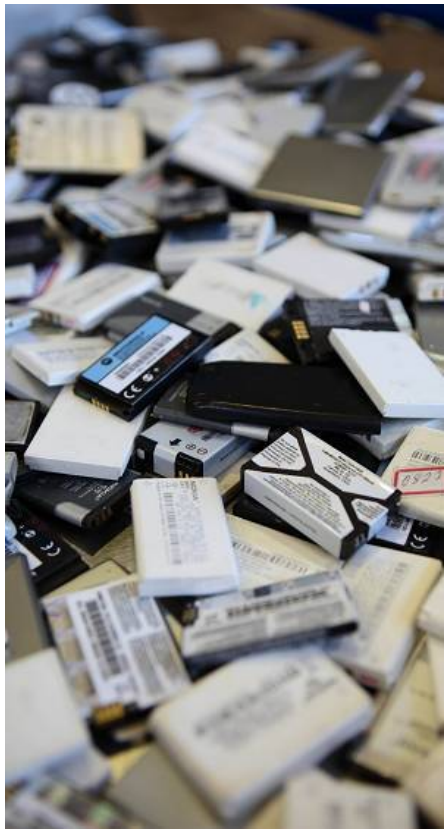
Battery Recycling

Jan Vliegen – Senior Vice President

Capital Markets Event on Recycling – 18-19 Nov 2010

Umicore Battery Recycling



First ever developed process with a specific focus on the need for rechargeable battery recycling

"Best Available Technology", allowing to meet current and future regulatory requirements

- Unique recycling process with a maximum valorisation of valuable metals
- Clean process with minimum energy use, CO_2 and waste generation
- Safe and full service from battery transport to recycling, all complying with the strictest regulations
- Flexible to treat all Li-ion and NiMH chemistries

First industrial-scale plant under construction, to be commissioned mid 2011

- Future volume of this business is driven by the emerging electrification of transport

Investments & technology

Pilot plant in Hoboken

- € 25 million investment
- Initial treatment capacity of 7,000 tonnes
  - Equates to some 250 million mobile phone batteries
  - Equates to some 150,000 (H)EV batteries
- Start-up foreseen mid 2011

Uses Ultra High Temperature (UHT) technology

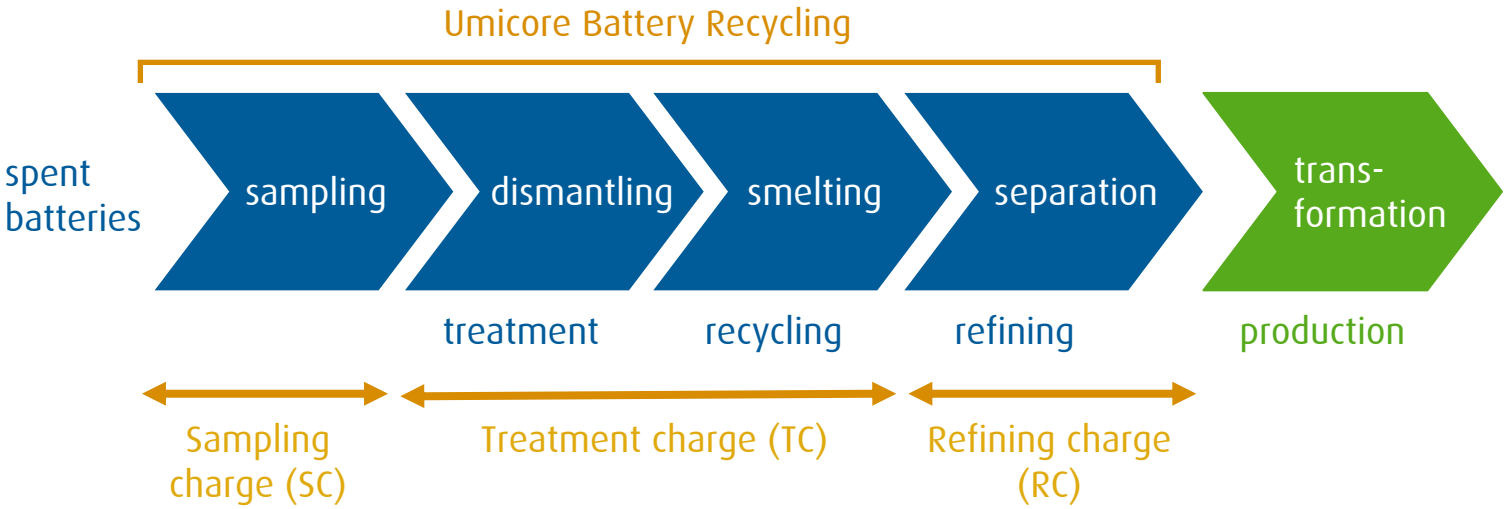
- Allows to extract Co, Ni, Cu (and Li) from Li-Ion, Li-polymer and NiMH batteries
- Slag by-product can be used in the building industry

Investment is expected to bring opportunities for

- New recyclable material types
- Optimisation of existing UPMR flowsheet

(H)EV dismantling pilot in Hanau

Value chain & business model

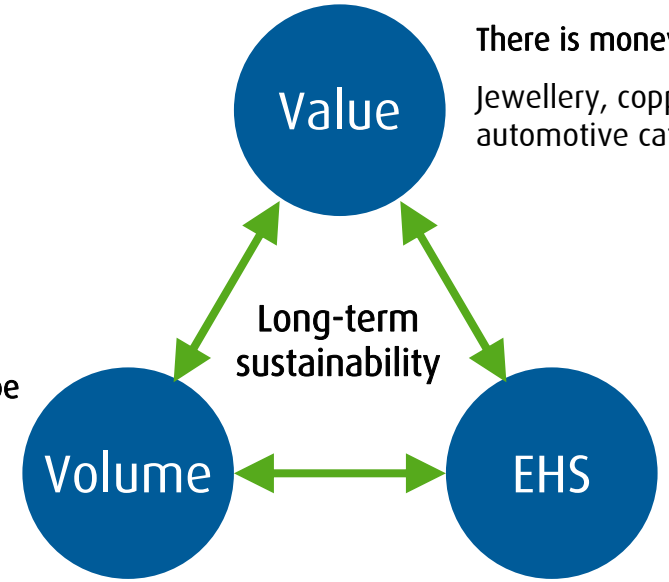


Service is more important than metal value

Safety and sustainability are decisive elements

Value of recovered metals will probably not be enough to pay for cost of recycling (different model than Precious Metal Refining)

Why do people recycle (now) ?



There is money to be made :

Jewellery, copper scrap, automotive catalysts, ...

The waste volume is so big that it can't be left "on the street"

Household waste, cars, construction waste, ...

There is a threat to the environment, to human health, to human safety:

NiCd batteries

"Value" driven recycling is taken care of by the market, pays for itself

"EHS" and "Volume" driven recycling are mostly society driven, at a cost, often have an ethical component, need policy / legislation

Business drivers

Value and potential scarcity of the metals

- Li-ion batteries contain Co, Ni, Li

Cost of recycling

- Li-ion batteries require a dedicated process due to their complexity

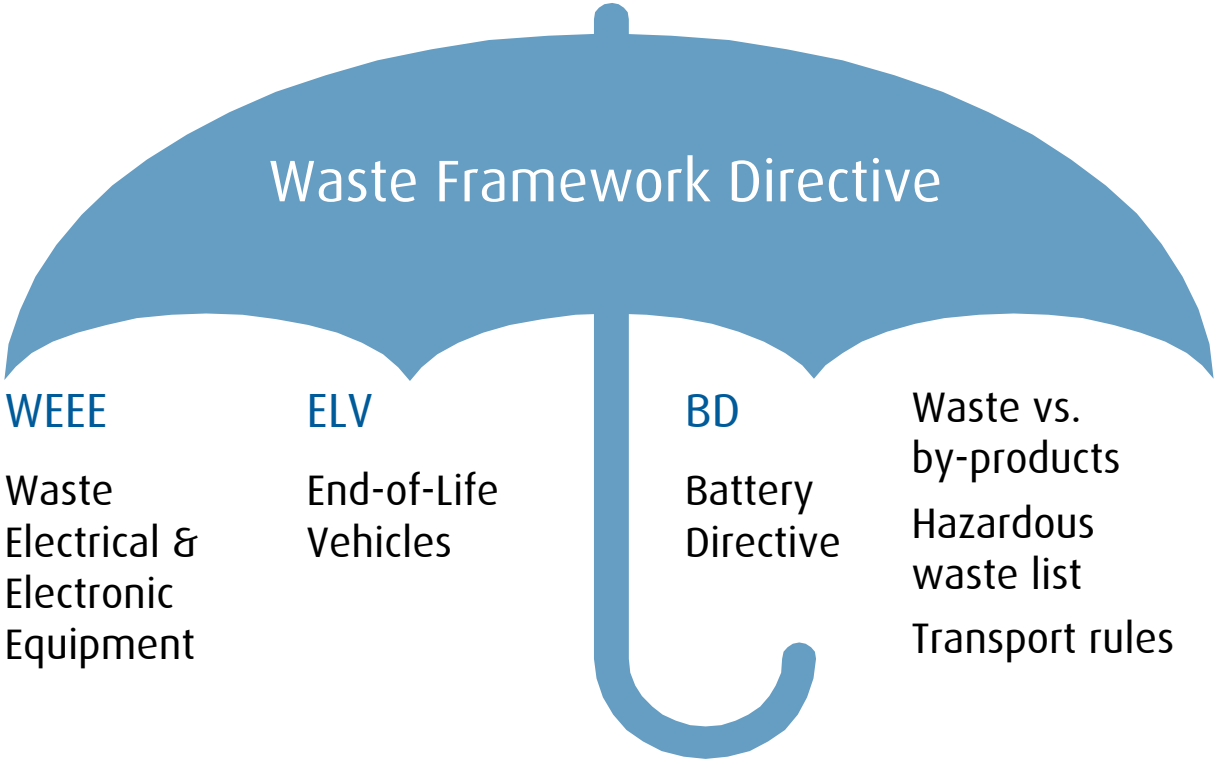
Legislation driven by sustainability considerations

- Carbon footprint, toxicity, security of supply,...
- Li-ion battery recycling is supported by:
  Battery directive, End of Life of Vehicles Directive, European Raw Materials Initiative and Waste Electrical & Electronic Equipment Directive

Volume of waste

- Multi-million battery cars will need some kind of recycling process
- In this context landfill is not a sustainable solution

Legislative Framework



The Waste Framework Directive contains the basic framework for handling waste, this is complemented by more specific directives in particular instances

WEEE and ELV directives

WEEE Directive (Waste Electrical & Electronic Equipment)

- Obligation to remove batteries from e-scrap

ELV Directive (End-of-Life Vehicles)

- End of Life concerns to be addressed from the design phase
- Feasibility of reuse and recycling targets to be demonstrated
- Promotes use of recycled materials
- Obligation to remove and collect batteries
- Reuse and recycling targets
  - 85% target today
  - 95% target by 2015

Battery Directive

Includes (H)EV batteries as “industrial batteries”

- Obligation for producers to take back batteries put on the market
- Landfill or incineration is explicitly forbidden
- Obligation to recycle after collection

→ Battery directive implies that the only option for (H)EV batteries is second life or recycling

For portable batteries, clear collection and recycling targets are set

- 25 % collection by September 2012
- 45 % collection by September 2016

Future legislation

The battery directive stipulates the requirement of attaining a recycling efficiency over 50% for the recycling of both Li-Ion and NiMH batteries

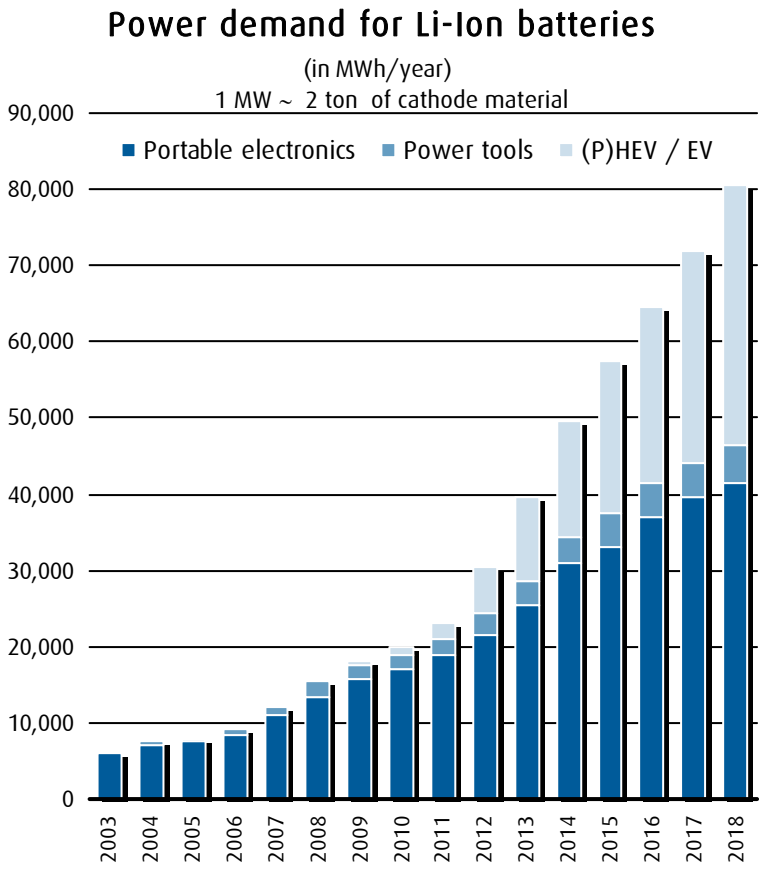
A discussion is ongoing on how to calculate the recycling efficiency

- Many players will not reach 50%
- Umicore's process will be above 50% recycling efficiency and the best available technologies

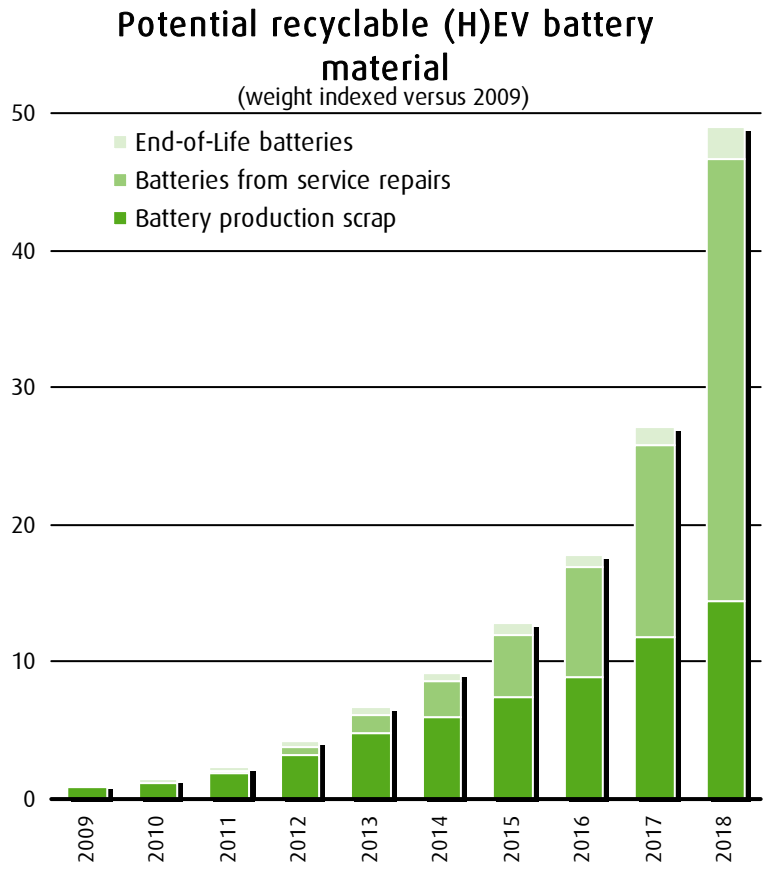
Recycling will be crucial for the penetration of HEVs

- Battery makers and car producers will have to be able to demonstrate the cleanness of their products and the handling of End of Life concerns
- Legislation will help push recycling demand further

Market estimates



Source: IIT Takeshita 2009



Source: Umicore

materials for a better life

Competitive advantages

The Umicore Battery Recycling process guarantees

- A low environmental impact
- Low energy use
- A valorization and/or reuse of all metals present

Umicore offers a recycling solution for all possible EV technologies

The service model is not dependent on metal prices

Competitive environment

Alternatives	Characteristics	Main players
Landfill	• Not an option in Europe • Worldwide a growing more stringent legislation	
Illegal and low standard activities	• Export outside Europe • Second-hand use • Low standard recycling	China, India, Dubai
Mainstream steel mills	• Cannot deal with a complex feed	Out of battery recycling business since 2010
Mainstream Ni smelters	• Can hardly deal with a complex feed • Low recycling yield	Xstrata, Sumitomo, Eramet
NiMH/ Ni-Cd recycling industry	• Small scale facilities • Co is prohibitive	SNAM, Accurec, Inmetco, KOBAR
Dedicated hydro-process	• Hydrometallurgical alternative • Process development hampered by battery complexity	Toxco, Chemetall, Recupyl, Nikko Tsuruga
Dedicated pyro-process	• High flexibility fitting the battery complexity • High performance (metal recovery & energy efficiency) • Best available eco-efficiency	**Umicore**
Second life for EV batteries	• Still under discussion • Can generate positive value for the traceability of the batteries • But delays recycling	Car manufacturers **Umicore follows closely**

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Jan Vliegen
Senior Vice President Battery Recycling

Jan Vliegen holds a PhD in Chemistry from the University of Antwerp. He started his career with Umicore in 1984 as a researcher. In 1997 he became business line manager Specialty Materials at Umicore's Hoboken site. Prior to becoming Senior Vice-President Engineered Metal Powders in 2002, Jan headed the Tool Materials business line in the period 2000-2002. Between 2004 and 2009, Jan Vliegen was in charge as Senior Vice-President of a number of activities – including Fuel Cells, Catalyst Technologies as well as ventures in the framework of Umicore's Vision 2015 project. In 2010, Jan became Senior Vice-President Umicore Battery Recycling and Fuel Cells.