

Urban mining as a solution for the supply of critical minerals

An illustration through Material Flow Analysis (MFA) of cobalt

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- What are critical minerals?
 - They have significant economic importance for key sectors (defense, aeronautics, space...)
 - They are faced with high risk of disruption of supplies
 - They suffer from a lack of substitutes
(European Commission, 2008)

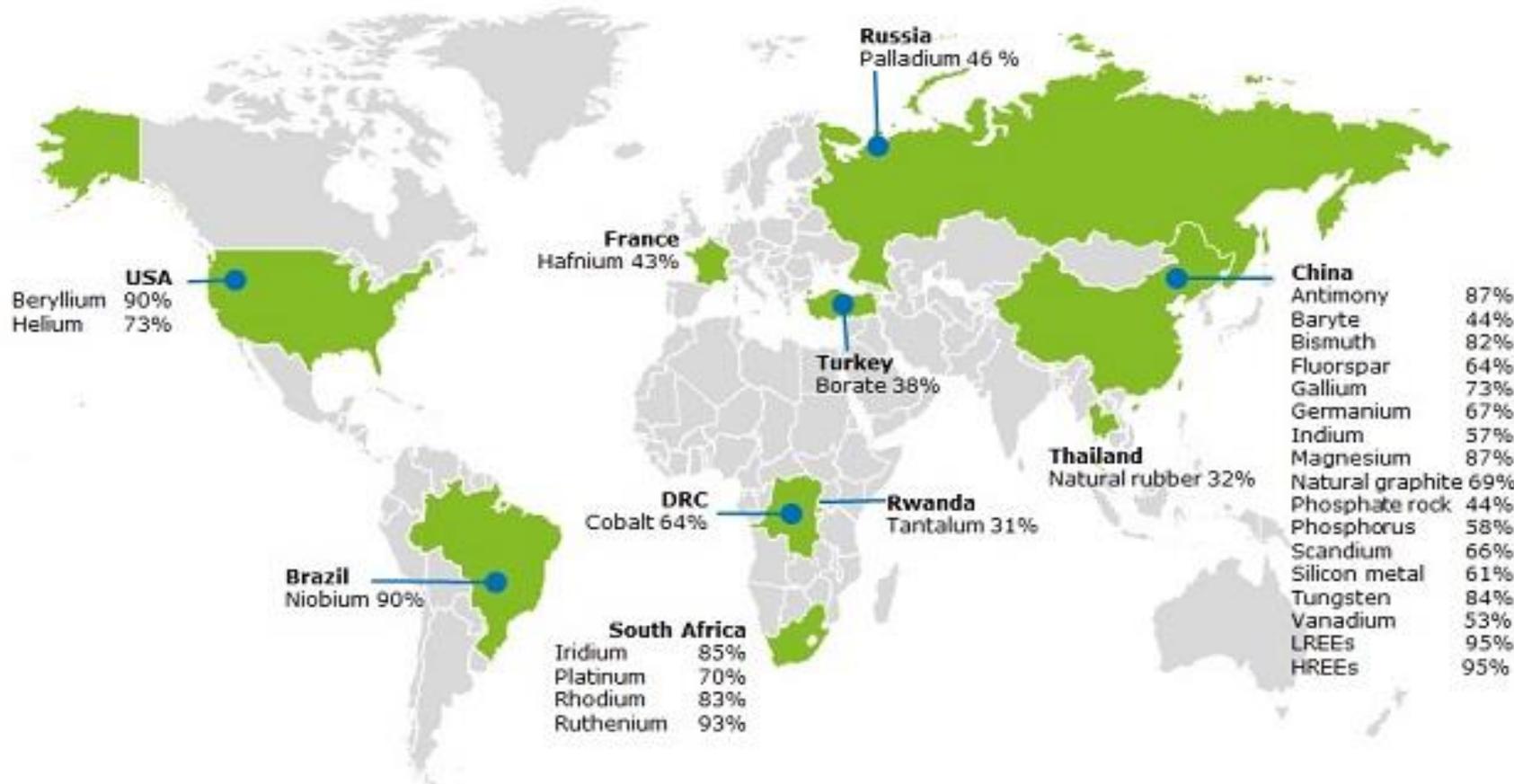
- 1920's: following the First World War, the US Department of Defense decides to publish a list of minerals which are critical for US security (Harbor list)

- Despite a crisis in Congo (Cobalt) and in South Africa (PGM's), the focus is on oil and gas and not on metals

- The beginning of the 21st century sees increasing tensions in metal supplies, for two reasons:
 - Increasing consumption in China
 - Mining industry's difficulty meeting this demand

- 2010: A territorial conflict between China and Japan about the Senkaku Islands leads to the rare earths crisis

Critical minerals for the European Union



European Commission, 2017

- Studies on raw material criticality began in 2007 (Japan-METI) and 2008 (European Union-Raw Material Initiative): Antimony, Fluorspar, LREEs, Phosphorus, Baryte, Gallium, Magnesium, Scandium, Beryllium, Germanium, Natural graphite, Silicon metal, Bismuth, Hafnium, Natural rubber, Tantalum, Borate, Helium, Niobium, Tungsten, Cobalt, HREEs, PGMs, Vanadium, Coking coal, Indium, Phosphate rock

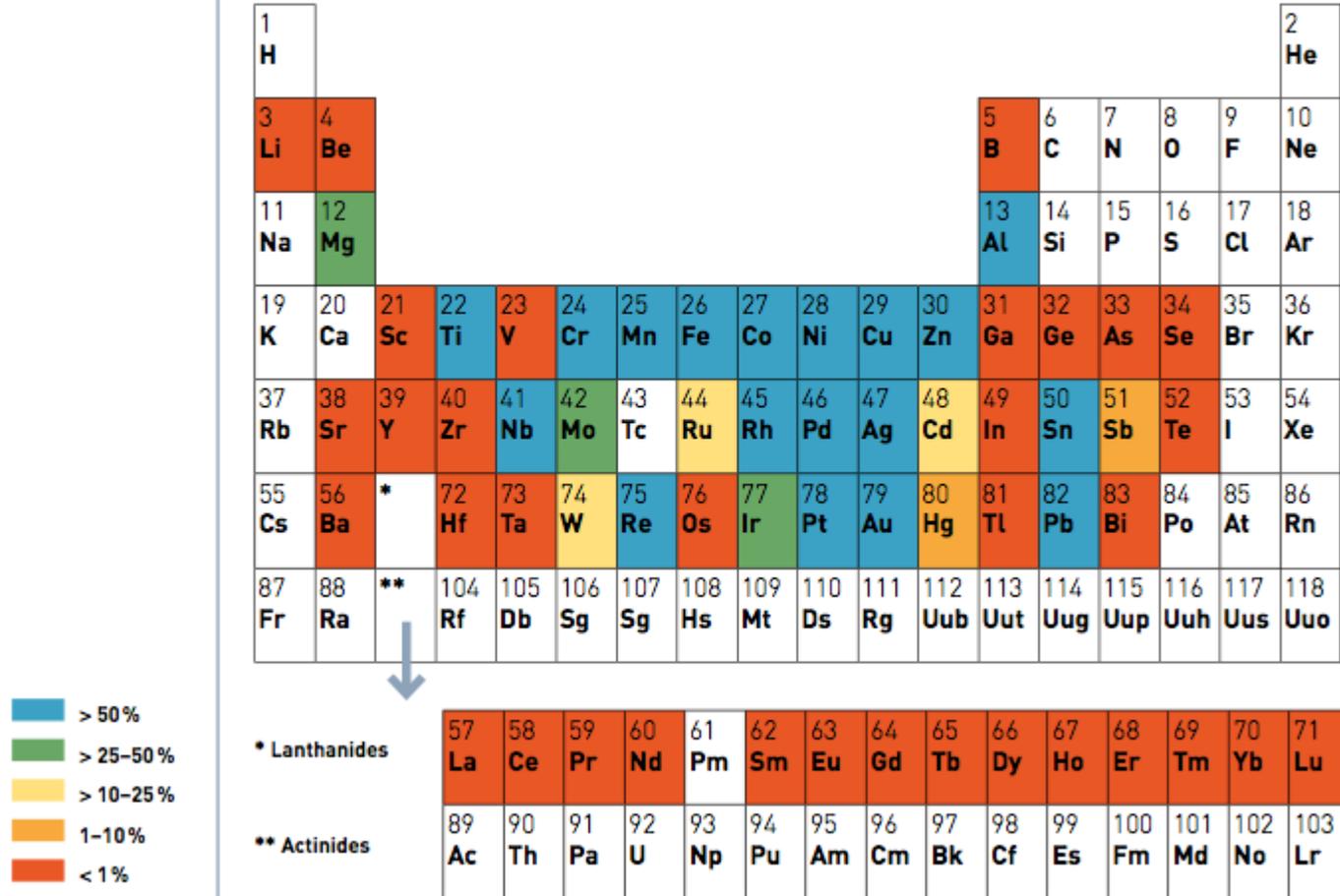
- These studies identified the causes of the tensions on raw material supplies:
 - Increasing consumption of these materials for the manufacturing of vital systems required for the security of a country or for the implementation of energy transition politics
 - Production capabilities are not matching the demand
 - Developed countries gave away the production of raw material to emerging countries, mainly China

- The three pillars of the Raw Material initiative:
 - Fair and sustainable supply of raw materials in global markets
 - Sustainable supply of raw materials within the EU
 - Resource efficiency and supply of 'secondary raw materials' through recycling (European Commission, 2008)

- Nowadays the terms ‘close the loop’, ‘joint the circular economy’ or ‘secure resources’ are becoming fashionable
- Urban Mining has been defined as ‘the process of reclaiming compounds and elements from any kind of anthropogenic stocks, including buildings, infrastructure, industries, products (in and out of use)...’ (Park JK et al, 2017)
- There are three types of urban mining:
 - Secondary mining or tailings
 - Landfill mining
 - Mining hibernation stock
(Park JK et al, 2017)
- Urban mining is the sum of all the wastes we create every day, but the ones we are interested in are the Waste Electrical and Electronic equipment (WEEE), as they concern critical raw material

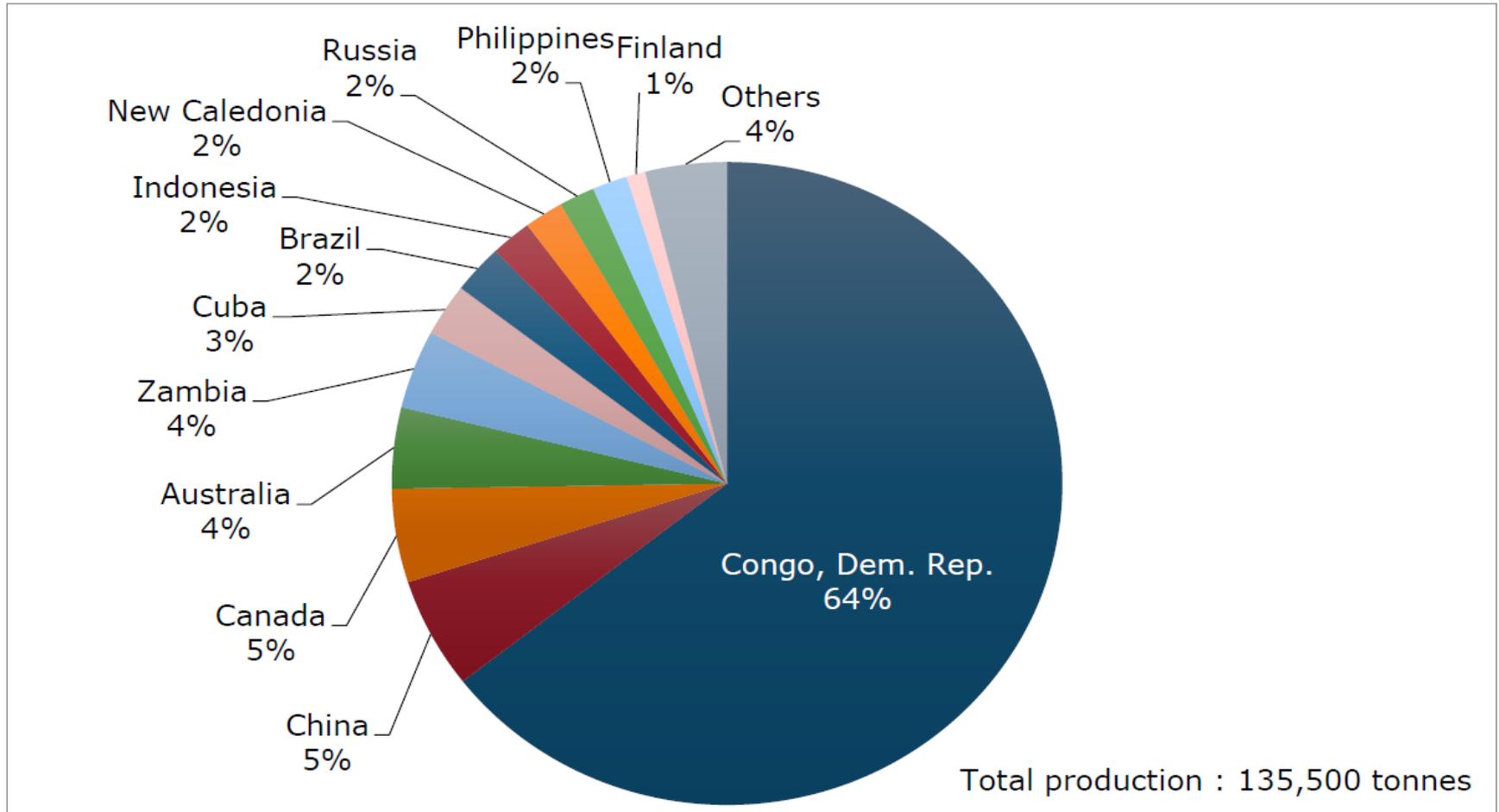
What is urban mining?

Estimated end-of-life recycling rate for 60 metals



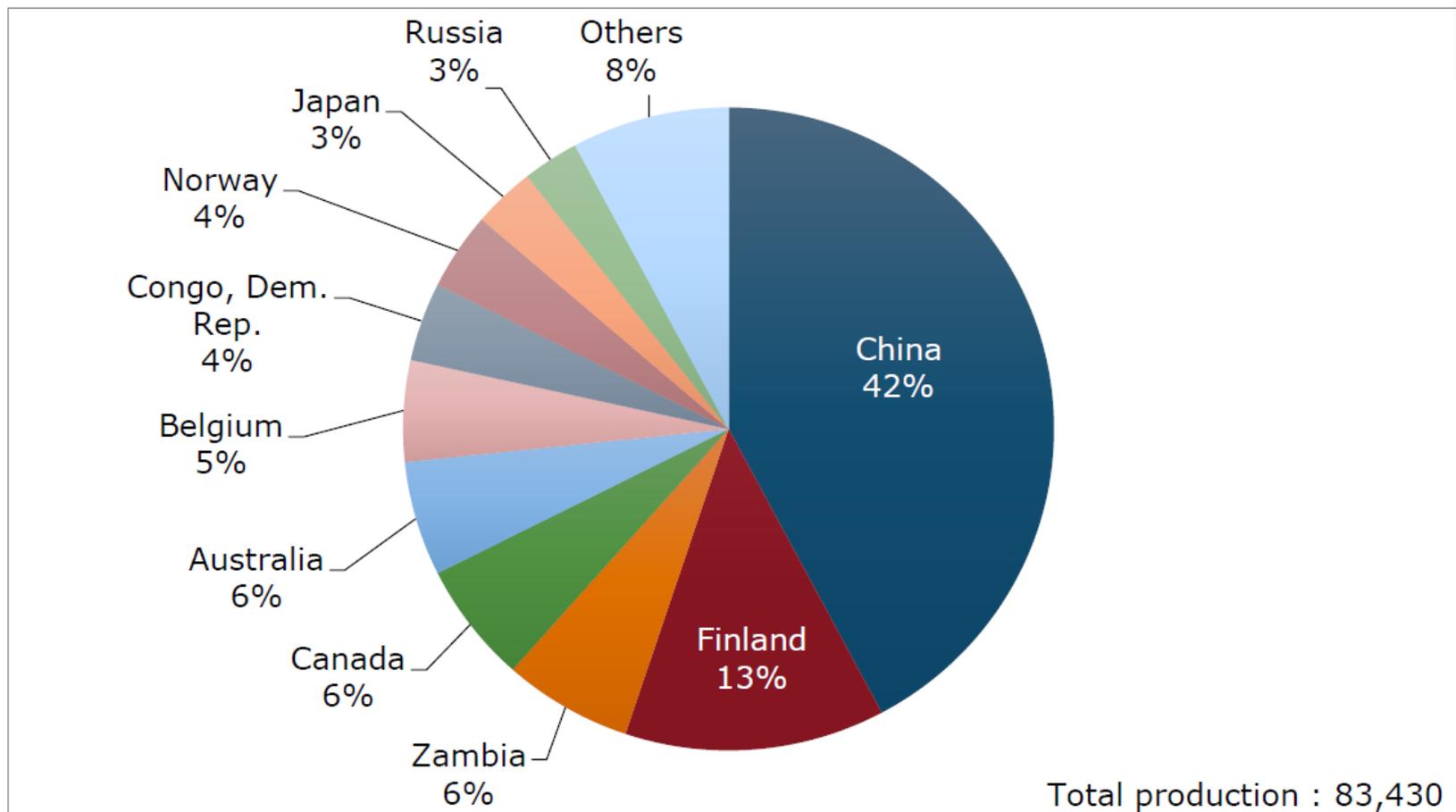
UNEP, 2011

- Global production of cobalt mineral, 2015



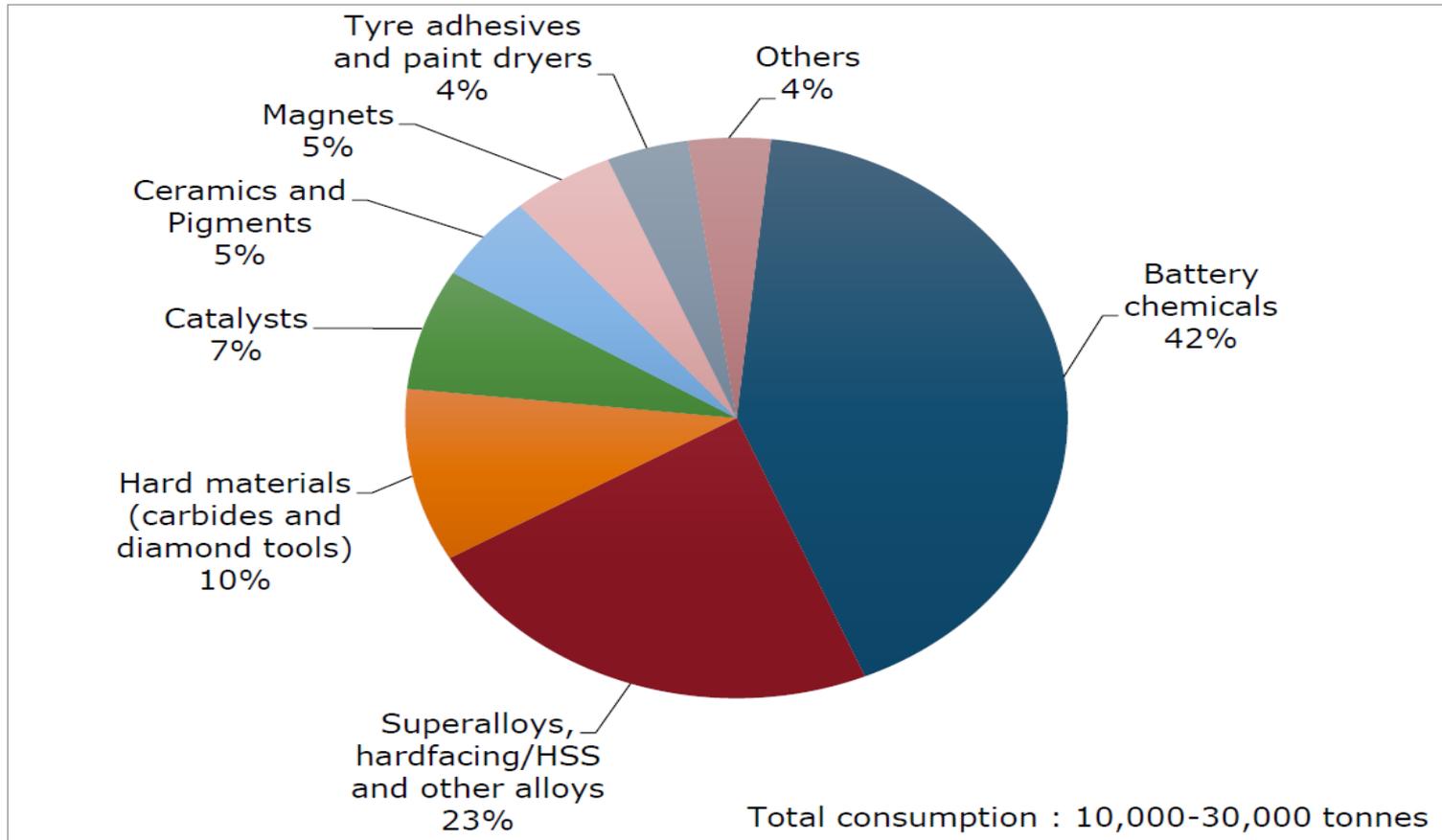
Study on the review of the list of Critical Raw Materials, Critical Raw Materials Factsheets; Written by Deloitte Sustainability, British Geological Survey, Bureau de Recherches Géologiques et Minières, Netherlands Organisation for Applied Scientific Research; Prepared for the European Commission, DG GROW: 2017

- Global production of refined cobalt, 2015



Study on the review of the list of Critical Raw Materials, Critical Raw Materials Factsheets; Written by Deloitte Sustainability, British Geological Survey, Bureau de Recherches Géologiques et Minières, Netherlands Organisation for Applied Scientific Research; Prepared for the European Commission, DG GROW: 2017

- Global consumption of cobalt, 2015



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Cobalt pigments



Samarium-cobalt magnets

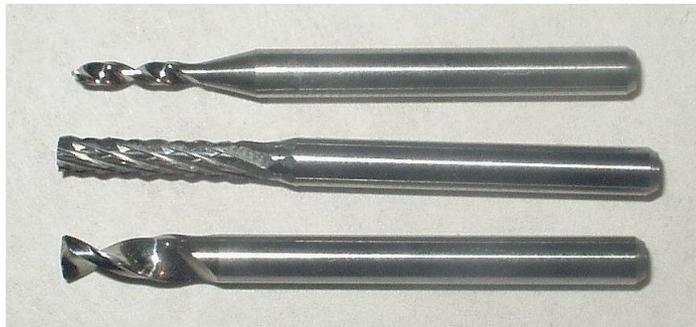


Tungsten carbides



Electric toothbrush

Aircraft fighter « Rafale »



- Material Flow Analysis (MFA) *'is a systematic assessment of the flows and stocks of materials within a system defined in space and time. It connects the sources, the pathways, and the intermediate and final sinks of a material'.* (Brunner and Rechberger, 2003)

- In the case of a metal, MFA is helpful to:
 - Understand the origin of a mineral or a metal
 - Observe the evolution of resources
 - Quantify the consumption of a material in a given time and space
 - Understand the vulnerabilities of the supplies on each segment of the value chain

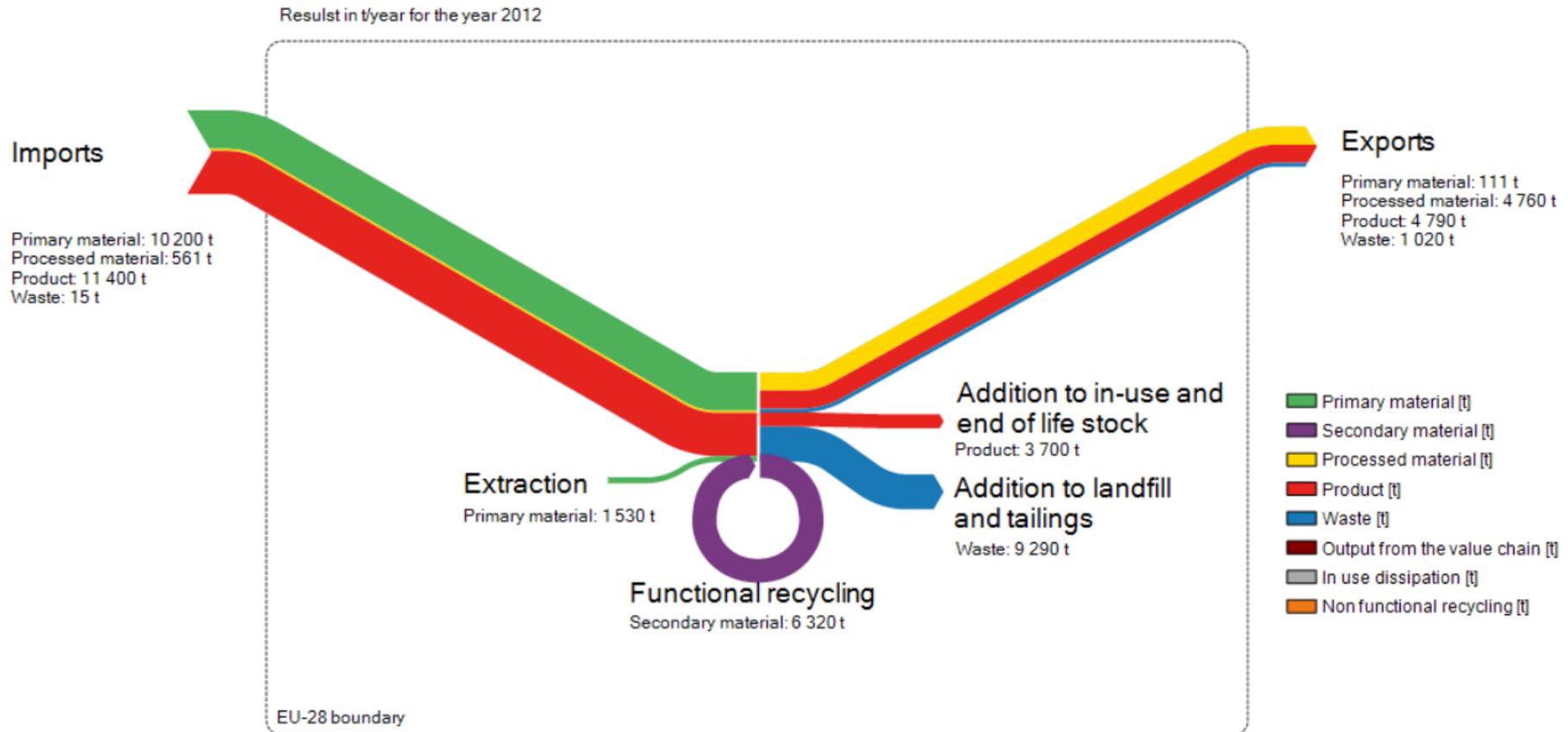
- Quantifying all the flows subsequently helps to quantify the final flow of the urban mine by calculating the potential recyclable quantity of a material

- However, before doing it, some definitions are necessary:
 - Functional/non-functional recycling
 - New scraps/old scraps
 - End of life recycling
 - Landfills and tailings

Material Flow Analysis of cobalt (RMSA, BIO by Deloitte, 2015)

Sankey diagram for cobalt

Figure 30: Simplified Sankey diagram for cobalt



BIO by Deloitte (2015)

Study on Data for a Raw Material System Analysis: Roadmap and Test of the Fully Operational MSA for Raw Materials; Prepared for the European Commission, DG GROW; 2015

Essential data to build a MFA:

- Flows containing cobalt
- Contained cobalt
- Lifespan

Nomenclatures Eurostat	Type of flows	Cobalt contained	Lifespan
2605 Cobalt ores and concentrates	Primary	7%	
2822 Cobalt oxides and hydroxides, commercial cobalt oxydes	Primary Processed	71,9%	
288332930 Sulphates of cobalt and of titanium	Primary Processed	???	
810530 Cobalt waste and scrap	Waste	???	
810520 Cobalt mattes and other intermediate products of cobalt metallurgy; unwrought cobalt; cobalt powder	Primary Processed Waste	???	
870390 Enclosed in electrically-powered vehicles	Product	3-60 kg	10 years
8525209070 Enclosed in cell phones	Product	1-5 g	3 years

There are different kinds of difficulties:

- Few or no data on some flows: pigments
- Very difficult to calculate other flows:
 - 810520 Cobalt mattes and other intermediate products of cobalt metallurgy; unwrought cobalt; cobalt powder
 - 810530 Cobalt waste and scrap
- Only a range of estimation about the quantity contained in the products:
 - 870390 Enclosed in electrically-powered vehicles
 - 8525209070 Enclosed in cell phones

What are the solutions?

- Association of manufacturers: number of planes, helicopters, electric vehicles sold every year
- Combining sold quantities with prices

- Even is the solution seems attractive, some difficulties occur when it is implemented:
 - Incomplete collection: only 5-10% of the Lithium-ions batteries in our phones are collected
 - The collected waste are often exported out of the European Union
 - Technically impossible to recover all the metals contained in one product
 - Often not functionally recycled, the intrinsic proprieties of a metal are lost

- However, first results are interesting:
 - The recycling rate figures of most of the articles and the studies on cobalt and critical minerals are incorrect
 - These results help us to understand the different steps of the value chain of cobalt, as well as the shareholders and the materials they use
 - They also help us to understand the vulnerabilities of the European value chain of cobalt