Umicore Battery Recycling
Recycling of NiMH and Li-ion batteries
a sustainable new business

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Dr. Jan Tytgat - Umicore
Umicore Battery Recycling

Triple bottom line (J. Elkington, 1997)

A sustainable business model is:
- Economically sound
- Environmentally safe
- Socially responsible

UBR-model: from recycling drivers to new business

EHS

Volume

Value

Technology

Economy

Ecology

Why?

How?
Economic aspects: **Legal Framework** as driver for recycling

Strong regulation of battery recycling is a basis for our ‘service model’: even for batteries having low intrinsic metal value, there is a service value.
Economic aspects: Proven market for Portable Rechargeable Batteries

In the EU, the market of PRB’s is about 35000 Tons/year and still growing.

- Collection target: 45% by 2016 = target market volume of 20 000 ton
- Collection today: +/- 6%
- Proven technology and position: UBR is running this business on pilot scale for 4 years before deciding in new, bigger and better installation

Source: IIT Takeshita 2009

Power demand for Li-ion batteries

(in MWh/year)

Portable electronics
Power tools
(P)HEV/ EV

Economic aspects: Expected market for (H)EV-batteries

Several business models expect up to 10% (H)EV by 2020 (% of sales of new cars)

1 million e-cars = 50 000 ton batteries

First wave:
- production waste
- warranty claims
- accidents

Source: Takeshita
Economic aspects: UBR market position

- the only industrial Li-ion battery recycler worldwide
  - 7000 ton/year capacity up and running
  - Competition: < 200 t/y capacity and unsolved qualification issues with some recycled fractions
  - Connects a new dedicated battery smelter technology with an existing large scale refinery
- the only industrial NiMH-battery recycler worldwide that recovers Rare Earth Elements
  - Unique collaboration with Rhodia: Umicore concentrates, Rhodia refines
- Intensive contacts with car-industry (Europe, US, Japan, Korea)
- Published relations, others under NDA
Compounds = “added value molecules” ➜ Compound Cost > Σ Element Cost
e.g.: LiCoO$_2$ cost > (Co + Li + O) cost

Recycling model based on compound value recovery makes sense

But, due to:

- High diversity of battery materials
- Rapidly changing specifications and long lifetime for EV batteries
- Contamination risks
- Low risk minded battery industry, heavy qualification process

Theoretical compound value hard to valorize: small market for recycled battery compounds

Umicore strategy = ‘element recovery’ and service
Economic aspects: UBR’s new Battery Smelter

- New UHT smelter in Hoboken, opened September 7, 2011 has a 7000 T/y capacity (= 140 000 (H)EV batteries or 250 Million cell phone batteries
- Sufficient for EU- and world wide market for coming years
- New installations will be geographical spread (N-America, Far East)
- Plant size will be determined by
  - Technology: physical limits, risks
  - Economy: investment and exploitations costs versus transport costs
  - Ecology: LCA methodology to balance between recycling and resource efficiency versus transport burden
- Commitment to have installed capacity to cover all customer needs
- Robust process, compatible with all Li-ion battery chemistries
Environmental aspects: **process description**

**The Unique Closed Loop Solution for batteries**

- **2011: Hoboken, Belgium**
- **Olen, Belgium**
- **Jiangmen, China**
- **Cheonan, South Korea**
- **Kansai, Western Japan**

- **Added value because of Li and Possibility for closed loop recovery of Li**
- **Closed loop for REE’s**
- **Possibility to recover F**
- **Recovery of Co Ni Fe Cu**
- **Closed loop for Co Ni Cu**
Environmental aspects: **resource efficiency**

The UBR process recycles most of the critical and economic important raw materials in the batteries and consumes only commodity chemicals (which are recycled as well).
Environmental aspects: 
Resource efficiency and CO$_2$-footprint

- Battery recycling increases the ‘green image’ of e-mobility
  - Several LCA’s, together with customers, tackle some environmental objections against e-mobility:
    - Recycling reduces global warming, acidification eutrophication and ozone depletion potential of EV’s (impact reductions from 20 to > 90 %)
    - The plant has a very low CO$_2$-footprint and nearly no external energy has to be added to the process; even if transport of batteries is included in the LCA –scope
  - Resource efficiency:
    - Study by University of Ghent shows more than 50 % resource efficiency credits
    - Chemicals used in the process are recycled for construction; hereby reducing the CO$_2$-footprint of construction materials as well
Environmental aspects: **Recycling Efficiency**

- **Recovered**
  - C
- **Emitted**
  - H
  - O
- **Collected**
  - F
  - Cl

**Ongoing discussion on:**
- use of C as a reducing agent
- dry or wet basis

⇒ **RE: Above 50% EU target**

Recycled as products and by-products
Environmental aspects: **Li-recovery**

Li: No immediate shortage, nevertheless, be prepared:

- geopolitical strategy
- sustainability considerations

UBR’s position today:

- through the UBR process, Li is recycled according to BD definition
- higher added value in special case because of Li-content (anti concrete cancer agent)
- possibility to extract Li

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**Can lithium extraction keep up?**

*Source: R. Klein (U. Leiden)*
NiMH batteries contain REE’s

- defined as critical raw materials for EU, because dependency on Chinese supply

Joint project with Rhodia:

- Umicore makes a REO-concentrate
- Rhodia refines the concentrate into pure REO’s
- These REO’s can be used for batteries again, or for other high end applications

REE = Rare Earth Element
REO = Rare Earth Oxide

Rare earth oxides. Clockwise from top center: praseodymium, cerium, lanthanum, neodymium, samarium, and gadolinium (bold = in NiMH batteries)
Social aspects: creating labour on several educational levels

- Dismantling and sorting of (H)EV batteries and portable batteries

- (H)EV dismantling at Umicore: manual job, today only in Hanau, but to be rolled out worldwide
- WEEE dismantling:
  - Dismantling avoids transport of parts which are ‘easy’ to recycle locally
  - Creates valuable jobs for lower educated personnel on several places
Social aspects: creating labour on several educational levels

- smelting of batteries
  - Highly specialized jobs in limited centers of competence
  - Avoids ‘backyard’ recycling with high EHS risks
Conclusions

Economic aspects
- Proven market for PRB’s, market for (H)EV still to be demonstrated, but generally accepted to grow to 10% of new sales by 2020
- Unique position because of technology and business relations

Environmental aspects
- Low carbon footprint,
- LCA-proven resource efficiency and very good results on all investigated impact categories
- Closed loop for most critical elements; possibility to close the loop for other strategic elements

Social aspects
- generates quality labour on several levels of education
- possible to roll out to several area’s worldwide
Contact: jan.tytgat@umicore.com