Recycling of Precious Metals from the Urban Mine

American Chemical Society National Meeting
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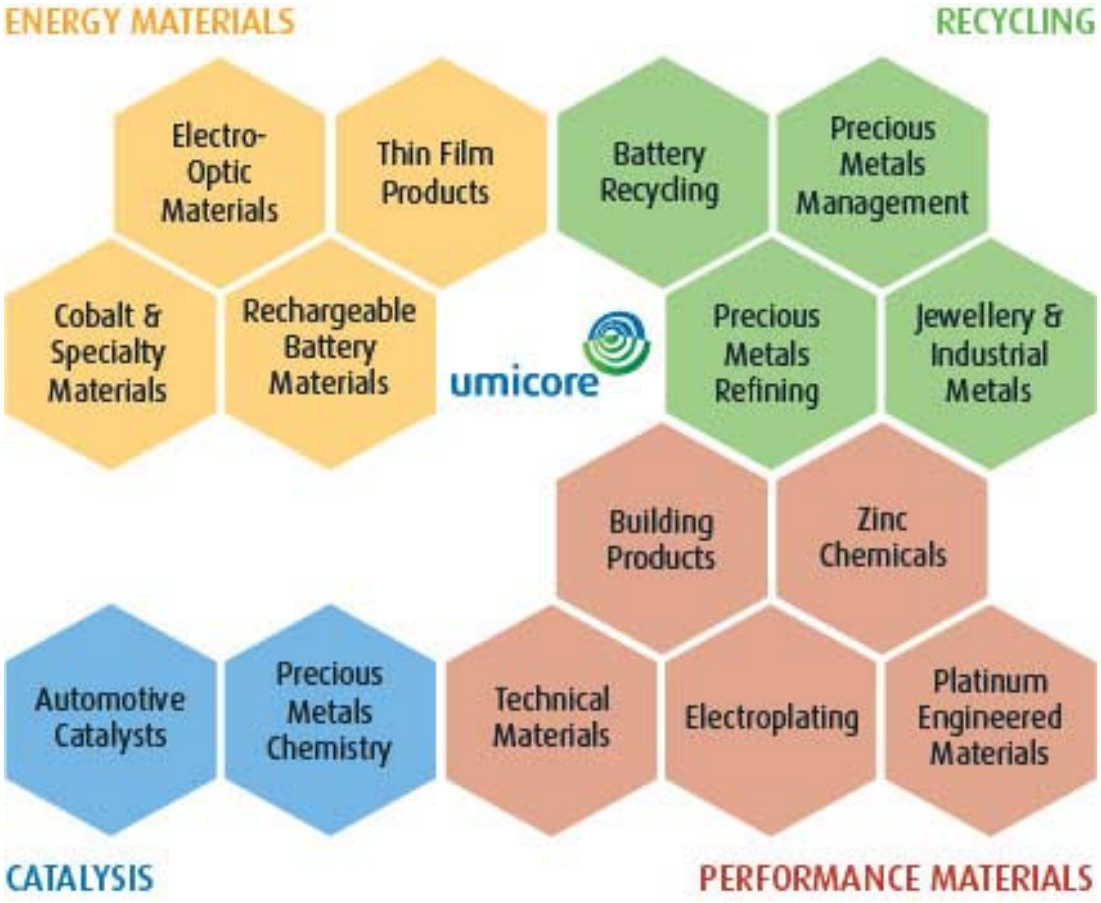
Agenda

- Umicore & precious metals
- Key concepts
- In practice
- Closing remarks

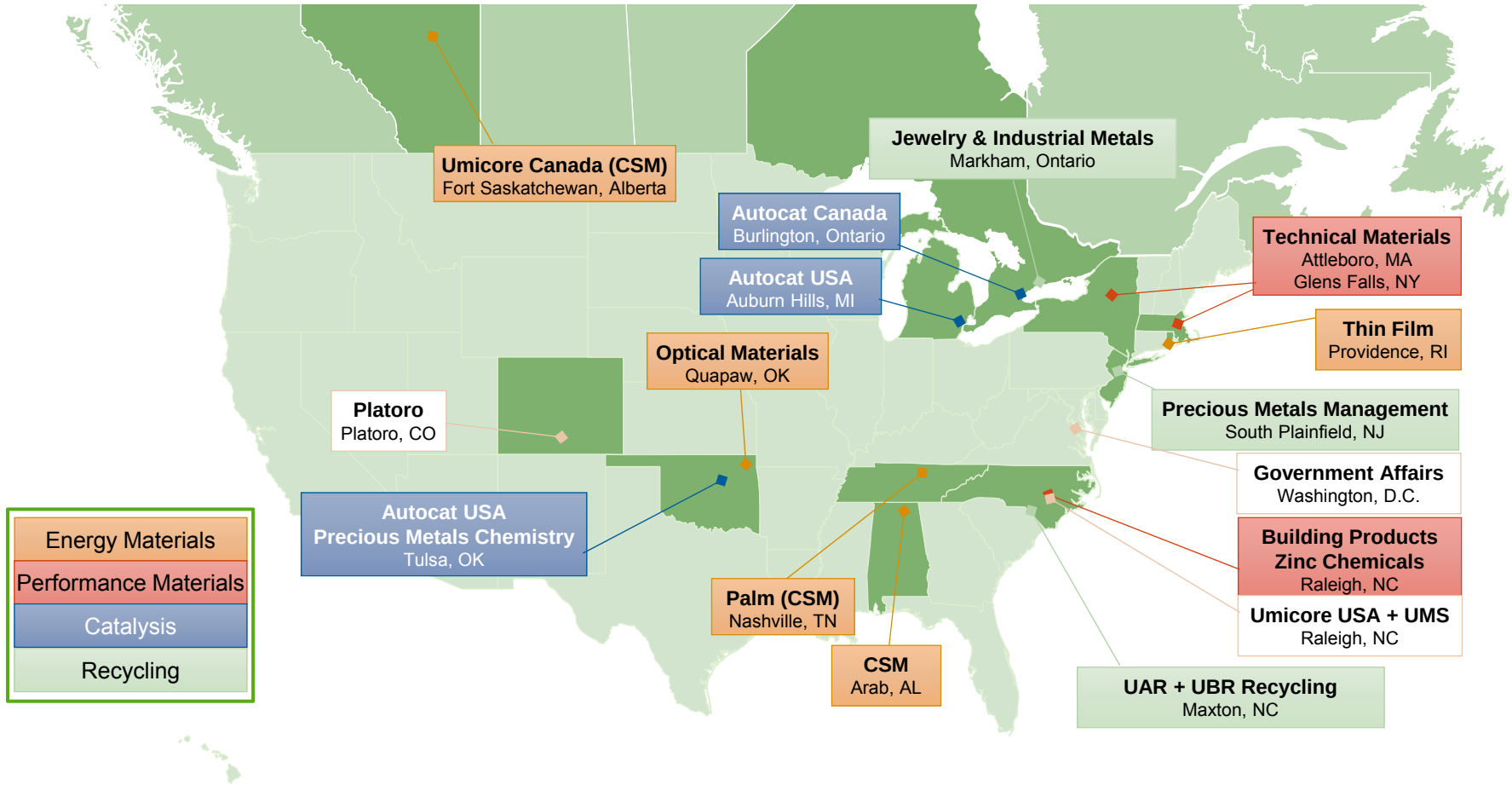
Umicore & precious metals

The Umicore Group

Manufacturing and recycling for a wide range of P(G)M applications



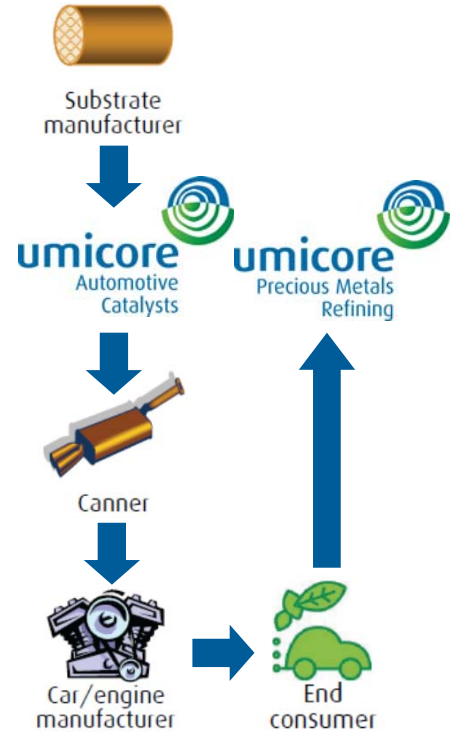
Umicore in North America



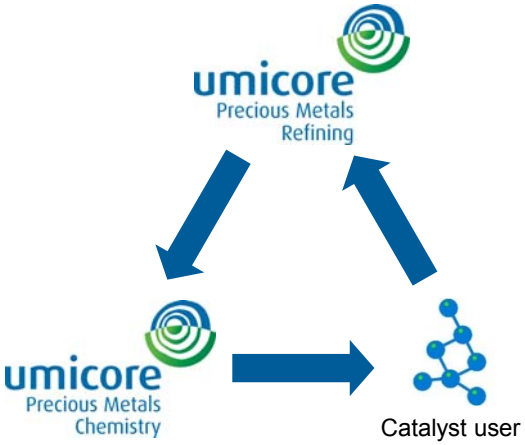
Umicore in the product life cycle

Closing the loop for key functional materials

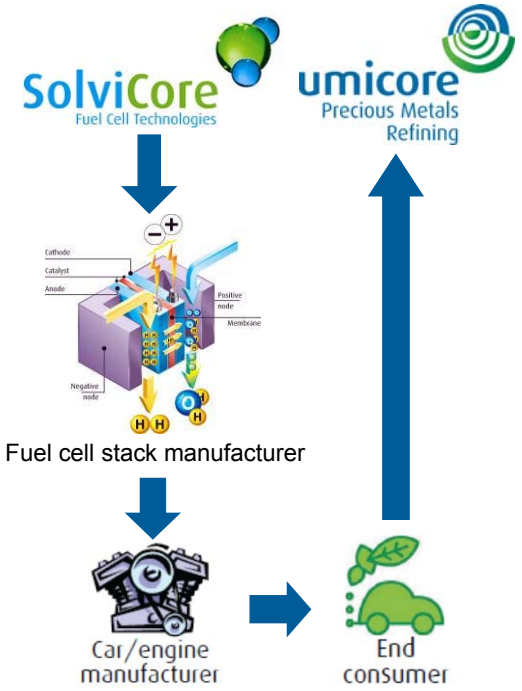
Automotive catalysts



Industrial catalysts



Fuel cells



Other examples: electronics, rechargeable batteries, photovoltaic, …

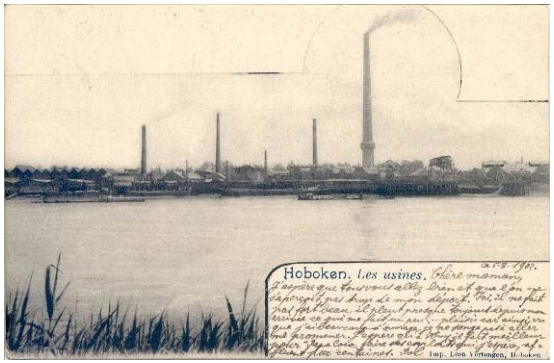
Umicore's strength in recycling

The result of a strategic transformation in Hoboken (Belgium)

1887
Start of a lead de-silvering operation in Hoboken

1995
Start of major investment program to re-engineer flowsheet

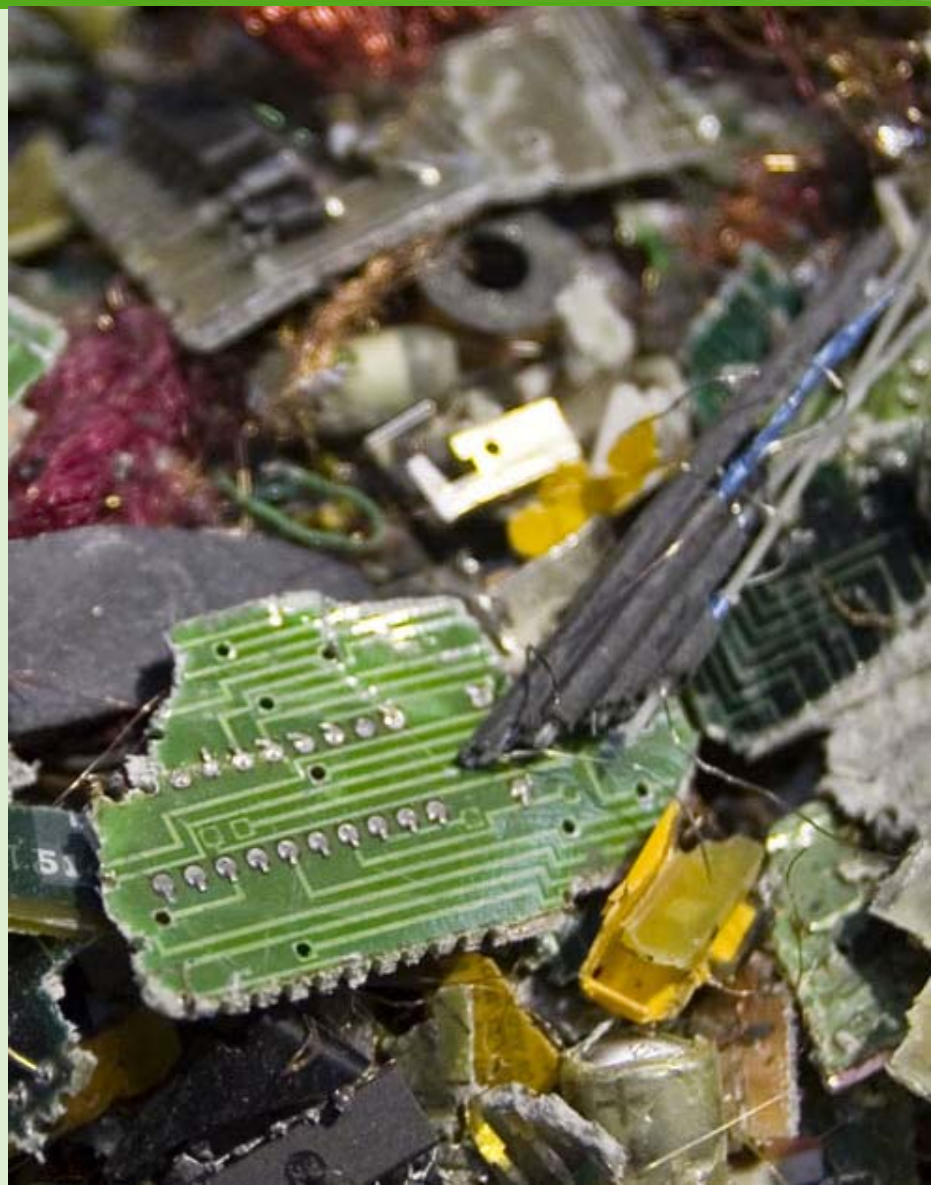
2013
Announced expansion to 500 kt/y treatment capacity



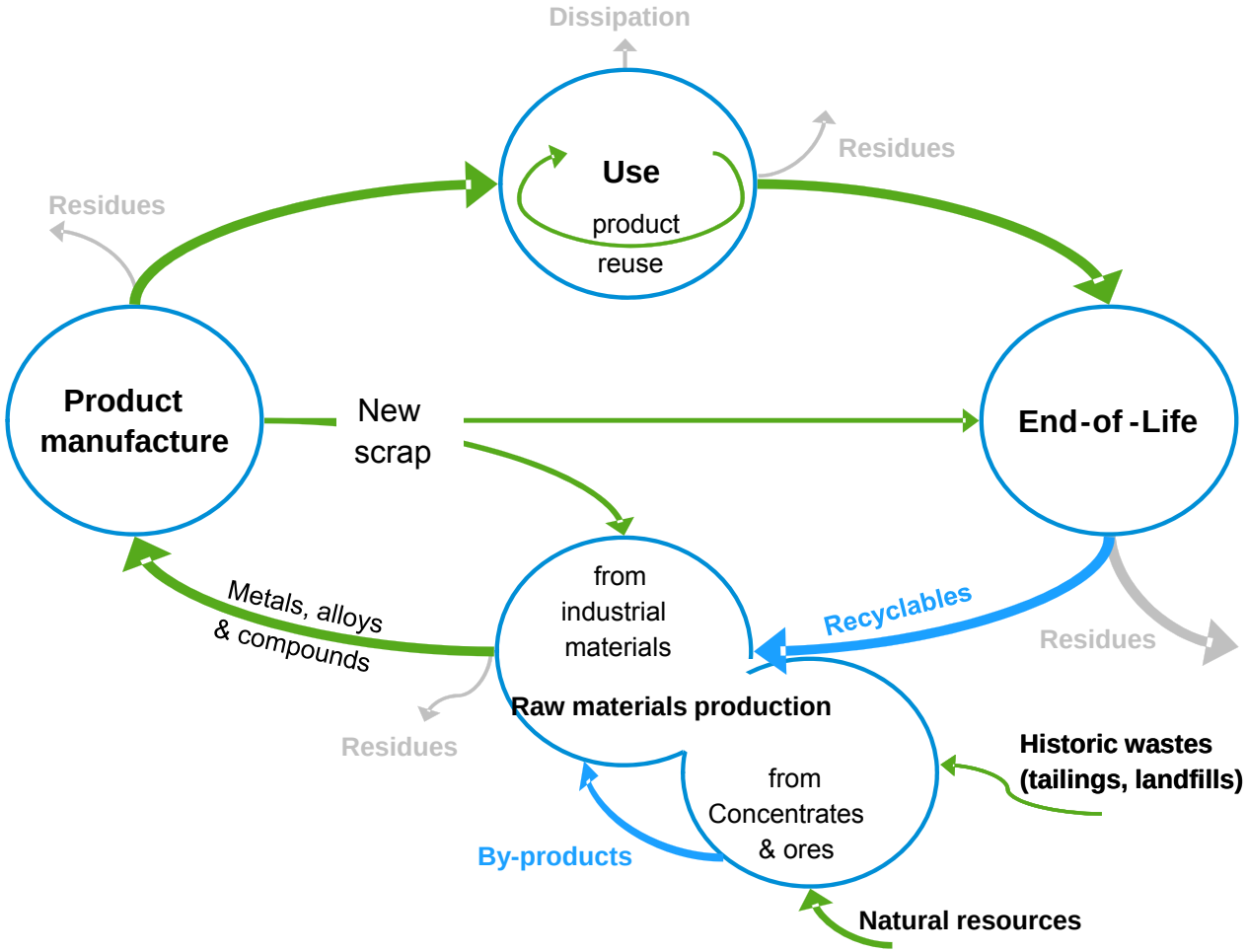
Recovery of 17 different metals from complex, precious metal bearing feed materials

A signifcant above-ground PGM mine in Europe with **~1.75 Mtoz PGM capacity**

Key concepts in (precious) metal recovery



Recycling occurs throughout the life cycle



Based on: C.E.M. Meskers: *Coated magnesium, designed for sustainability?*
PhD thesis Delft University of Technology, 2008

Benefits of recycling

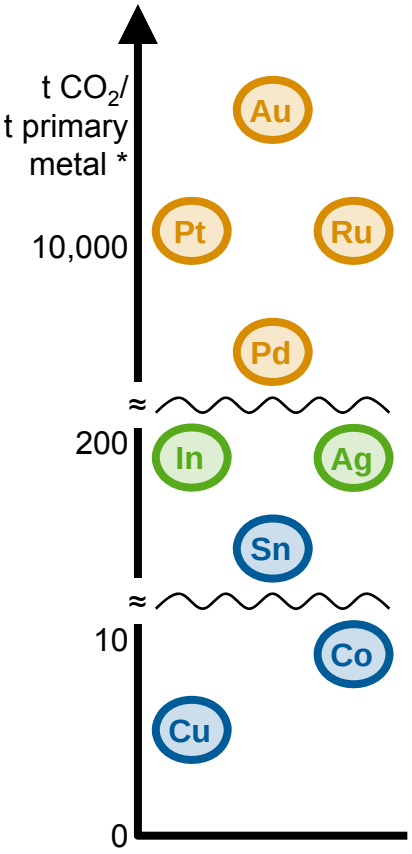
Significant environmental advantages, especially for PMs

Recycling:

- Lowers the CO_2 footprint for majority of metals
  - Example of Umicore Hoboken: ~1 Mt CO2 saved vs. equivalent metal production from ore*
- Mitigates environmental impacts of mining
- Prevents impact from non-recycling (i.e. landfill)

Capturing these benefits, however, requires the use of state-of-the-art processes that avoid harmful emissions:

- From the product itself
- From substandard processes
- From reagents used in the recycling process

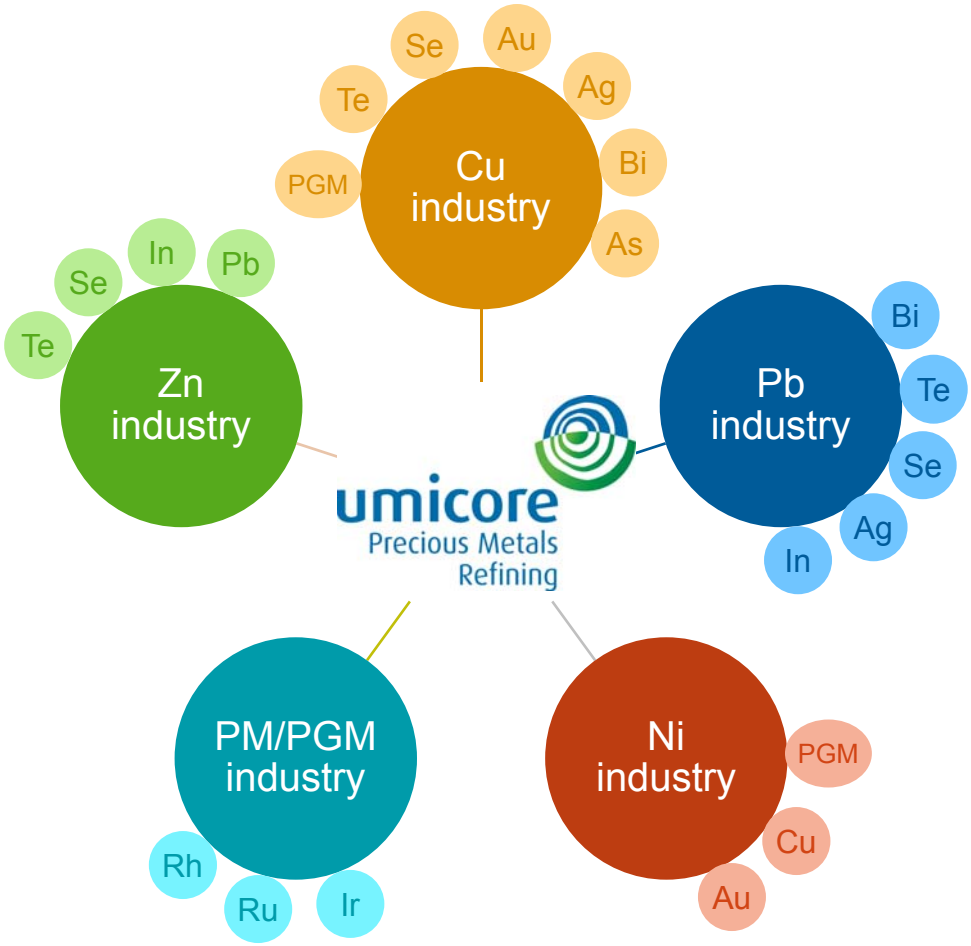


*Source: Ecoinvent 2.0, EMPA/ETH-Zürich, 2007

Industrial By-products

Critical mineral recovery occurs through a global network

- The production of critical minerals from ores requires the **efficient treatment of by-products**
- Many critical minerals are produced from the **global non-ferrous metallurgical network**
- Declining ore grades and increasing complexity leads to more by-products



Recycling is a funnel

Materials are concentrated towards specialized end-processors

		Collection	Pre-processing	End-processing	
Electronic scrap	**Use**	**WEEE Collection**	**Dismantling Shredding Sorting**	**Smelting Leaching Refining**	**Pd Au Ag Cu …**
# of actors worldwide	1,000,000,000's	100,000's	1,000's	~10	

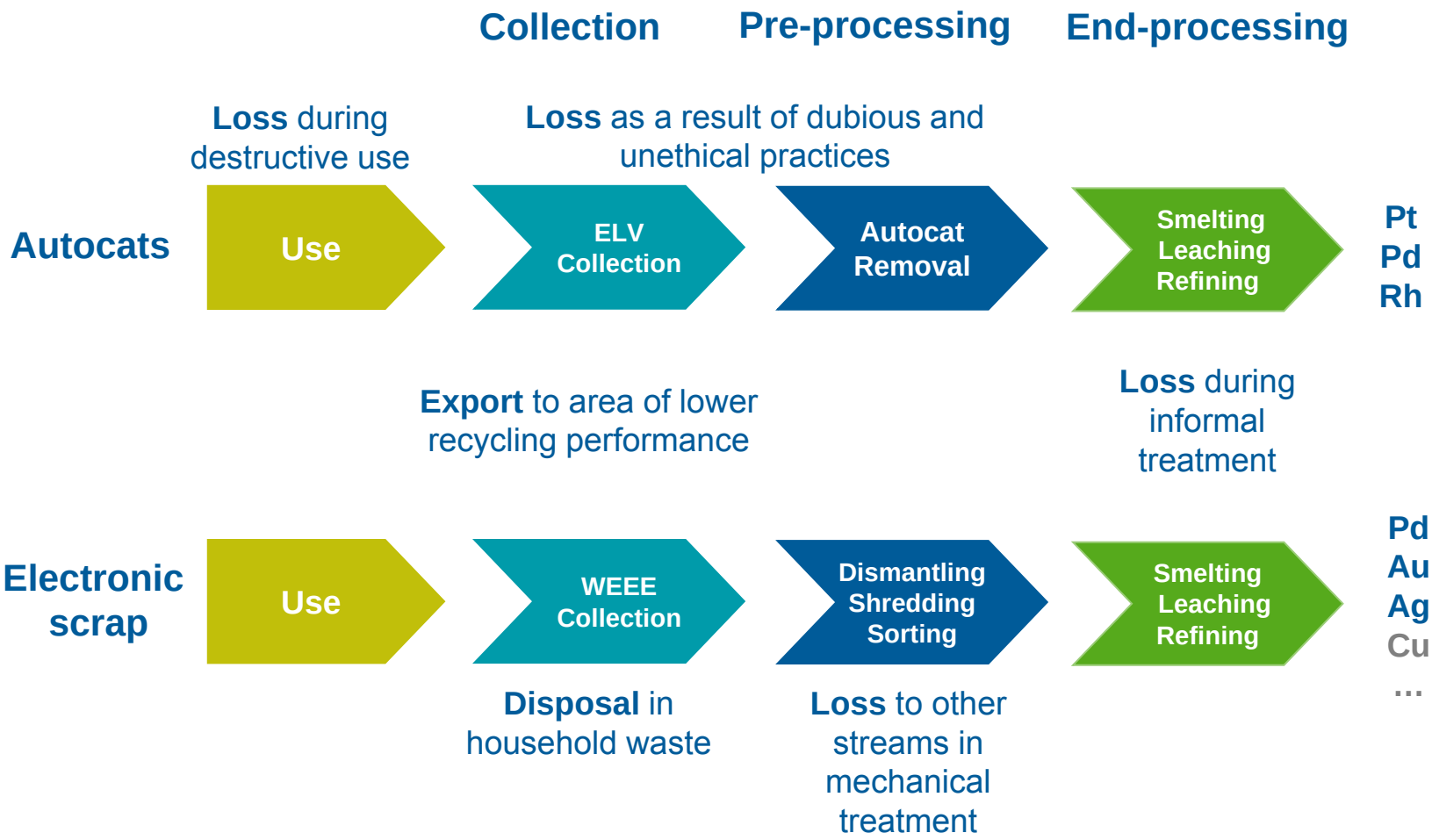
ex. Laptops: 200M adults (5y life, 50% ownership*) → 20M units (PWB = 500 g) → 10,000 mt PWB (Au = 100 ppm) → 1 mt Au

A large population can be served by 100's of pre-processors supplying 1 end-processor

*Source: http://www.pewresearch.org/data-trend/media-and-technology/device-ownership/

Recycling is a chain

Efficient recycling depends on a strong chain of actors



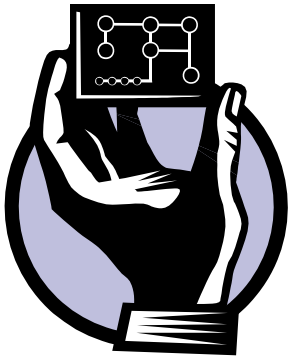
Recycling is dynamic

Products are rapidly changing – example: electronics

Cloud

Convergence of devices

Unit weight decrease
& miniaturization



These trends and others are already felt in the recycling industry and impact:

- Volumes & tonnages -> risk of capacity mismatch
- Material composition -> what's in there?
- Recyclability -> which materials to focus on? need to rethink approaches?

Importance of sampling & assaying

Ethics, resources and skill are required

Sims investigates potential fraud at WEEE sites

An internal investigation has been launched into potential fraud at the WEEE recycling arm of scrap metal firm Sims Metal Management, after it emerged that **the value of the company's inventory had been overstated by around $60 million (£37m).** *(letsrecycle.com 2013)*

Implats taking platinum recycler to US court

Impala Platinum (Implats) has initiated court proceedings against a US recycler for $182-million... In 2012, Implats **took an impairment of R212-million against amounts allegedly owed by A-1**. However, since then, A-1 has ceased deliveries of all material. *(Mining Weekly, 2013)*

Each material requires its own method

Autocatalysts		Decanning & sampling of ceramic converters
Electronic scrap		Three separate lines for shredded & unshredded material
Metallic material		Sampling after remelting in induction or gas furnaces
Lumpy material		Sampling via crushing and milling
Liquid spent		Homogenization; increments from bulk flow, e.g. spent Rh catalyst

Precious metal recycling “in practice”

Our raw materials

Industrial By-products

e.g. **slags** from nickel, PGM & PM industry and slimes processing

Electronic Scrap

Spent Industrial Catalysts

- UPMR is an integrated smelter-refinery specialized in treating complex and precious metal-bearing materials from around the world

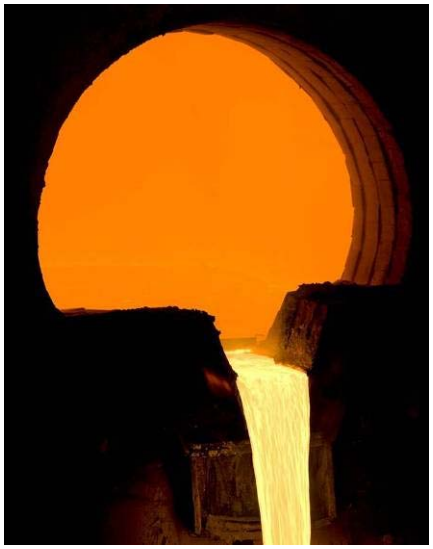
- All materials are treated at the Hoboken plant, though our autocat network provides local sampling in the USA, Brazil and Thailand

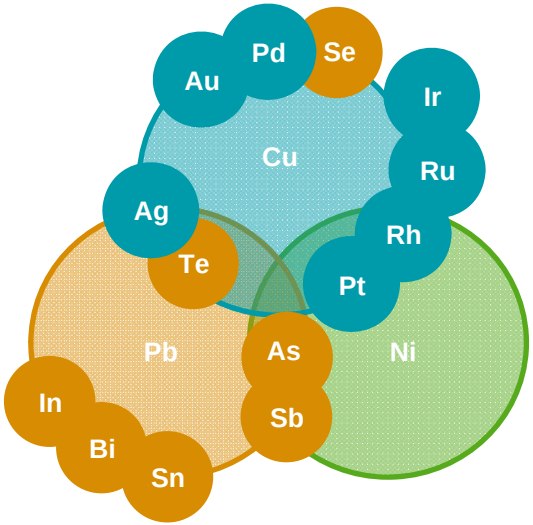
Our process

The UPMR flowsheet employs:

- unique and innovative technology,
- both pyro- and hydro-metallurgy, and
- advanced process control

…to efficiently recover 17 metals at the highest environmental standard and with minimal waste generated





Expert in sampling & assaying

Sampling

- Reducing several tonnes of material down to a representative few kilograms
- Dedicated processes for all raw materials, using material-specific procedures
- Secured area
- 190 people, +/- 8.000 lots/year

Assaying

- High accuracy determination of metal content down to parts per million
- Recognized leadership in the precious metals industry
- State-of-the-art analytical equipment
- 109 people, 55.000 samples/year

Investing in our future

Capacity expansion
€100m over 2014-2015 to expand treatment capacity by 40% to 500 kt/y

Biological wastewater treatment
€15m for an additional water treatment plant to further reduce metal emissions to water by 90% - operational 2014

Sampling
€25m to upgrade and expand the sampling facility to increase capacity and reduce throughput time – operational 2013

R&D
UPMR spends about 4% of its turnover on R&D, more than double the industry average

Our key strengths

Flexibility

Material compositions & complexity –
our flexible process allows us to treat the widest range of materials in the industry and respond to market conditions

Sampling & assaying

Accuracy & transparency –
our robust process for determining customer return is trusted throughout the industry and is used to optimise processing

High metal recovery

Efficiency & impurity management –
our unique and complex flowsheet enables a highly efficient recovery of PGMs from both primary and secondary sources

Innovation

Technology & environment –
our focus on continuous optimisation and new process innovation opens doors to the recycling markets of tomorrow

Many pieces to the end-refining puzzle

Closing remarks

Truly “value”-ing your precious metals

Let’s take recycling to the next level!

umicore
Precious Metals
Refining

Openness	Transparency on material flows & transactions Reliable, accurate sampling & assaying
Innovation	Continuously improving yields and reducing impacts Forward-looking solutions for the entire life cycle
Teamwork	Supply chain cooperation & stable business relationships Engaging emerging markets to improve recycling
Respect	For the environment, health and safety Close interaction with stakeholders
Commitment	Collaborative long-term approaches Strive as an industry toward high performance standards

Thank you

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