?

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

New materials structures would be required!

Batteries technologies changes

1. Many new technologies are under study or development: after the fuel cells, there is now a hype around lithium air, graphene, or other systems like Lithium sulfur. Nevertheless, their state of development is too early to evaluate their competitiveness after a future industrialization. The coming years will be dominated by Li-ion.

2. Globally, significant efforts are already organized in the European Institutions for the technical development of the Li-ion battery, objectives are clearly described for the materials development.

Battery technlogy trends conclusion

- There is a need to maintain a perspective for the new technology development at industrial level:
  - Next generation li-ion first
  - New products in the future mid or long term.

- There is a need to work on new materials, new processes, to enable the success of a new technology.

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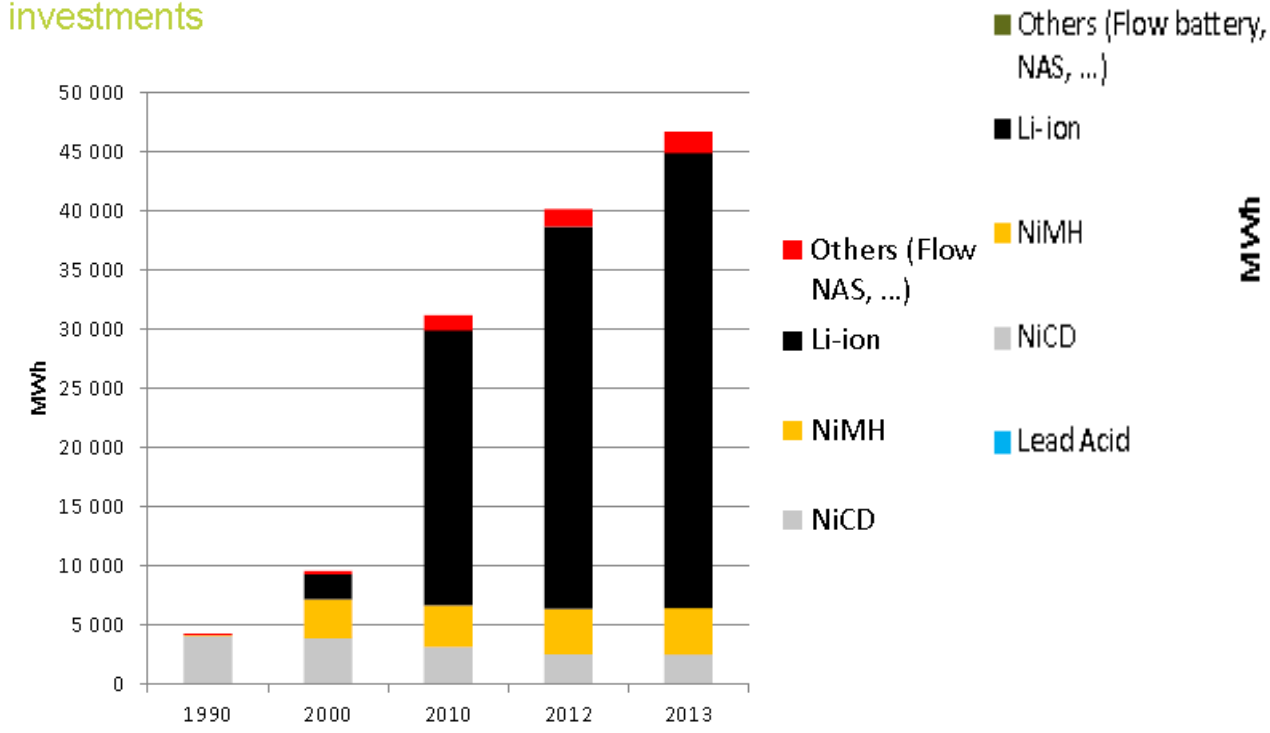
1. Batteries technologies trends

2. Batteries market trends in e-mobility

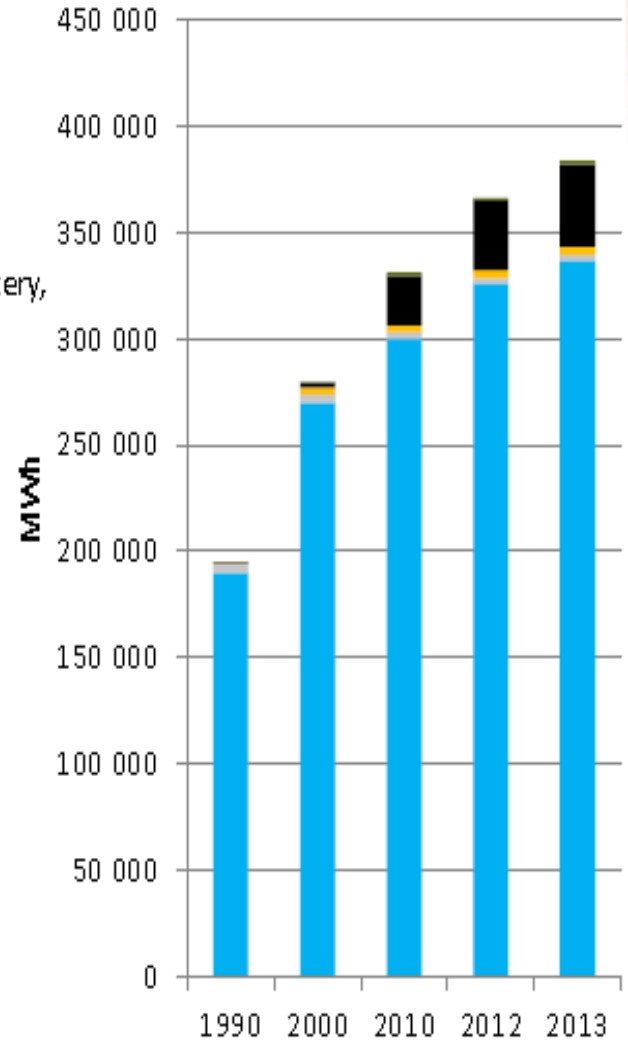
Batteries market trends

- Li-ion is showing the largest market growth (avicenne 2014)

Lithium Ion Battery: Highest growth & major part of industry investments

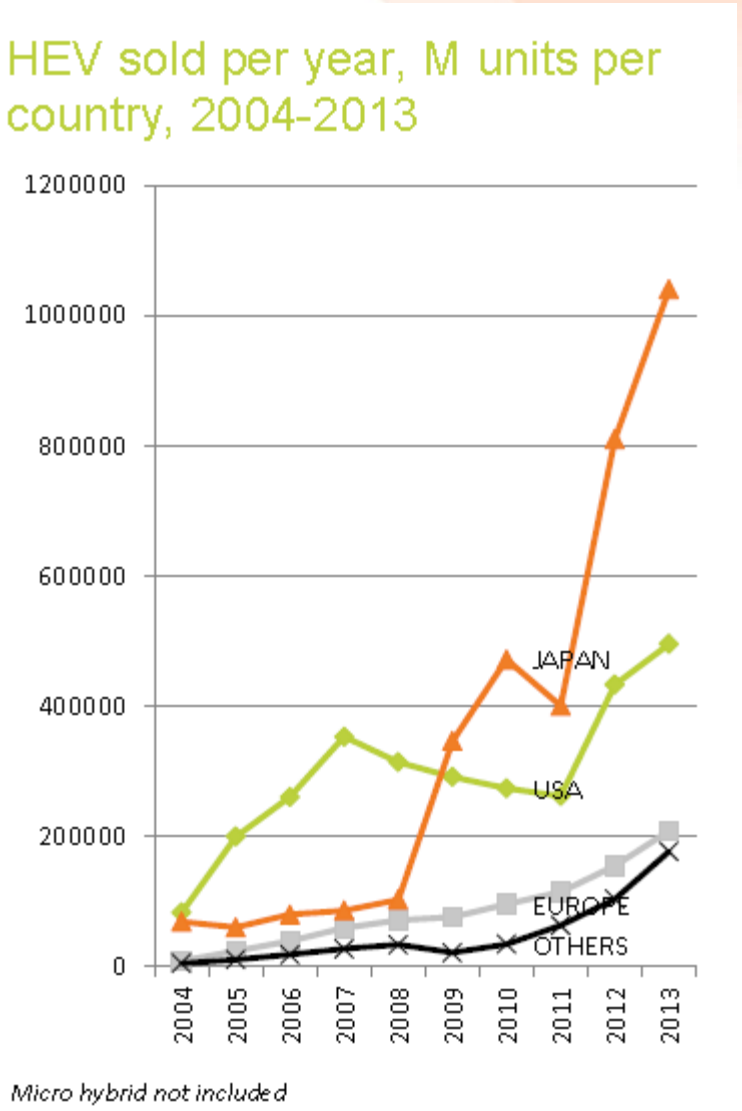


Source: AVICENNE ENERGY, 2013



Batteries market trends: e-mobility

- Li-ion is showing the largest market growth (avicenne 2014)
- And Europe has a significant market share



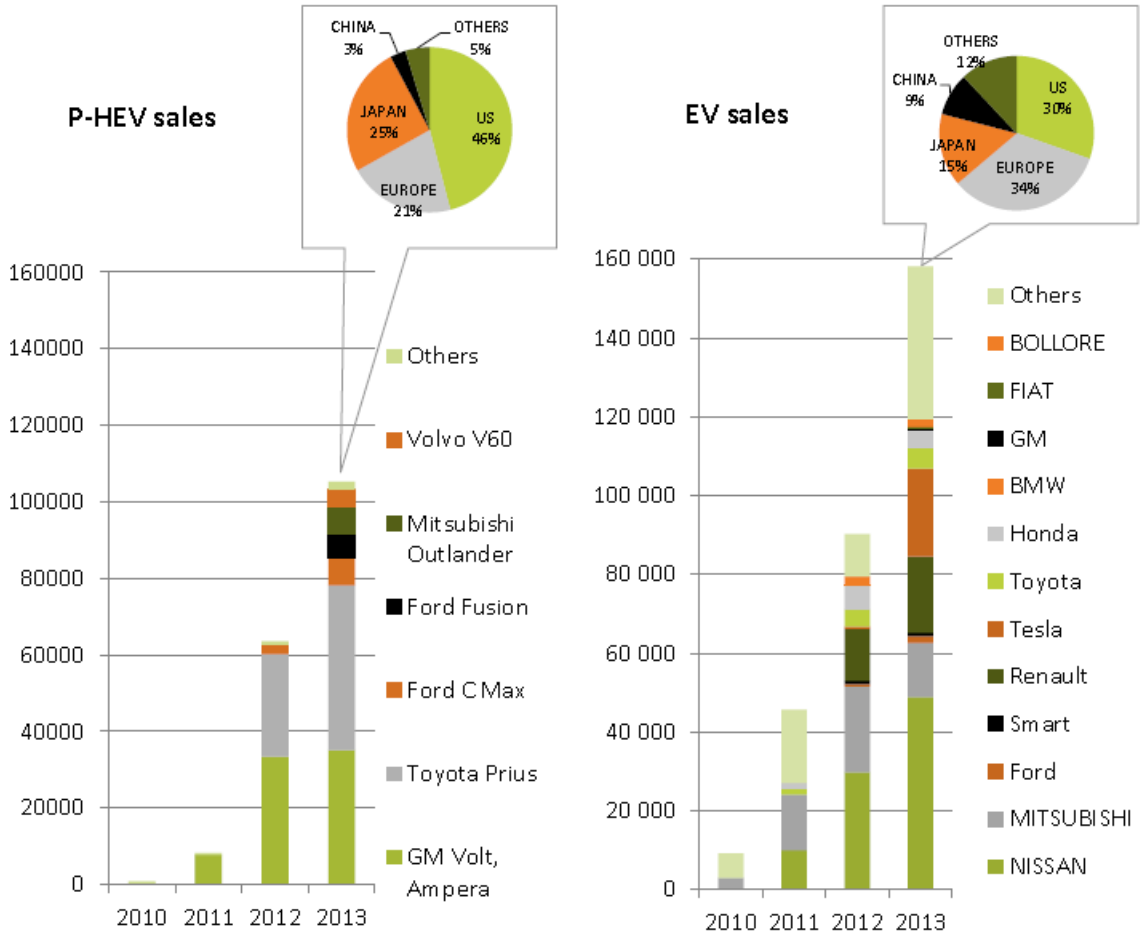
Micro hybrid not included

E-mobility industry is strong in Europe

- European Car Makers have significant sales in e-mobility, in relation to the European market.

- **But the batteries (cells) are not manufactured in Europe**

P-HEV & EV SALES 2010-2013 (YEARLY)



Source: AVICENNE ENERGY Analyses

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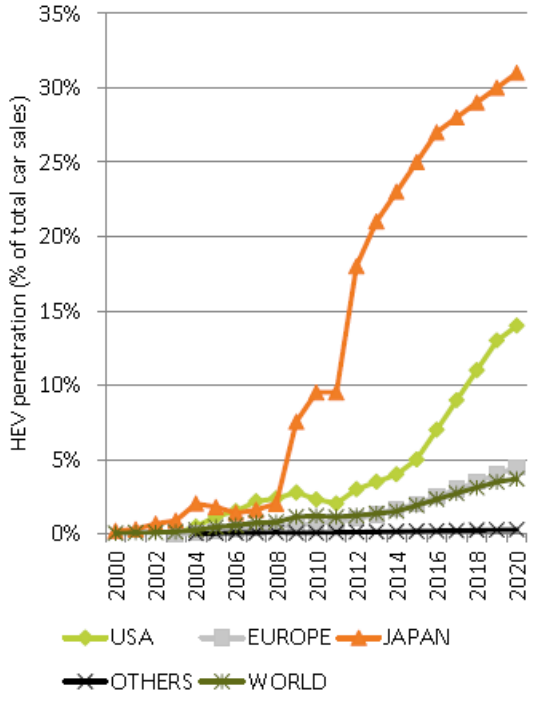
E-mobility Batteries market: projections

- Penetration projection are lower in Europe than in US and Japan,
- But still represents a significant potential growth.
- **How to ensure a successful development of the European industry?**

HEV MARKET: 2,5 Million units in 2015 – 5 M in 2020 – 7 M in 2025



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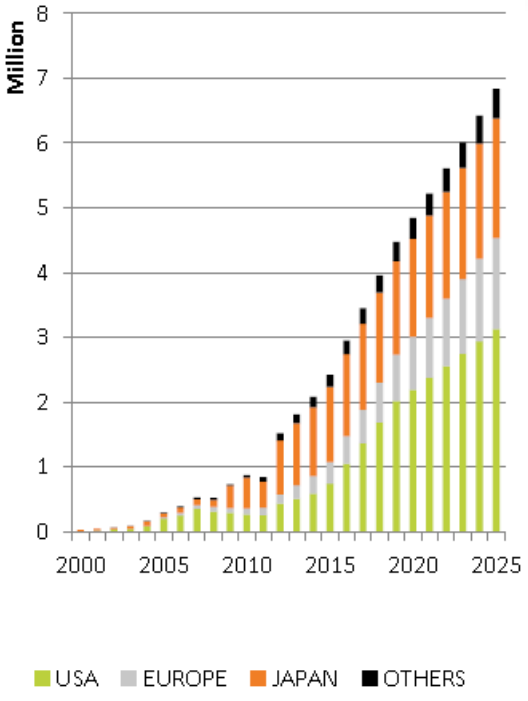

Source: AVICENNE ENERGY Analyses 2013

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Can new technologies be developped in Europe

A new technology enable industry structure changes:

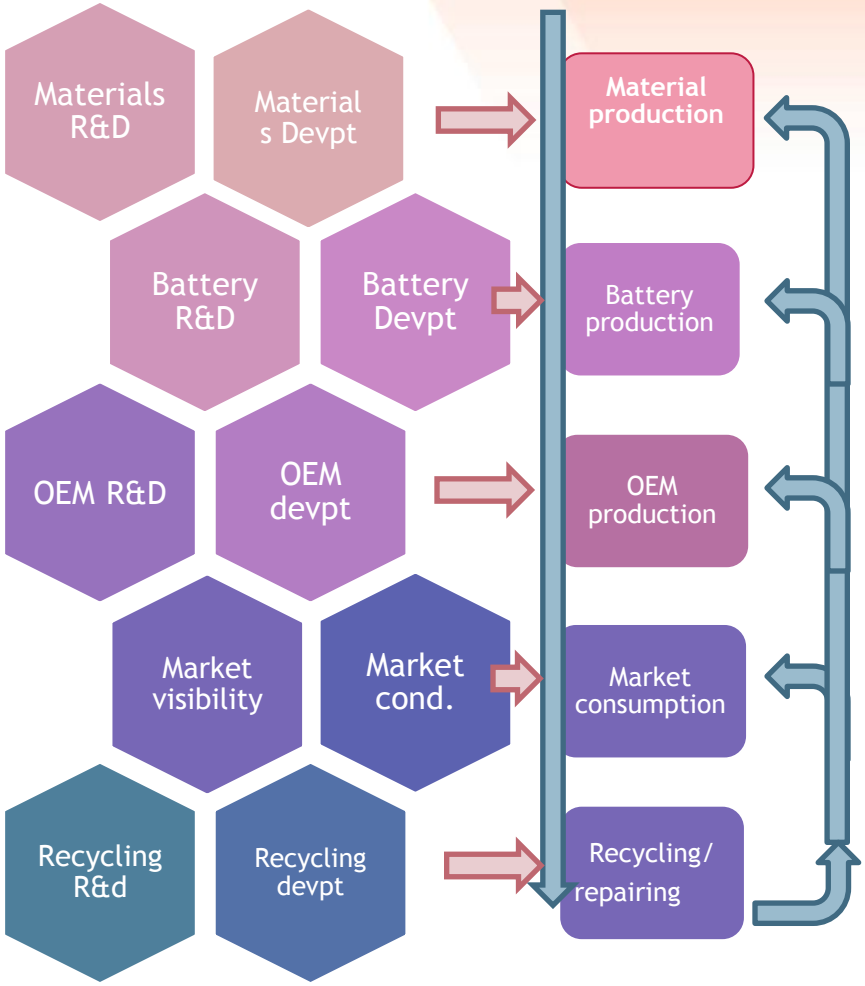
- Exemple of EV enabling Tesla start up.
- Opportunity is here, with significant improvement at stake, but winner is still unclear
- The technologies changes require several years befor representing significant market share (example of the Ni-MH in HEV application).

The battery industry has opportunities to «restart in Europe».

Battery Industry in a European network

The Battery industry has to be embedded in a European network

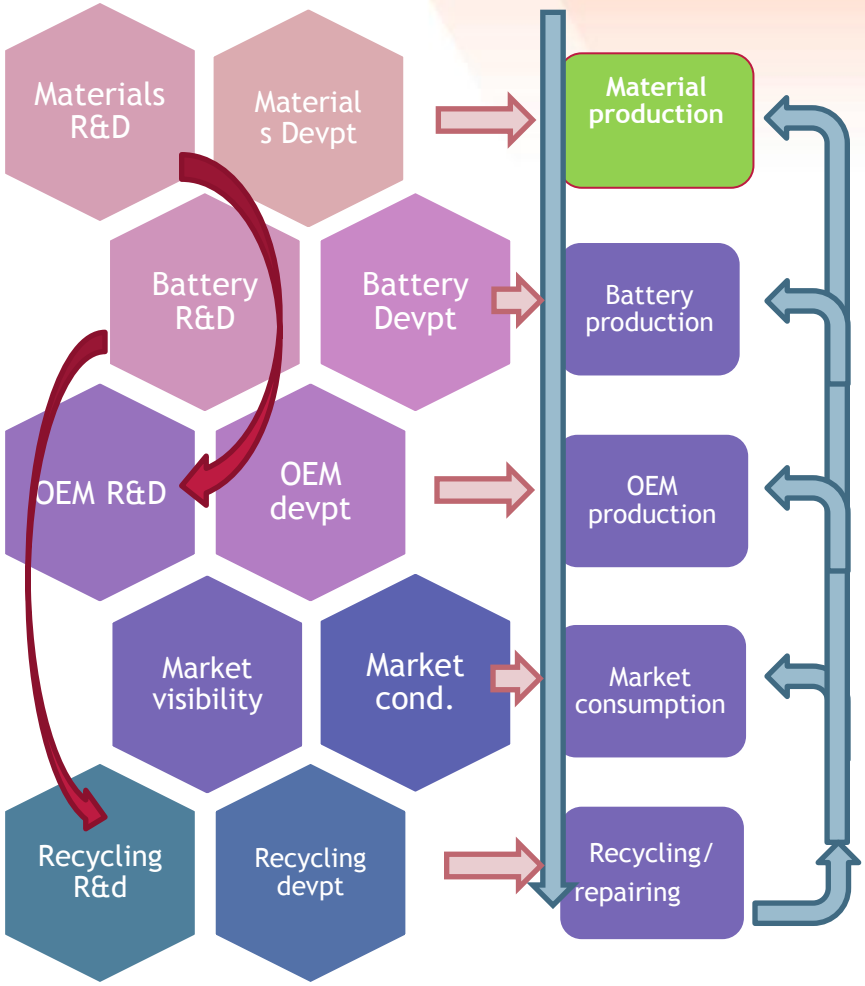
- local manufacturing for local markets
- New technologies are an opportunity associated with the new markets (e-mobility and future grid connected energy storage systems)



The need of a strong industry in Europe

The European network must be strengthened

- Relation car manufacturers-new battery suppliers.
- Market conditions: stability of supports?
- Global loop integration: recycling cost and feasibility



The need of a strong industry in Europe

Cooperation in European R&D programs such as MAT4BAT is a good opportunity for:

- **The creation of a network of competences.**
- **The creation of confidence between partners through collaboration.**
- **The identification of common technologies objectives and priorities**

Conclusion

The challenges for batteries in Europe are important: the largest part of the industry is in Asia, there is a high risk that the EU Battery industry can't make decisions to invest in Europe until the market becomes a reality…

But the new technologies are an opportunity to restart development and production locally.

Projects like MAT4BAT should be used as opportunities to strengthened a the European industry network and facilitate this development.