Risk management of SVHCs that are critical for breakthrough sustainable technologies: the case of Cobalt in Li-ion batteries

Wouter Ghyoot, Group Director Sustainable Value Chain, Umicore

Antwerp, 7 November 2018
Eurometaux Workshop on Stimulation of Substitution within a Circular Economy perspective in the metals sector

Introducing Umicore

Our foundations

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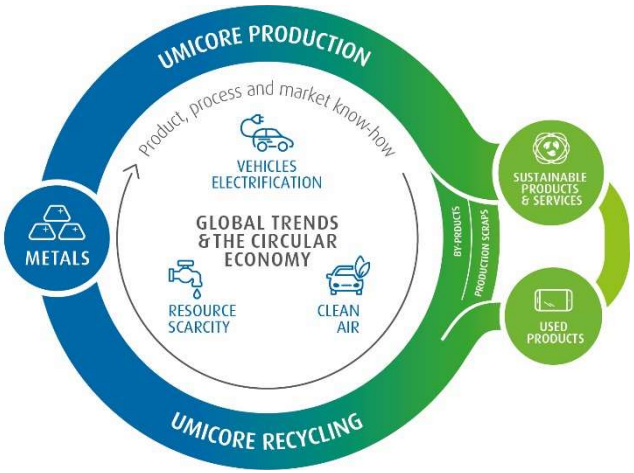
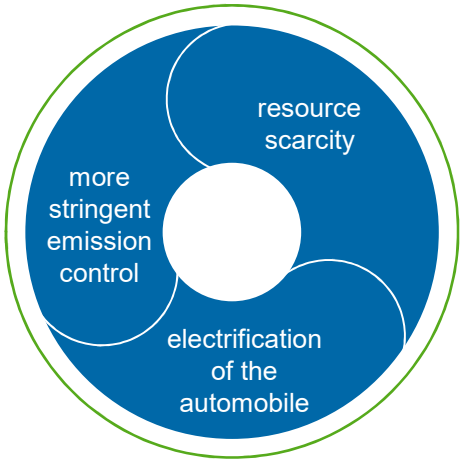
Unique business model



Supportive megatrends



Industry leader in sustainability

Taking on the global challenges

Identification of 3 megatrends where our skills make a difference

MORE STRINGENT EMISSION CONTROL

ELECTRIFICATION OF TRANSPORT

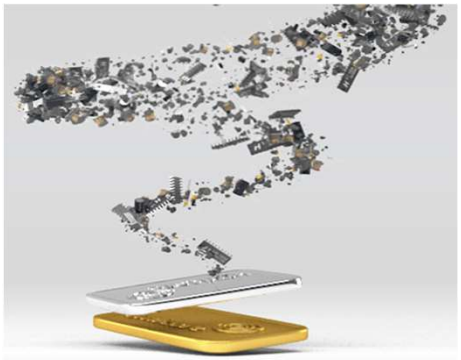
RESOURCE SCARCITY

Taking on the global challenges

Matching our products and services with these global needs….

AUTOMOTIVE CATALYSTS

RECHARGEABLE BATTERY MATERIALS

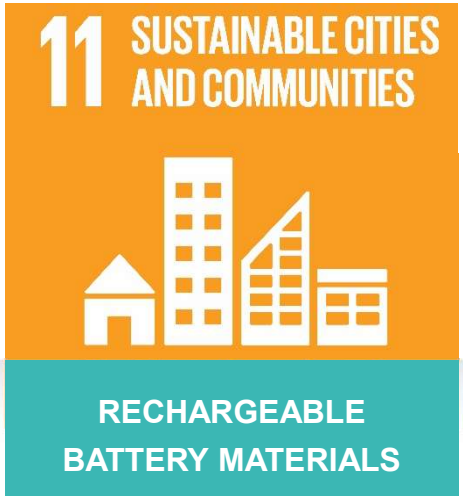


RECYCLING

Taking on the global challenges

…and the UN sustainable development goals

AUTOMOTIVE CATALYSTS



RECHARGEABLE BATTERY MATERIALS

RECYCLING

Umicore's global presence

PEOPLE
9,769

PRODUCTION SITES
51

R&D | TECHNICAL CENTERS
14

North America

858 people

12 production sites

2 R&D technical centres

South America

685 people

5 production sites

1 R&D technical centre

Africa

262 people

1 production site

Europe

5,782 people

19 production sites

5 R&D technical centres

Asia / Pacific

2,182 people

14 production sites

6 R&D technical centres

Figures exclude associated companies (December 2017)

RBM (Rechargeable Battery Materials) global presence

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Rechargeable Battery Materials

Brussels

Sales, Commercial HQ

Olen

Production, Battery lab, Process Competence Centre

Hanau

Applied Technology

Nysa

Production

Seoul

Headquarter : Sales, Applied technology

Cheonan

Production, Battery lab

Jiangmen

Production, Sales, Applied Technology

Auburn Hills

Sales, Applied Technology

Tokyo

Sales

Kobe

Applied Technology, battery lab

Taipei

Sales

The biggest facilities in the world

for cathode materials production

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Rechargeable Battery Materials

Cheonan, Korea

Greenfield plant to be built

close to existing plant

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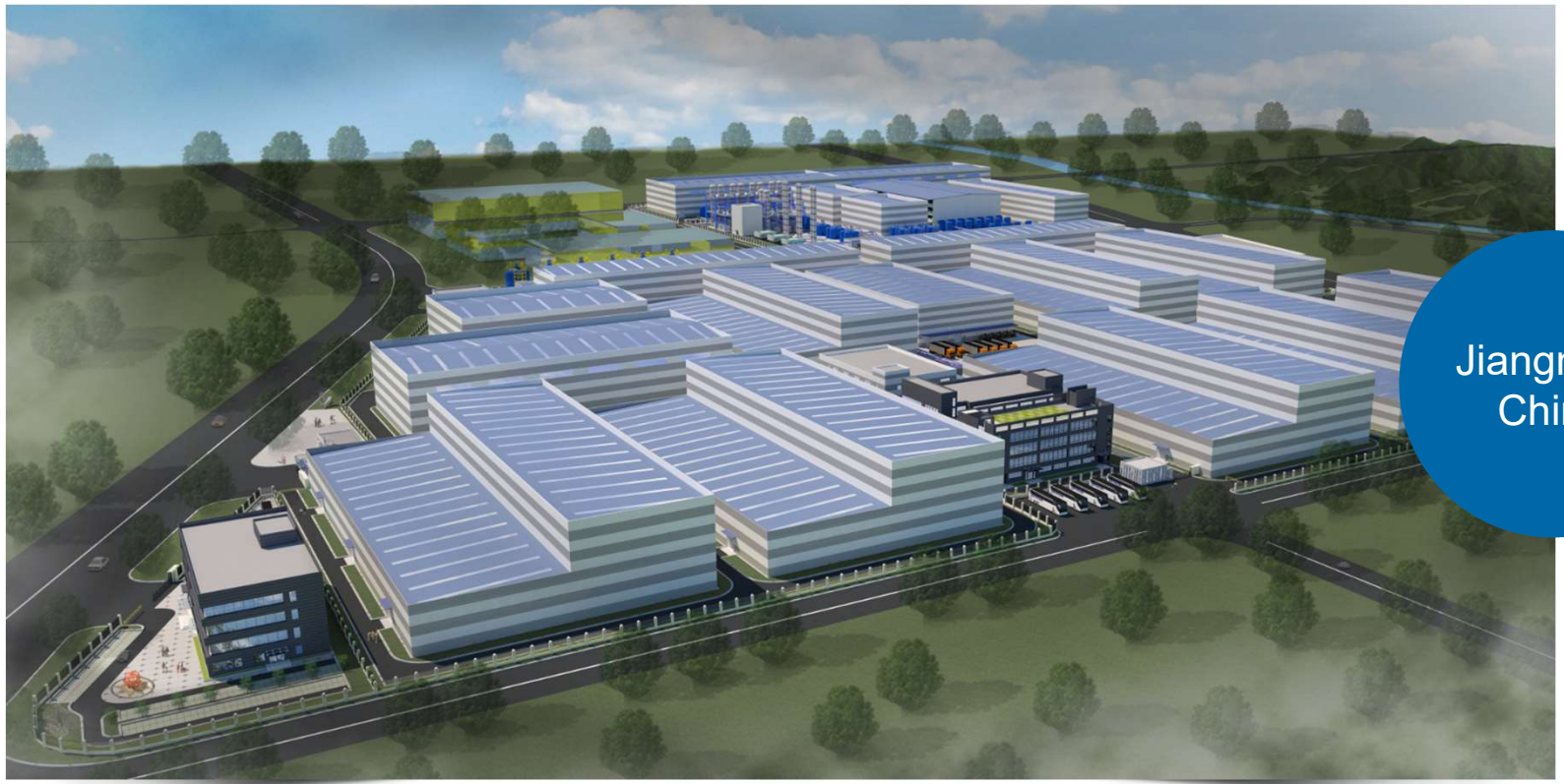
Rechargeable Battery Materials



Global leader in active materials for rechargeable batteries

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Rechargeable Battery Materials

Umicore RBM has already produced enough cathode materials to…

….provide a smartphone to every person on this planet

…power more than 1Million EV´s

1 out of 5 batteries ever made contains Umicore technology

Over 15 years in the market

6 production sites

Unique Integration in the Value Chain

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Rechargeable Battery Materials

Raw material

Recycling & intermediates

Refining feed

Co Ni

Metal

Product

Li Co

Li Ni

Co Mn

Application

Li-ion rechargeable batteries

- Portable electronics
- Power tools
- (P) HEV / EV
- E-bikes
- Stationary power

Umicore occupies a unique position in the value chain guaranteeing high speed to market, supply security, and responsiveness to customer needs

Closing the loop

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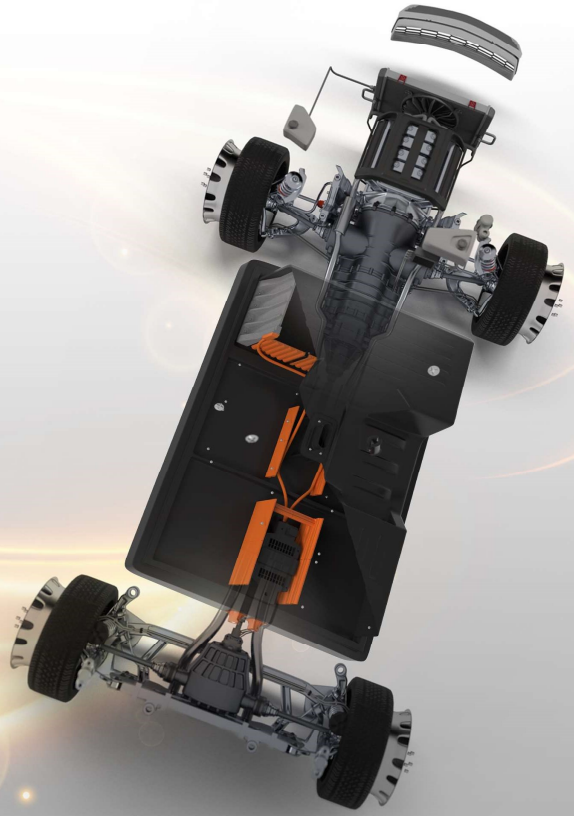
Rechargeable Battery Materials

Full closed loop possible due to in-house technology



Different battery chemistries

Different battery chemistries

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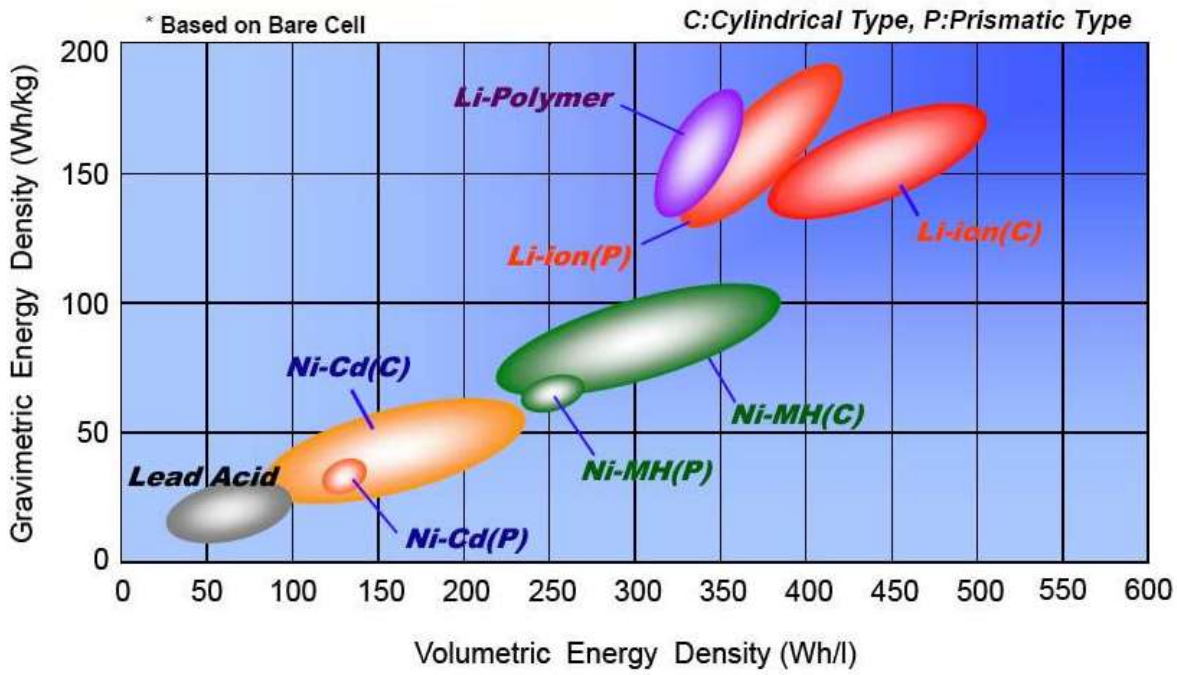
Rechargeable Battery Materials

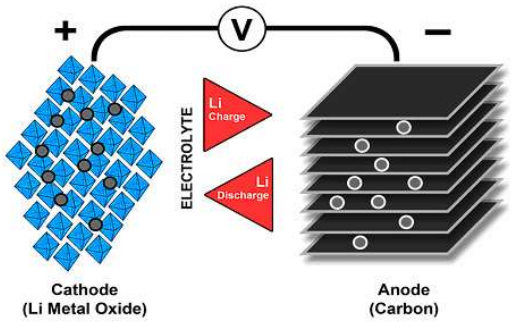
Li ion batteries have highest energy densities and are therefore used in electronics, automotive and energy storage systems



The essential role of cobalt in cathode materials

Cobalt improves life cycle and safety performance

- Lithium Cobalt Oxide (LCO):
  - Cobalt is the main transition metal in LCO.
  - Typically used for portable electronics
  - Preferred cathode material for portable telephones where volumetric energy density is one of the most important criteria
- Lithium Nickel Manganese Cobalt oxide (NMC):
  - Cobalt is one of the three transition metals in NMC with main application in electric vehicles and stationary energy storage
  - It is not possible to substitute cobalt entirely, because it offers an essential contribution including improved life cycle and safety performance (cobalt keeps the structure stable)
  - There are benefits of NMC materials with higher nickel content, for instance NMC 811, but we are convinced that materials with a medium nickel content (e.g. NMC 532) offer the best total cost of ownership and are therefore the preferred material to support the electrification of the automobile industry



xEV battery materials technologies roadmap

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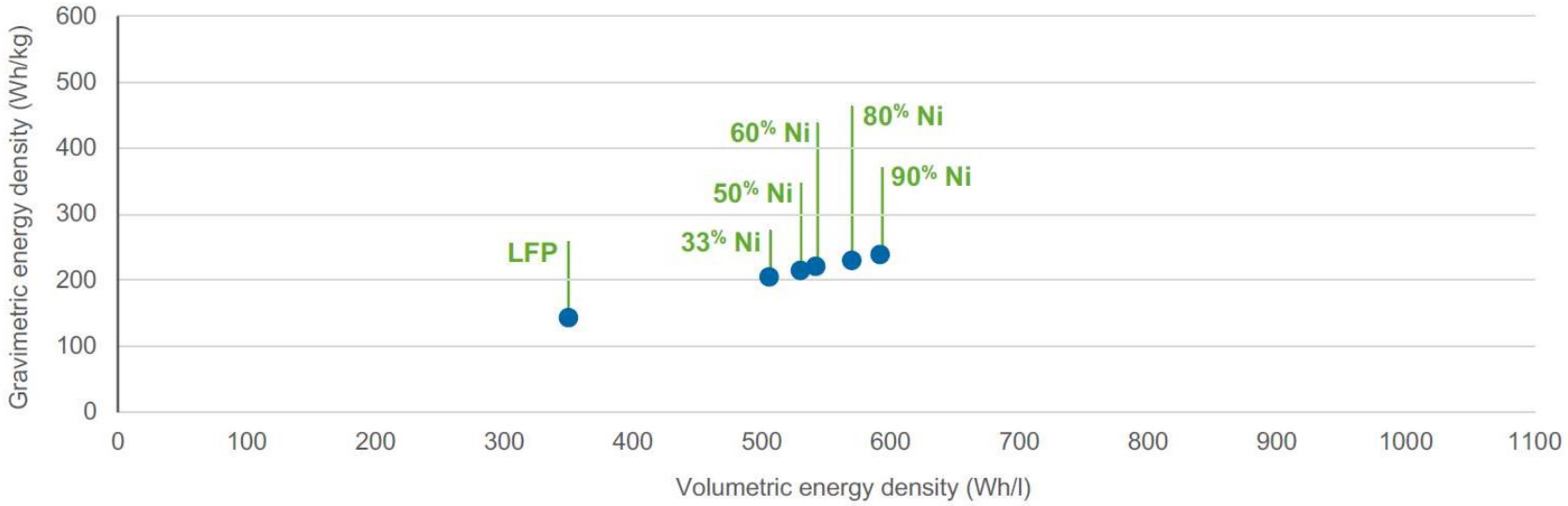
Path towards longer driving range

Wh/kg as a function of Wh/l for state-of-the-art Li-Ion

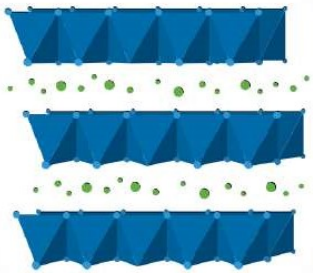


Car OEMs are looking for the highest (volumetric) energy density

CAPITAL MARKETS DAY POWERING AHEAD

Cathode material optimization

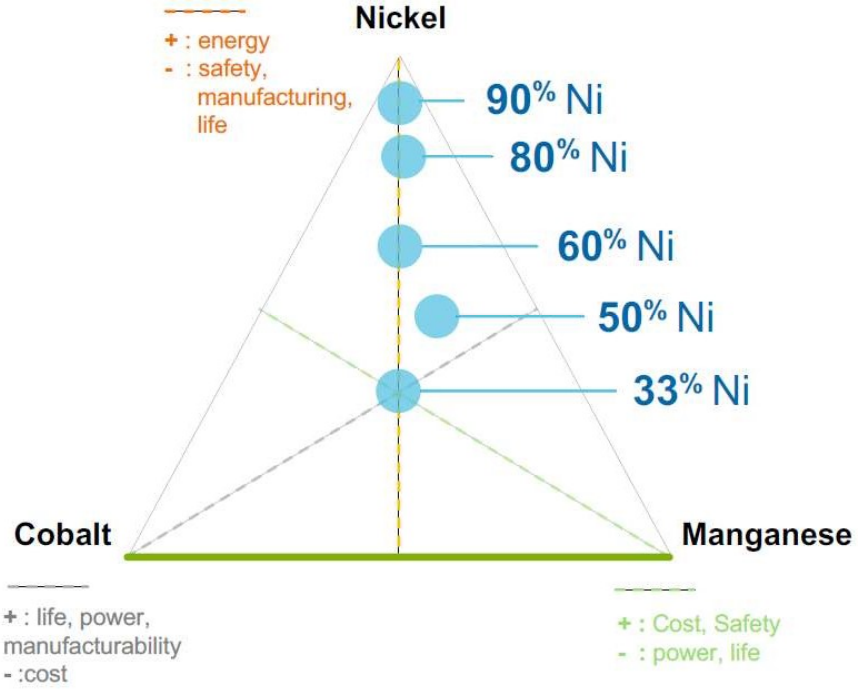
One big family of products



LCO, all grades of NMC, NCA: all layered materials sharing:

- crystal structure
- base manufacturing concepts

Exact properties depend, among others, on relative ratio metals in metal site



Umicore has the full spectrum of materials in portfolio

Composition

Cathode material optimization

Higher nickel NMC is an obvious track

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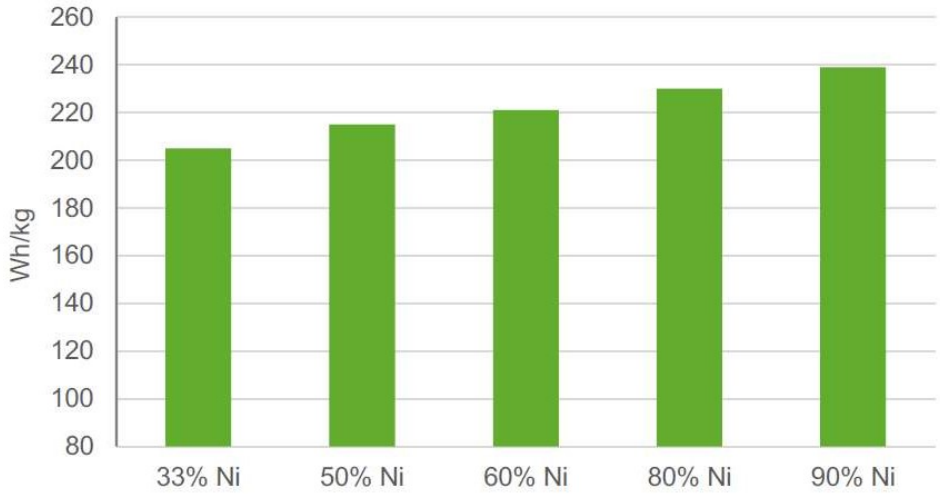
- **Energy density increases proportionally** with Ni content in the cathode material
- **Gains up to 17%** could be obtained by moving from 33% to 90% Ni
- Cathode materials need to be **tuned**

Wh/kg as a function of Ni content at constant 4.2V



Umicore's twenty years experience in producing complex cathode materials provides a strong edge to tune cathode materials for higher energy density

CAPITAL MARKETS DAY POWERING AHEAD

Cathode material optimization

Is higher nickel the holy grail?

High nickel is part of the solution towards higher energy density

However, basic fundamental drawbacks must be considered:

- Technology limitations:
  - *Cycle life: not yet on a par with lower Ni compounds*
  - *High voltage stability and safety yet to be demonstrated*
  - *Limited experience of integration into large cells at battery makers*
- Performance comes at a cost
- Industrial application at 90%+ Ni yet to be demonstrated

Through technology Umicore can address some of these drawbacks

The full spectrum of chemistries is and will be needed to serve customers' requirements

Umicore offers the full range of lithium layered cathode materials - all certified for the most stringent automotive requirements

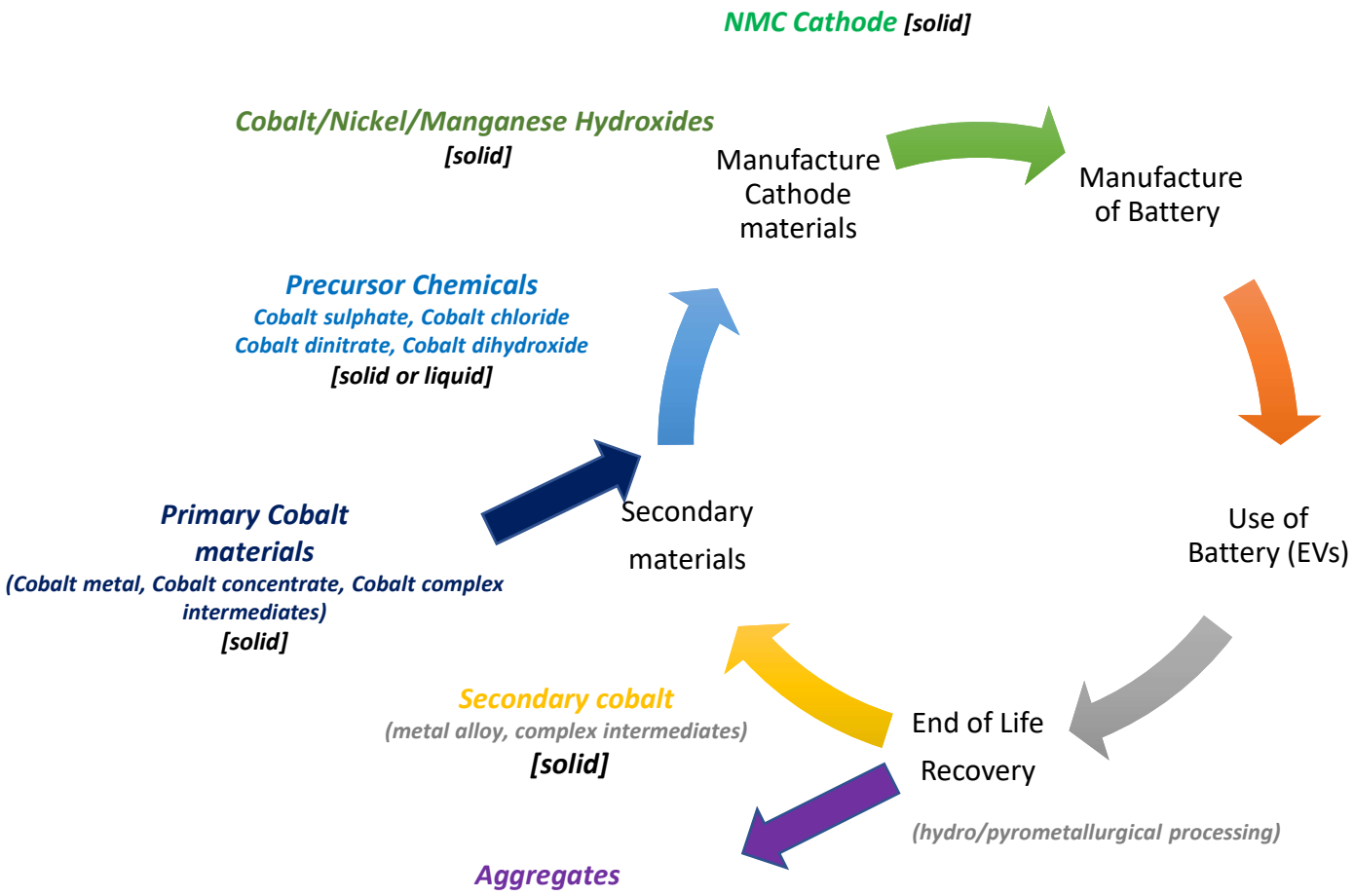
Materials supply & demand

A combination of primary resources and recycling is key

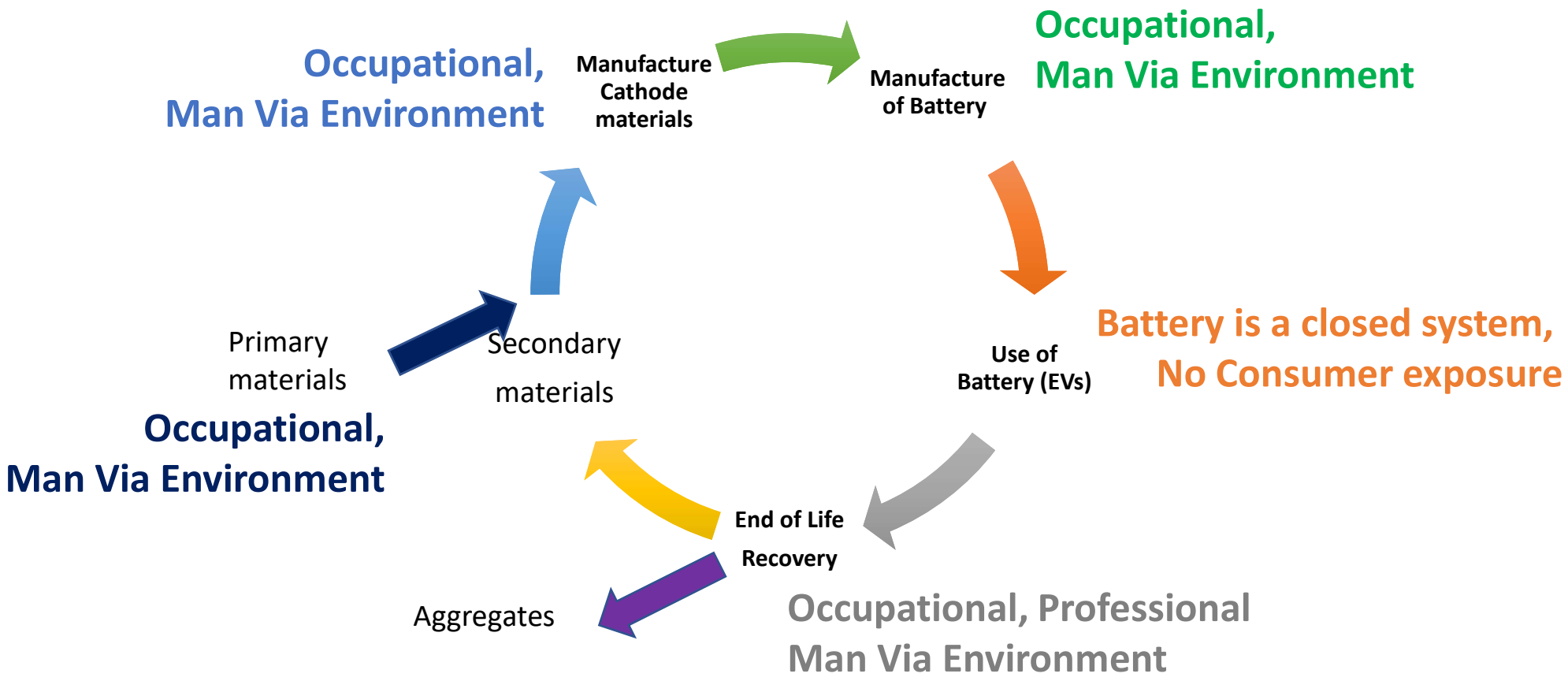
source: http://www.mckinseyenergyinsights.com/insights/metal-mining-constraints-on-the-electric-mobility-horizon/

Cobalt in the different life cycle stages of Li ion batteries

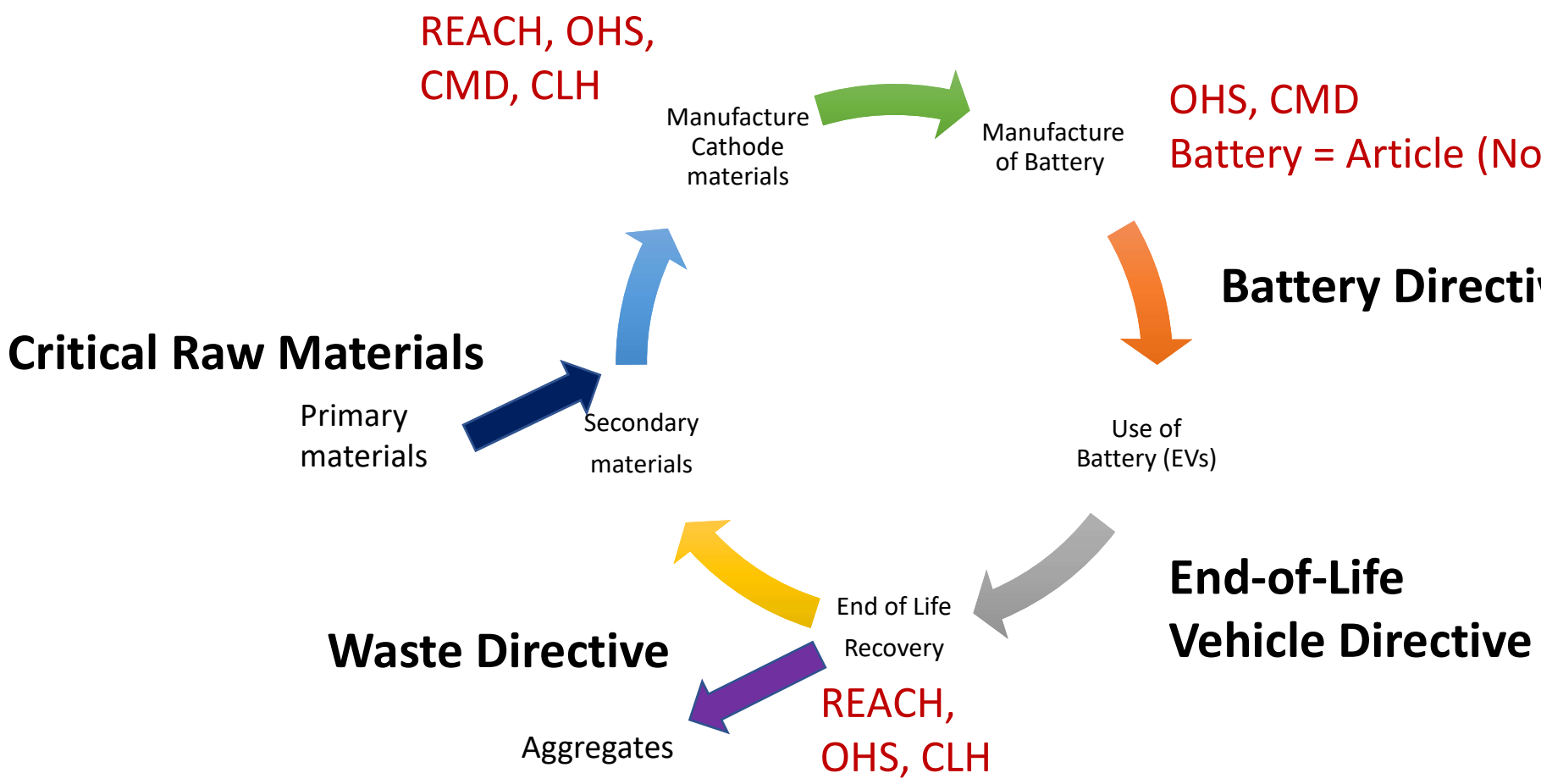
Life Cycle Stages of Cobalt in Battery Value Chain – Cobalt Compounds



Life Cycle Stages of Cobalt in Battery Value Chain - EXPOSURE



Life Cycle Stages of Cobalt in Battery Value Chain - REGULATORY



A risk controlled environment

Framing the non-toxic environment strategy for the metals sector

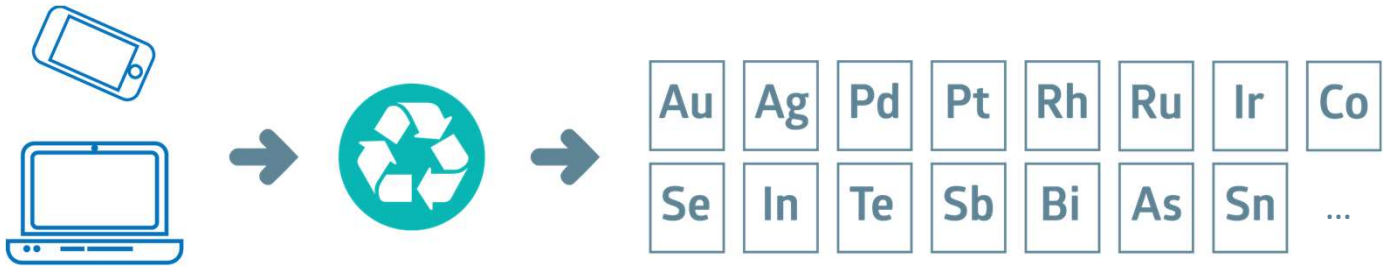
Safe Use Along the Supply Chain

Efficient chemicals management for metals: prevent exposure, **don't stigmatise hazard**

Workplaces – reduce exposure levels

Products – prevent releases and even limit hazard properties

Recycling – utilise effective & safe processes



Chemicals and Circular Economy: effectively closing the loop

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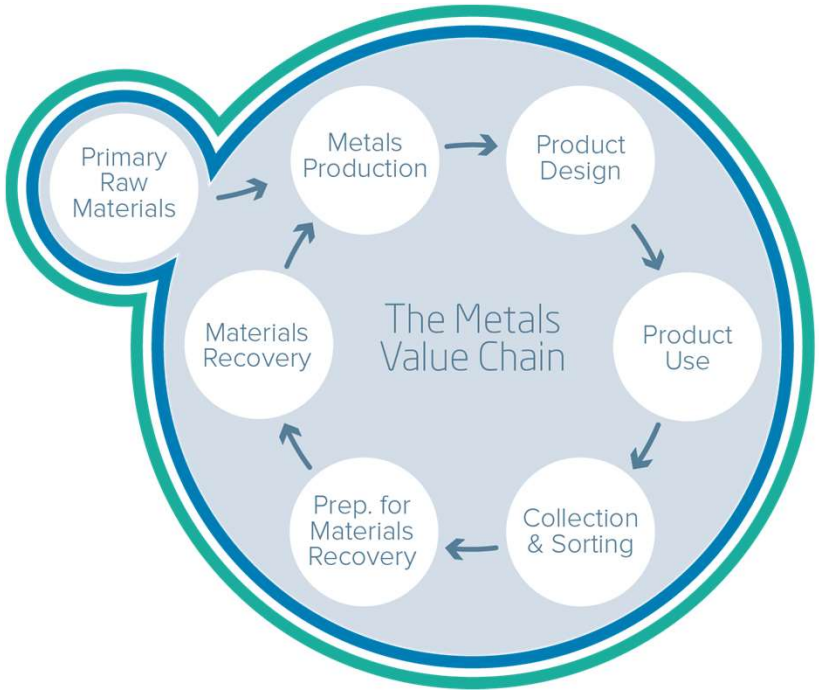


CHEMICALS POLICY

Focus on handling materials safely

- Safe use
- Safe manufacturing
- Safe recycling
- Article legislation

CIRCULAR ECONOMY POLICY

Focus on keeping materials in the loop

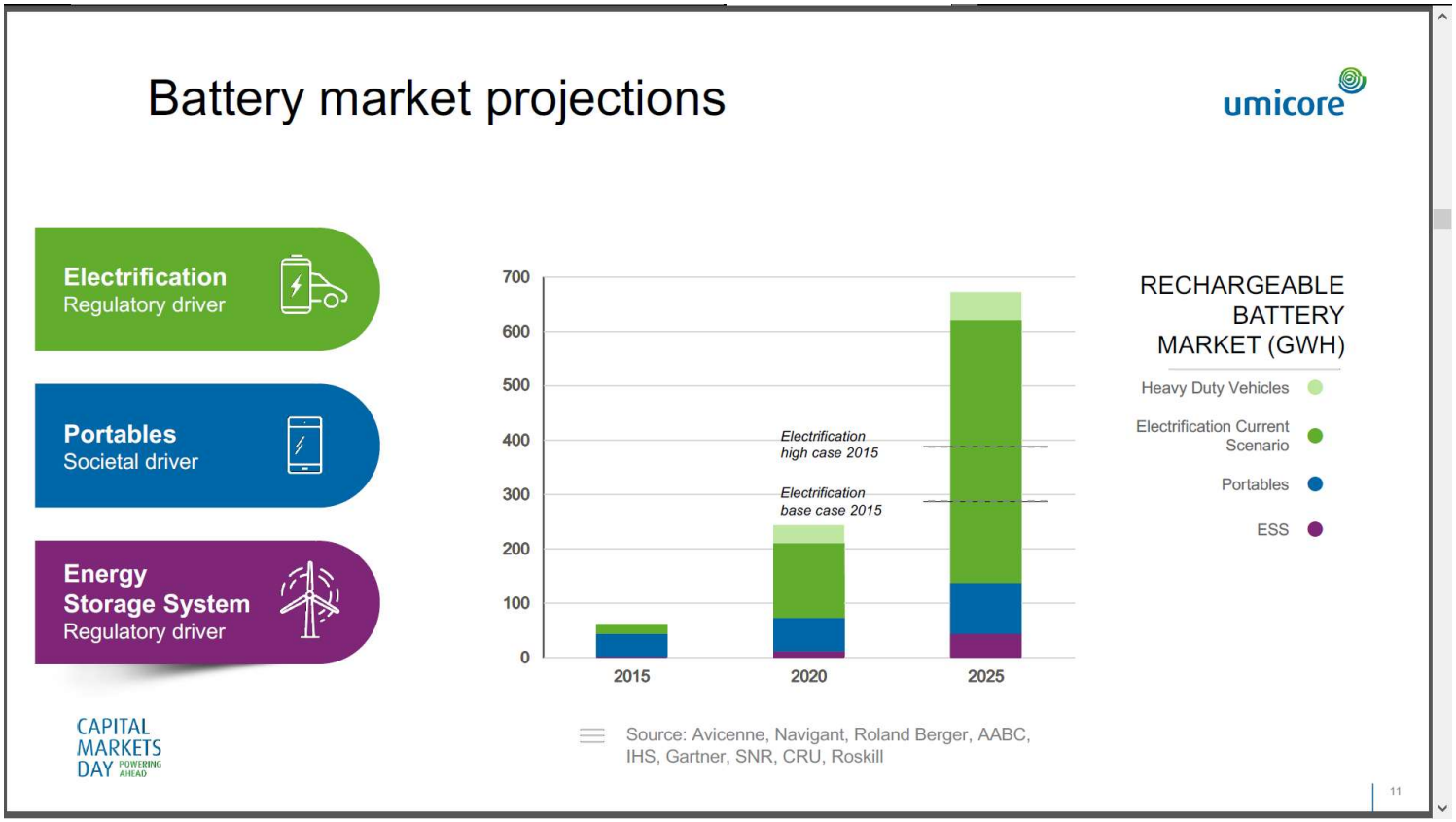
- Industrial Symbiosis
- Ecodesign
- Waste management
- Secondary raw materials markets

Closing the loop through ***reuse or materials recycling*** improves substance performance!

Cobalt use in Li ion batteries will grow

Battery market projections until 2025

Growing Li-ion batteries market will require



Conclusions

Conclusions

- Cobalt is essential for the performance of Li-ion batteries and will be essential in the electrification of the automotive
- A risk-based management of cobalt is needed along the various life cycle stages and it is the responsibility of manufacturers and users to control exposure
- Cobalt use will increase with the electrification of the automotive, even if there is a trend to higher nickel content chemistries.
- Cobalt has an essential function in performance and safety of the batteries
- To make a truly sustainable battery value chain, it is important that chemicals management policies and policies on circular economy are matched
- A risk-based regulatory framework will allow for sustainable growth of European cobalt transformation and recycling operations, and a future for the European battery value chain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materials for a better life