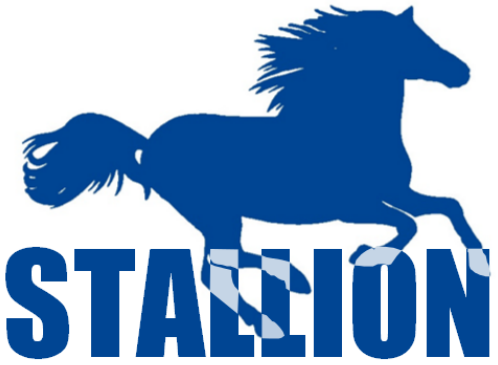


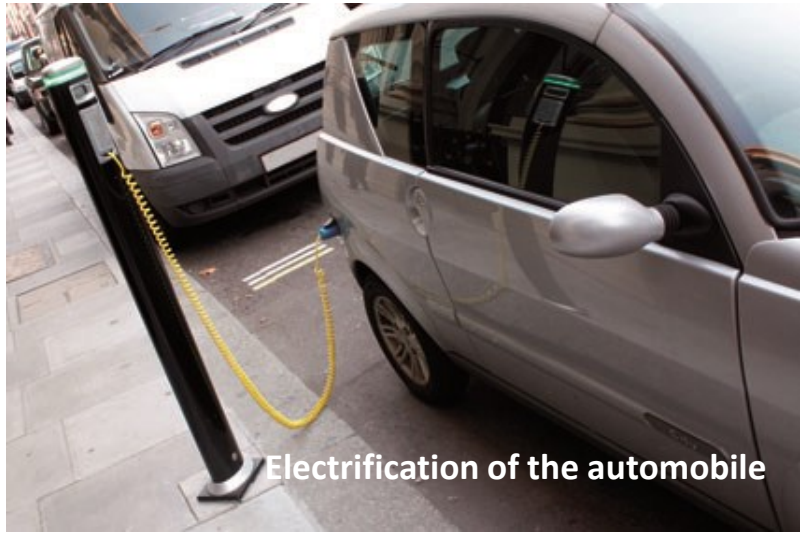
Supporting the deployment of safe Li-ion stationary batteries for large-scale grid applications

Presentation of material selection protocol

David MERCHIN, Umicore
David.merchin@umicore.com

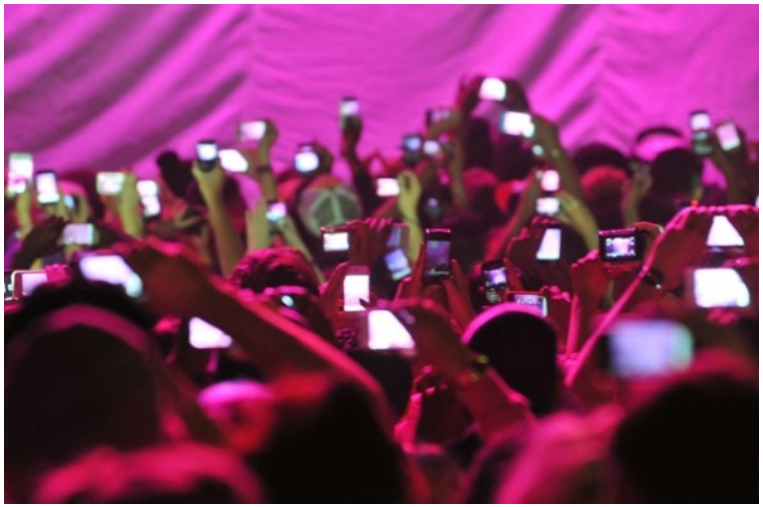
Düsseldorf, 10 March 2015

Key megatrends for Umicore



Global leader in key materials for rechargeable batteries

Umicore RBM has already produced cathode materials to…



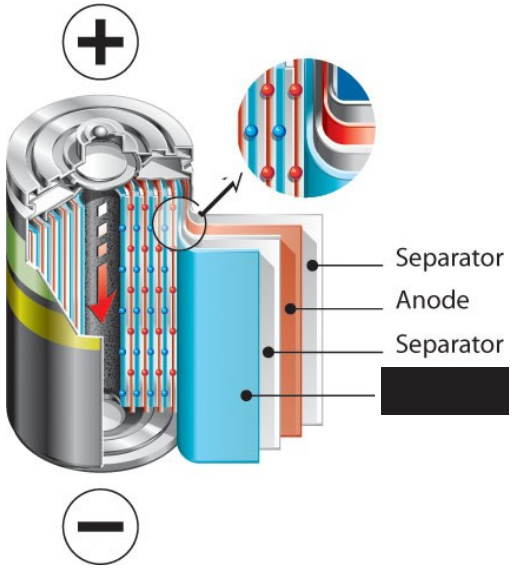
….provide a smartphone to every person on this planet

….power more then 1Million EV´s

Cathode Material Choice Strongly Determines Characteristics & Performance of Li-Ion Batteries

Umicore is integrated along the Li-ion battery value chain

Raw materials	Functional materials	Components (electrodes)	Cell	Pack	Application	Recycling



Application know-how enables Umicore to support end-user in terms of:

- Performance
- Overall system cost
- Product development
- Future roadmaps

Report on methodology for selecting appropriate cathode/anode materials

Choice of appropriate active material couple

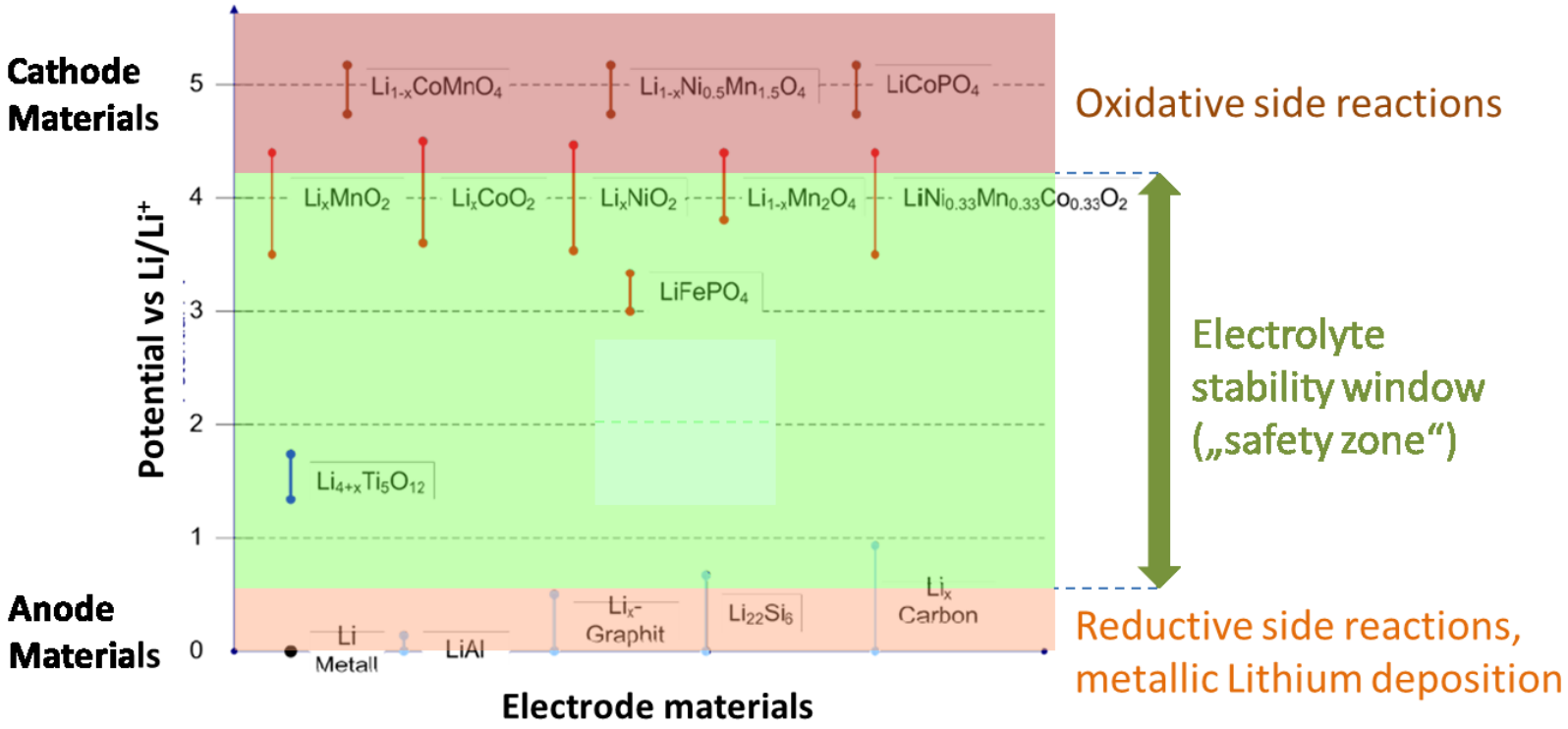
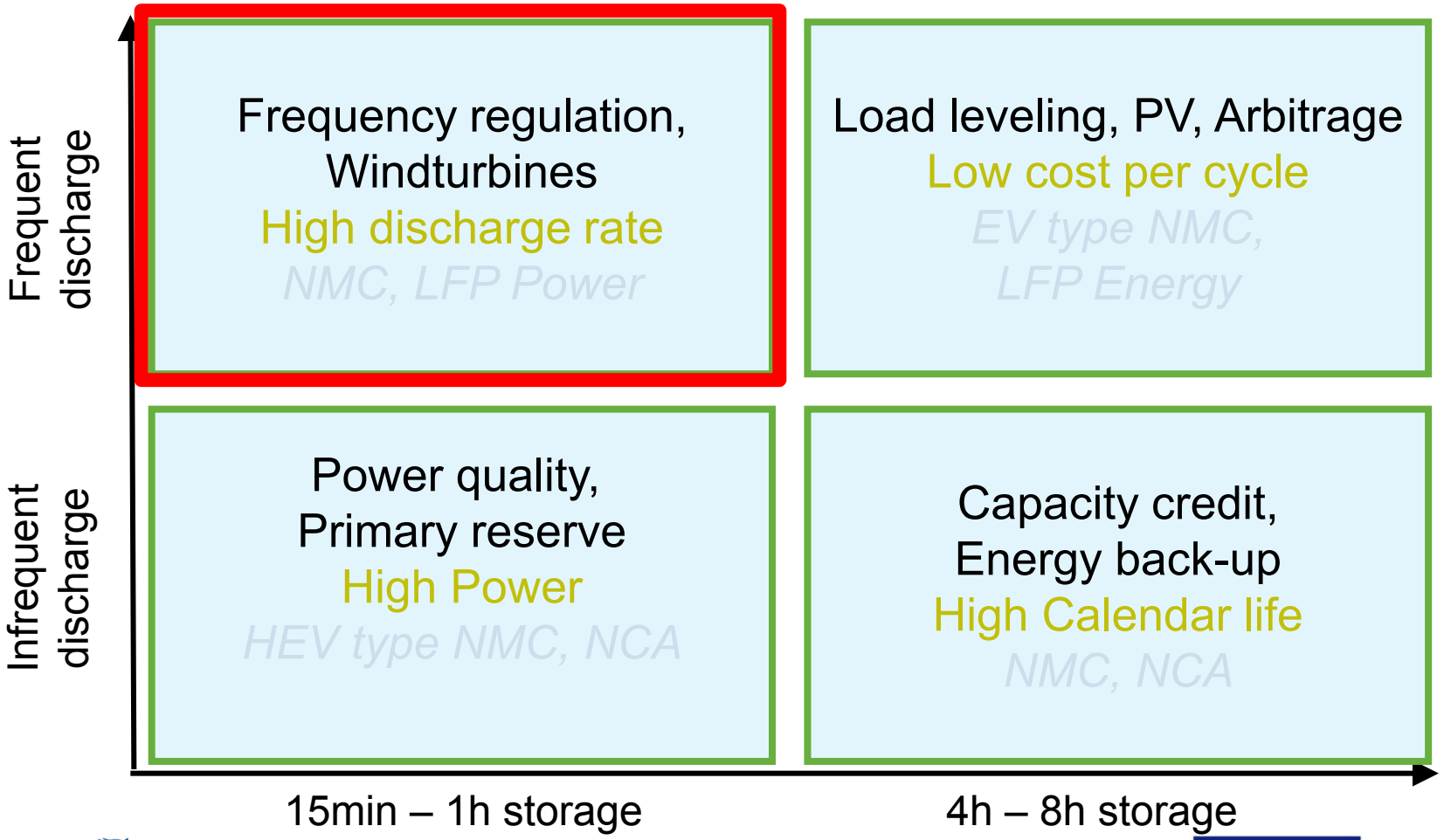


Figure 1: Energy diagram of battery Materials (Source: Copyright: Dispatch Energy Innovations GmbH)

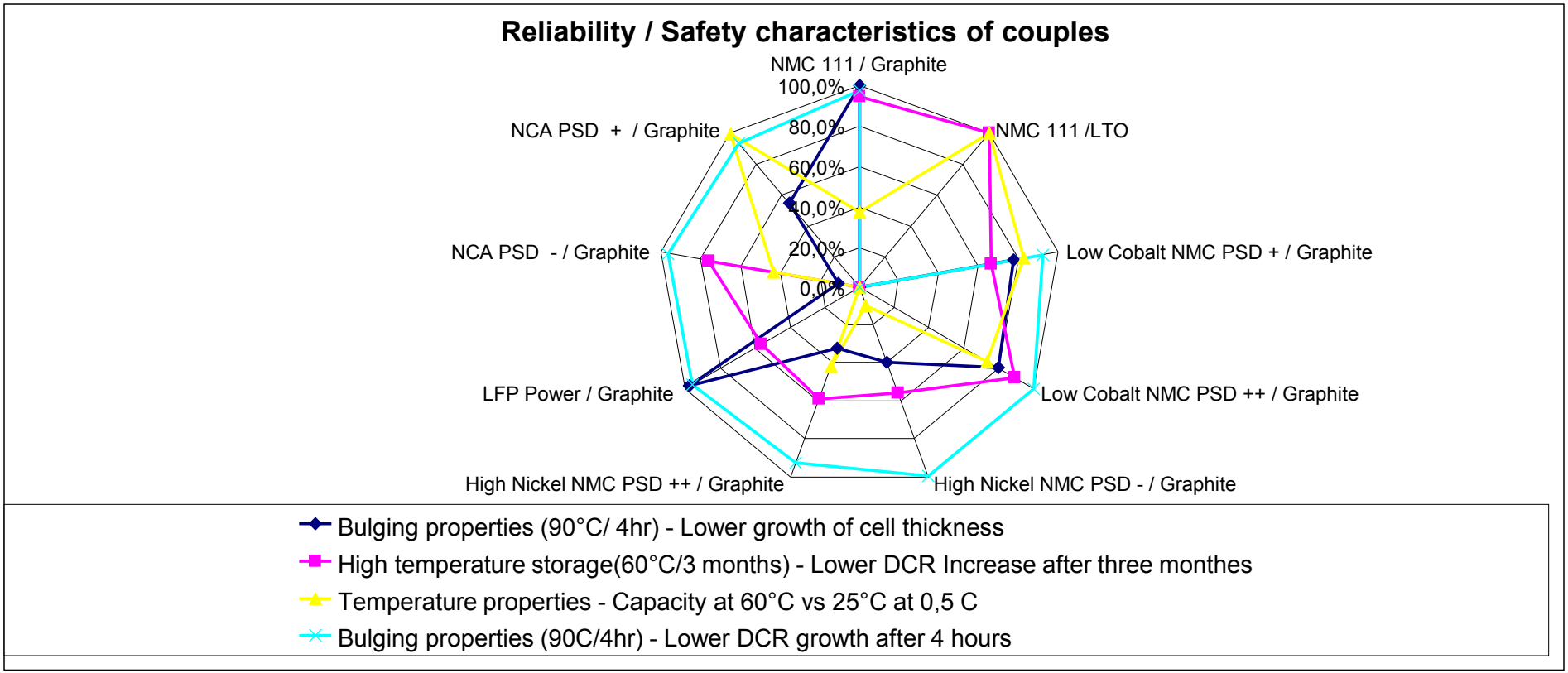
From LIB Characteristics to Active Materials

Breakthrough materials are first tested in PE and xEV markets



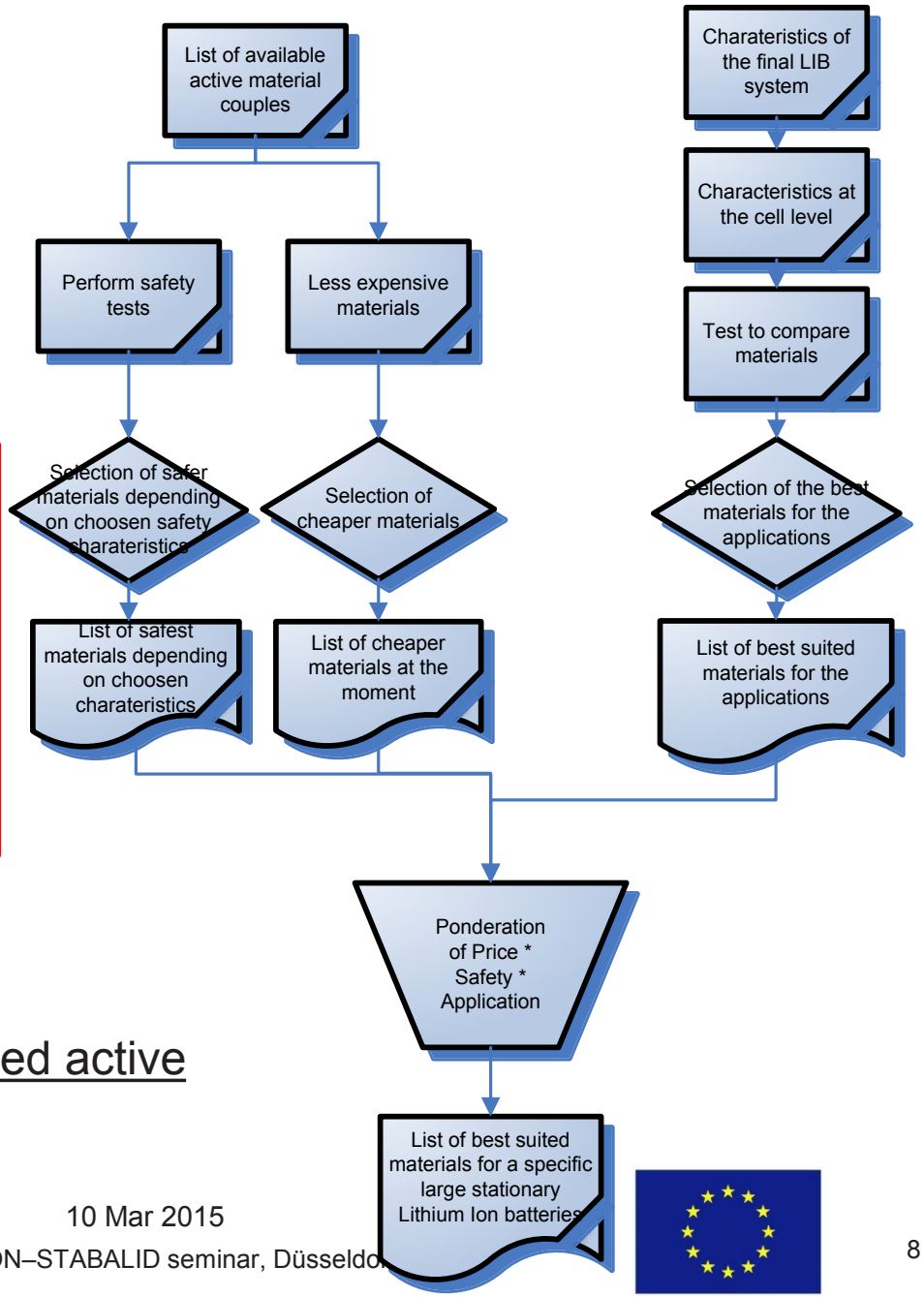
D4.1 - Report on methodology for selecting appropriate cathode/anode materials

Tests done a cell level @ Umicore Applied Tech labs (1Ah)



Graphical representation of safety test results

- Three pillars for selection:
  - **Safety** or reliability test to identify safest materials
  - **Price** analysis of less expensive active materials
  - Convert **end-users needs** and complete systems characteristics to battery and materials characteristics.



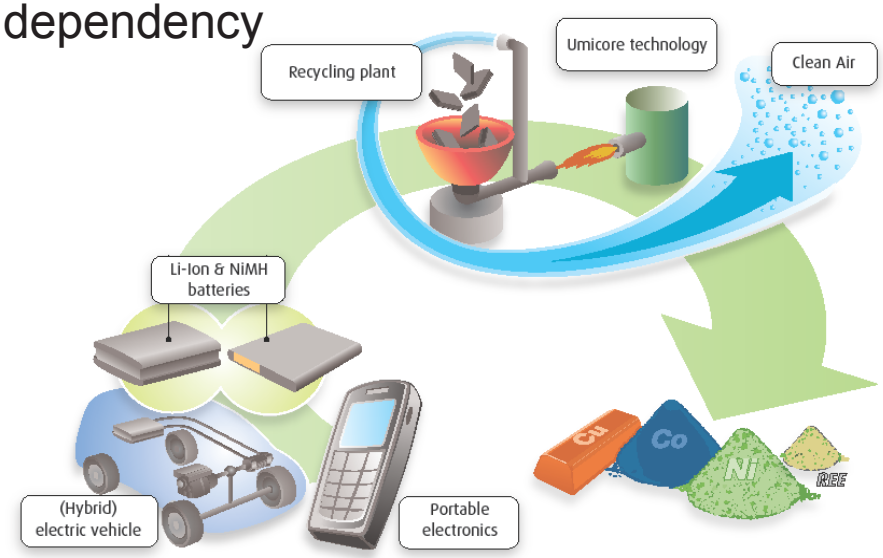
Methodology to select best suited active materials for LIB ESS systems

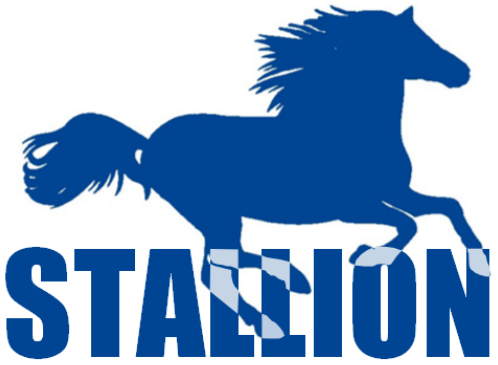
Closing the loop via battery recycling

Umicore Battery Recycling

Recycling of LIB cells, packs, production scrap

- Global drop-off points for collection of spent material
- Recycling installation in Hoboken, Belgium
  - Capacity: 7000 mT p.a.
  - Excellent energy- and CO_2-balance
- Selected partner for Tesla and Toyota
- Re-using metals reduces market dependency





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Thank you!
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