Meeting Demand for Raw Materials in a Circular Economy

Ester van der Voet (Institute of Environmental Sciences, Leiden University)
Globe-EU event Recovering Resources from End-of-Life Products in a Circular Economy | 18 May 2020
Meeting demand for raw materials

- Primary materials extraction has tripled over the last 50 years
- This trend shows no slowing down: doubling expected until 2050
- Leads to major challenges
  - supply issues
  - waste generation
  - environmental impacts
- Circular economy is introduced as a way out: keeping resources in use will reduce the need for primary production
- We still know very little about the dynamics of our societal material system
The urban environment as a hub of materials

- What happens to the materials after extraction?
The urban environment as a hub of materials

- Materials extracted from the environment are consumed and used in cities

- Cities form a huge urban mine of resources accumulated in in-use-stocks
  - Stocks can be linked to services and to value
  - Stocks generate secondary material supply after useful life span has elapsed
  - the dynamics of these stocks is presently not well understood ...
  - ... but is very important when planning for a circular economy.
The urban environment as a hub of materials

- Stocks are expected to grow as well as flows, as a result of economic development
- Stocks may saturate: decoupling of economic growth and material growth
- When they do, there is a chance to really close the loop

(figure compiled by Deetman, based on Deetman et al., 2020; SSP2 baseline)
Urban mining for a circular economy

- Urban mining research mostly focuses on two areas:
  - Built environment, esp. residential buildings. Here are the largest stocks.
  - Tech applications: electronics, renewable energy systems, vehicles. Here are the valuable materials: metals and critical materials

- Presently expanding the scope to include infrastructure, textiles, furniture etc., and to other sources of information such as GIS data
Urban mining for a circular economy

Sources: Marinova et al., 2020 (SSP2 baseline)
van Oorschot et al., 2020

Steel stock in residential buildings 1970-2050, global level

Legend
kg/m²
- < 70
- 70 - 150
- 150 - 250
- 250 - 400
- > 400

Discover the world at Leiden University
Urban mining for a circular economy

Stocks of steel, aluminium and neodymium in the global energy system: grid, generation and storage, under SSP2 baseline assumptions

Source: Deetman et al., 2021
Urban mining for a circular economy

- Urban mining research is mostly in the stage of prospecting: how much of which materials are in the urban mine, and when will they become available.
- Picture is becoming clearer: urban mine is already very large, and still growing.
- For Dutch urban mine: the amount of copper in the urban mine per person is already of the same order of magnitude as the amount of copper still in the ground.

- Next steps: making the connection to a circular economy.
- The aim of a circular economy is to reduce primary inflow, to prevent supply constraints, environmental impacts and waste generation.
Urban mining for a circular economy

- Urban mine refers to **materials** contained in **products**
- Circularity strategies different for products and materials
  - Products: repair, reuse, refurbishing, remanufacturing etc.; keeping products in use for as long as possible, and/or getting as much service out of a product as possible
  - Materials: recycling, downcycling; closing material loops
- Both are essential!
- And for both, it starts already at product and material design: DfRobustness, DfDisassembly
Urban mining for a circular economy

- We don’t know yet what an urban mining system will look like ...
- ... but if we manage to pull it off, it really can make a difference!

Source: van der Voet et al., 2019; assuming 90% EoL RR from present

Aluminium production (10^9 kg/year)  
Related CO2-emissions (kg CO2-eq / year)
Sources

Thank you for your attention