metal production

sfi Senter for forskningsdrevet innovasjon

Circular Economy from a Metallurgical Perspective

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SINTEF and Helmholtz-Institute Freiberg for Resource Technology, Germany

Conference on Circular Economy

New Opportunities for Value Creation Through Innovation and Research

May 10-11 2017, Mo i Rana

SINTEF NTNU teknova HYDRO ALCOA GLENCORE MANGANESE NORWAY AS

ERAMET NORWAY FINNFJORD Elkem WACKER TiZir Titanium & Iron

SFI Metal production

Vision: Resource efficient metal production from a clean industry

Primary objective

Strengthen the future of Norway's largest, land based industry by establishing an interdisciplinary Research Centre for Metal Production enabling industrial innovation.

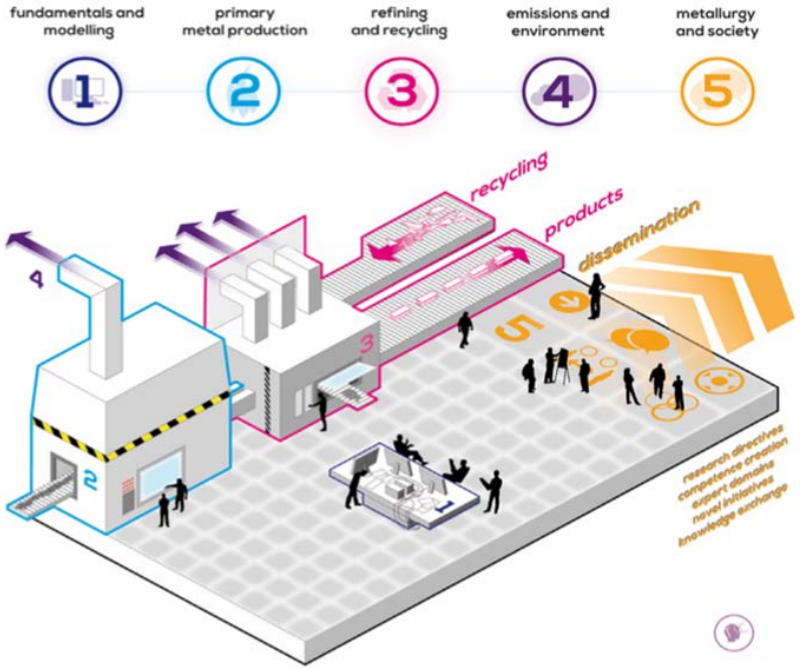
Give the industry long term access to world class fundamental competence and candidates.

The Centre will focus on close collaboration between Industry and Academic/Research communities in Norway, to enable accelerated implementation of new knowledge in industry practice and innovation

metal production

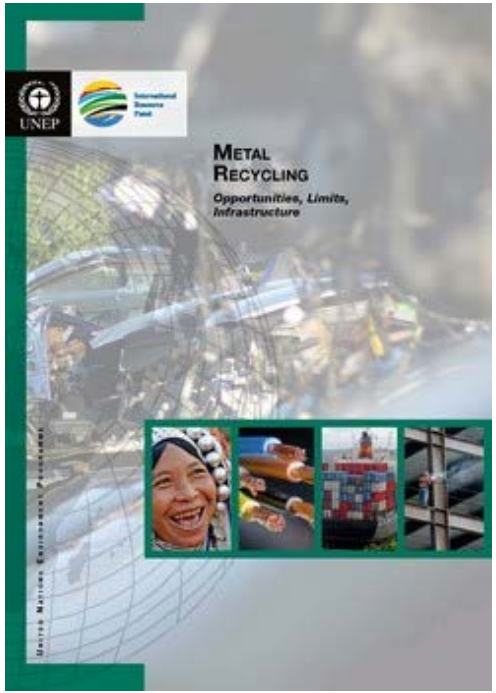
SFI Metal Production

Research Domains



UNEP Report

Lead author: Markus Reuter



Metal Recycling: Opportunities, Limits, Infrastructure

The discussion is based on data about recycling input, and the technological infrastructure and worldwide economic realities of recycling

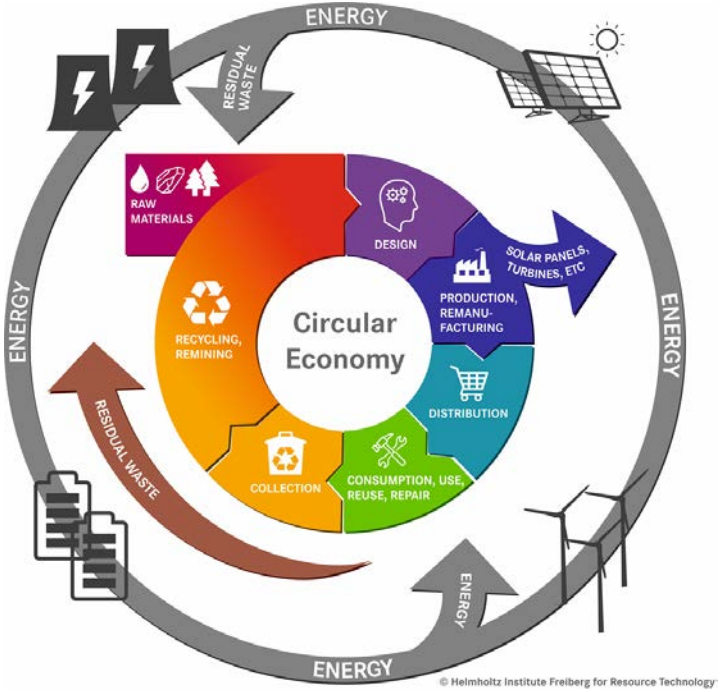
metal production

Circular Economy

EU perspective

Circular Economy

Metallurgical Perspective

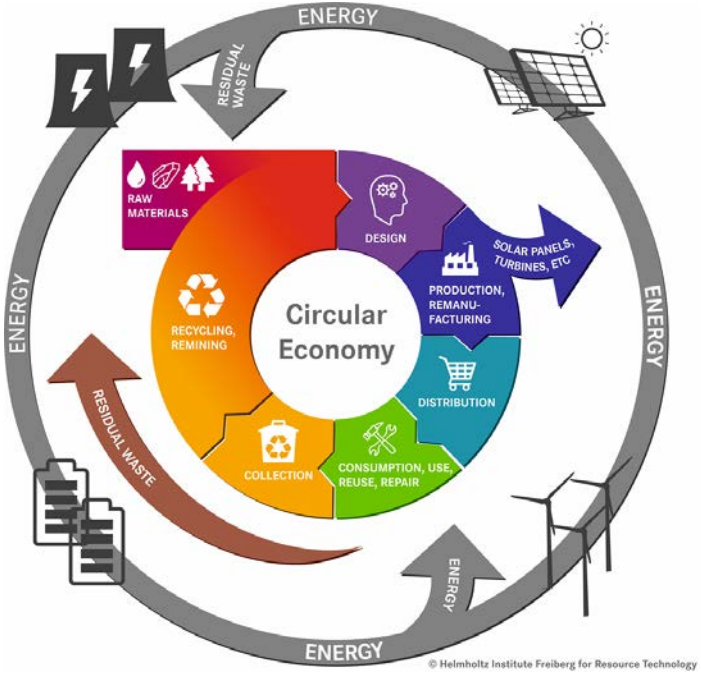


Metallurgy is necessary to realizing the Circular Economy

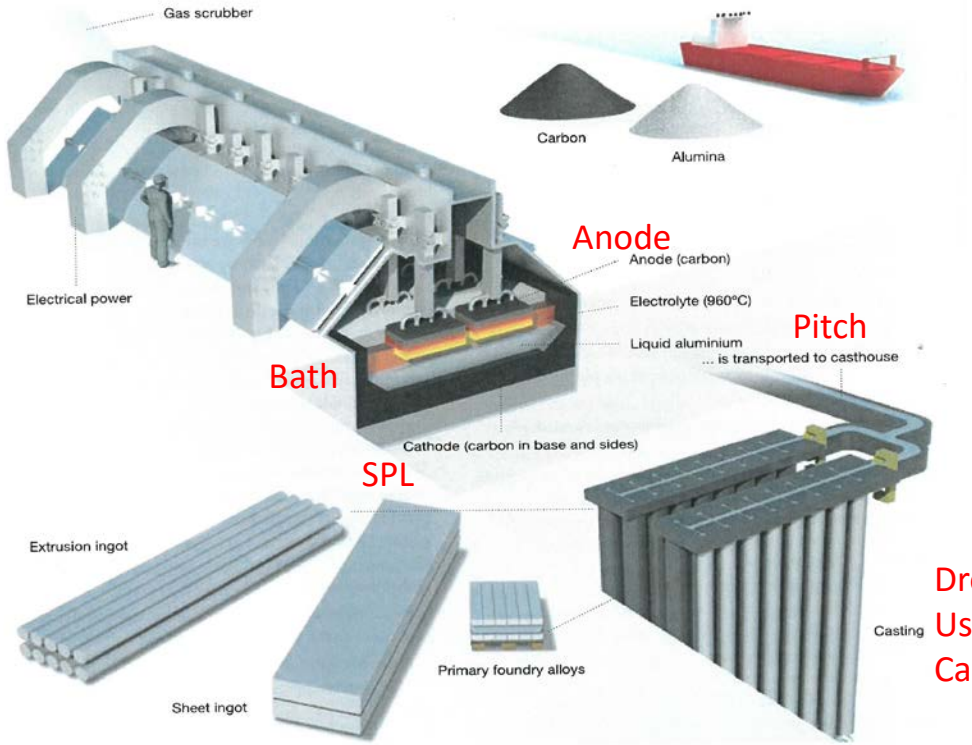
Create realistic solutions while also exploring and quantifying limitations

Production part

as well as in the residues part:

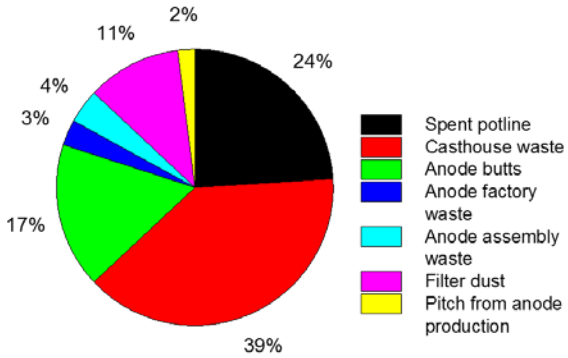


Filter dust



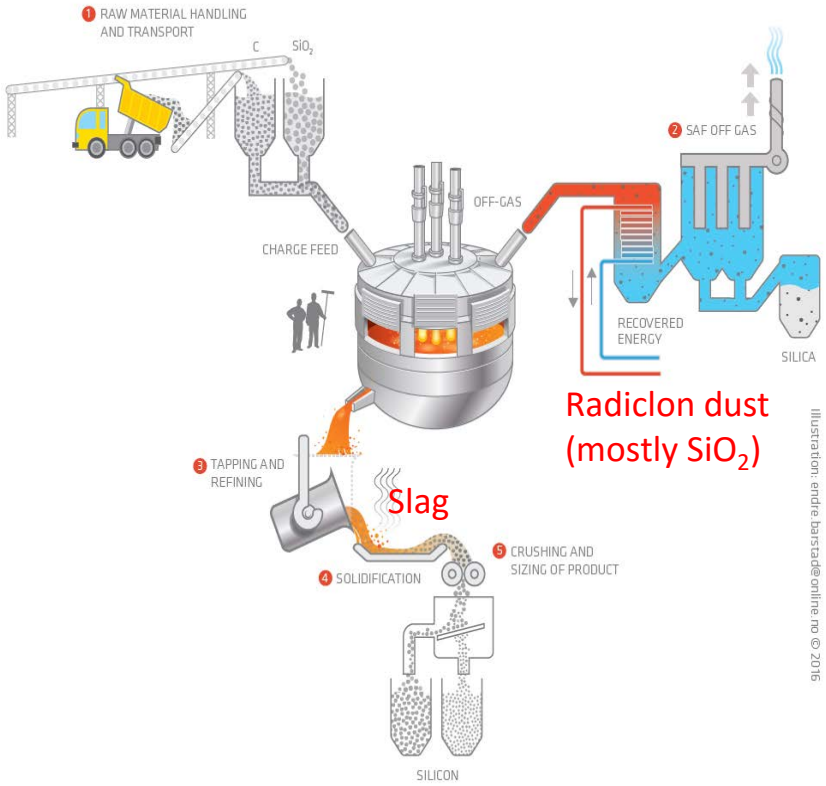
Dross
Used Filters
Cast house waste

Aluminium



Ferrosilicon

SiO_2 fines



Radiclon dust (mostly SiO_2)

Slag

Example Production of Ferrosilicon

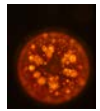
Production of Ferrosilicon 1960

Production of Ferrosilicon today

Ferrosilicon

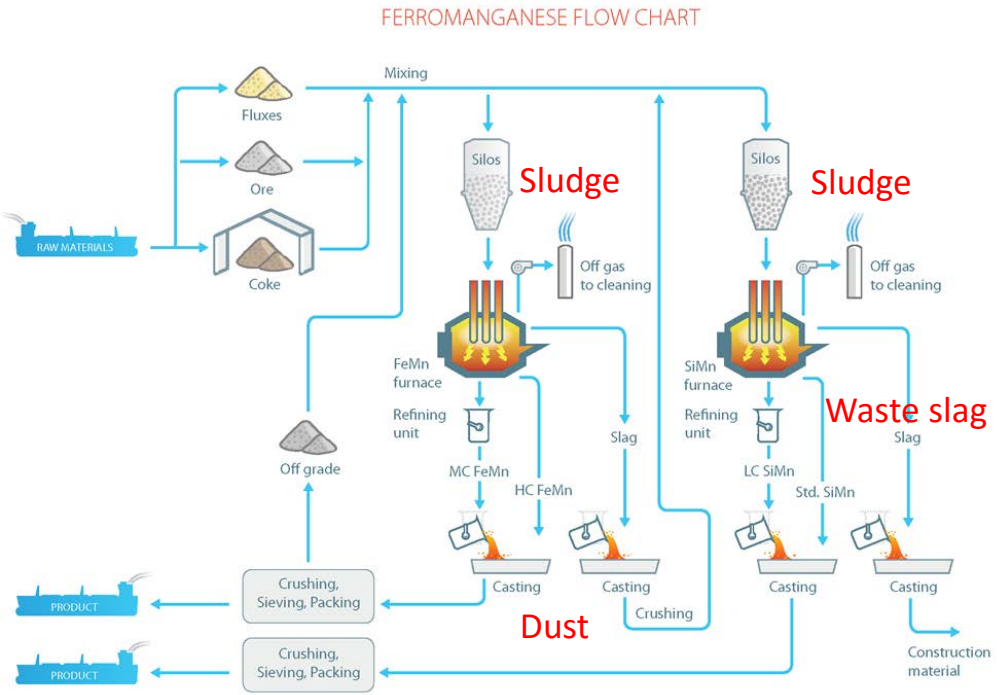
Power production

Microsilica Concrete



Silicate algaes

metal production

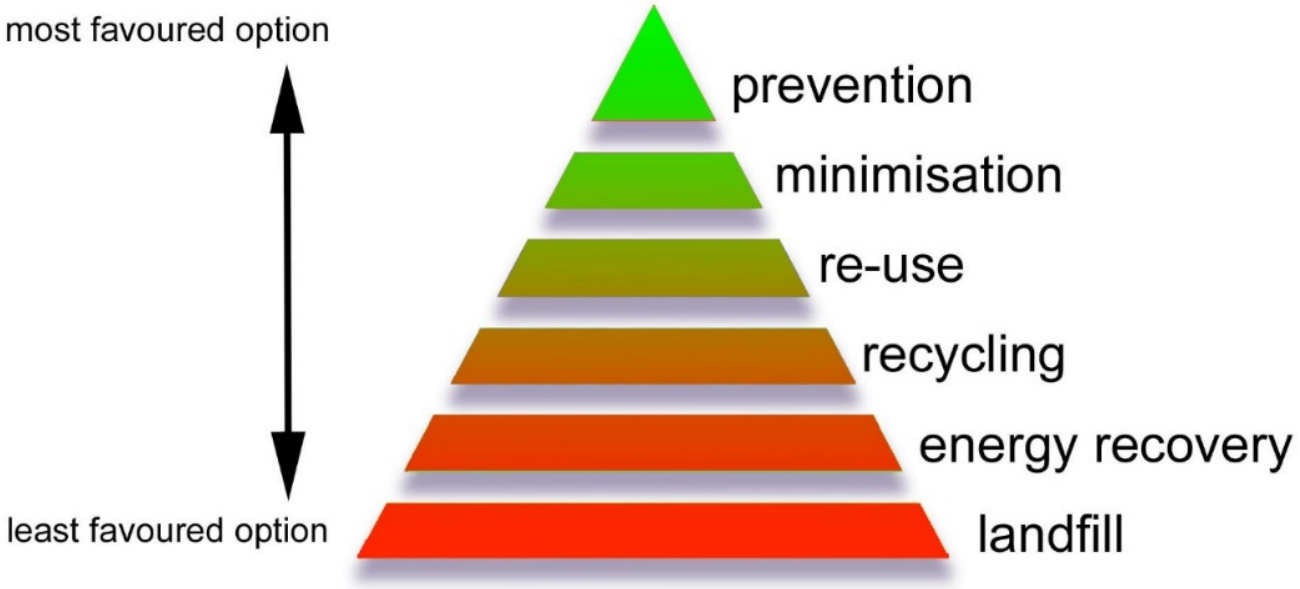


Manganese alloys

Type	By-product
Slag	SiMn slag
	MOR slag
Dust	MOR dust
	Various dust from tapping fumes and centre stack
	Crushing dust
Dried sludge	FeMn sludge
	SiMn sludge
Refractory	Used refractory

Moving up promotes Circular Economy

The Waste Hierarcy



Landfill waste examples

- Red mud/Bauxite residue
- Part of SPL (mainly 2nd cut)
- Radiclon dust and quartz residue
- Slag and sludge from SiMn

Recycling examples

- Anode butts, anode scrap,
- Dust from bath residual, bath,
- Aluminium cathode bottom cakes,
- SPL (mainly 1st cut)
- Manganese: CO gas

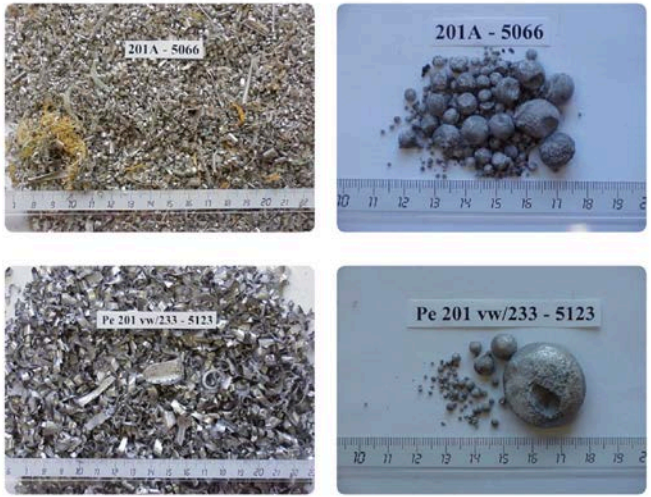
Re-use examples

- Bauxite residue/red mud, bath and dross, part of the SPL
- Slag from SiMn production, and refractory
- Silica, skulls, and slag
- FeSi fines, silica and refractory
- Silica dust
- Sludge, sand, dust, empty container, oil, used acid, and part of active coal

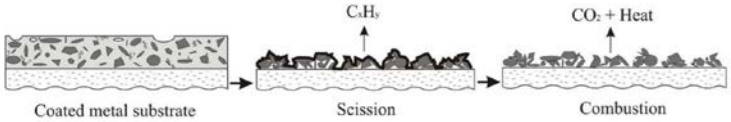
Impurities is the tail that wags the recycling dog

Research example - Coated materials

Leads to increased oxidation and re-melting challenges



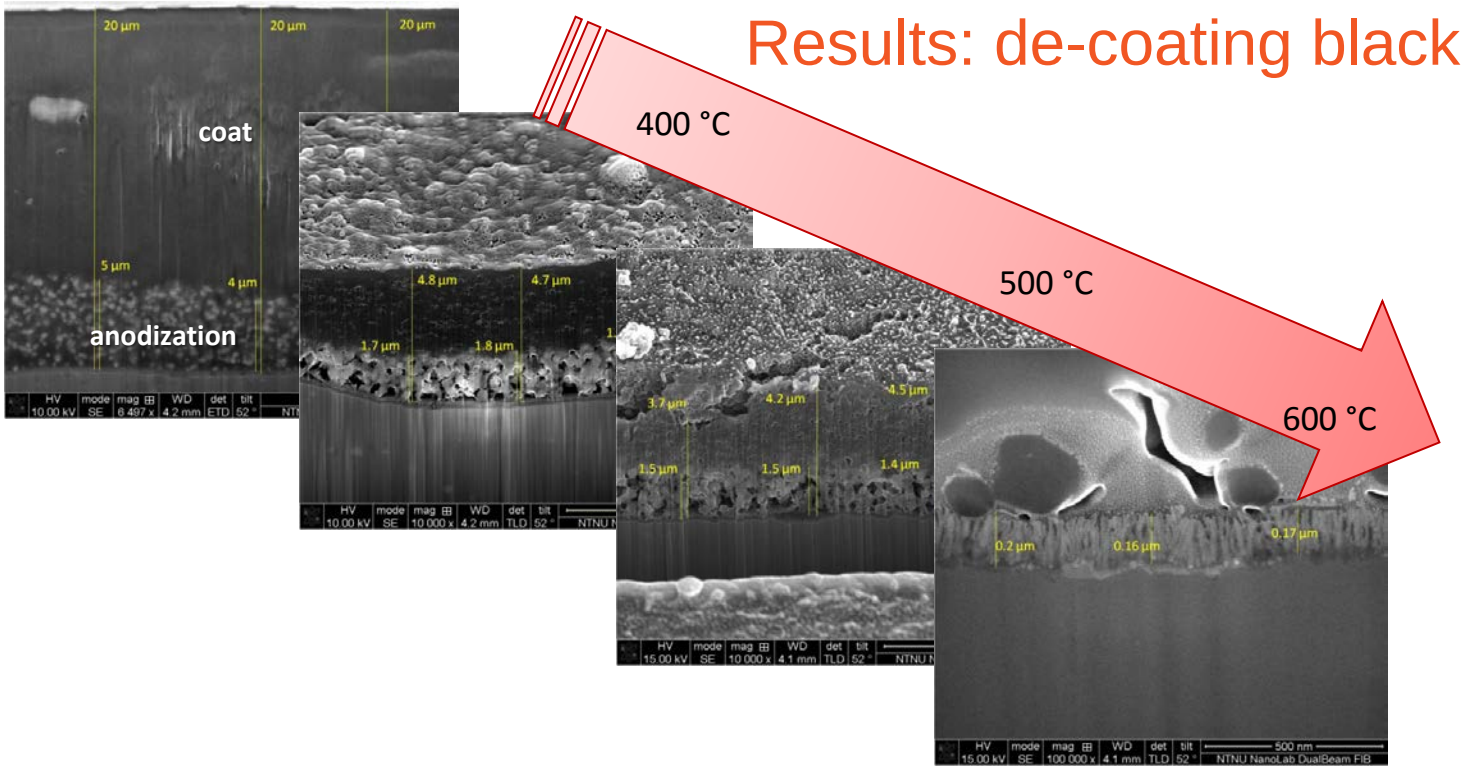
UNEP Recycling Report, 2013



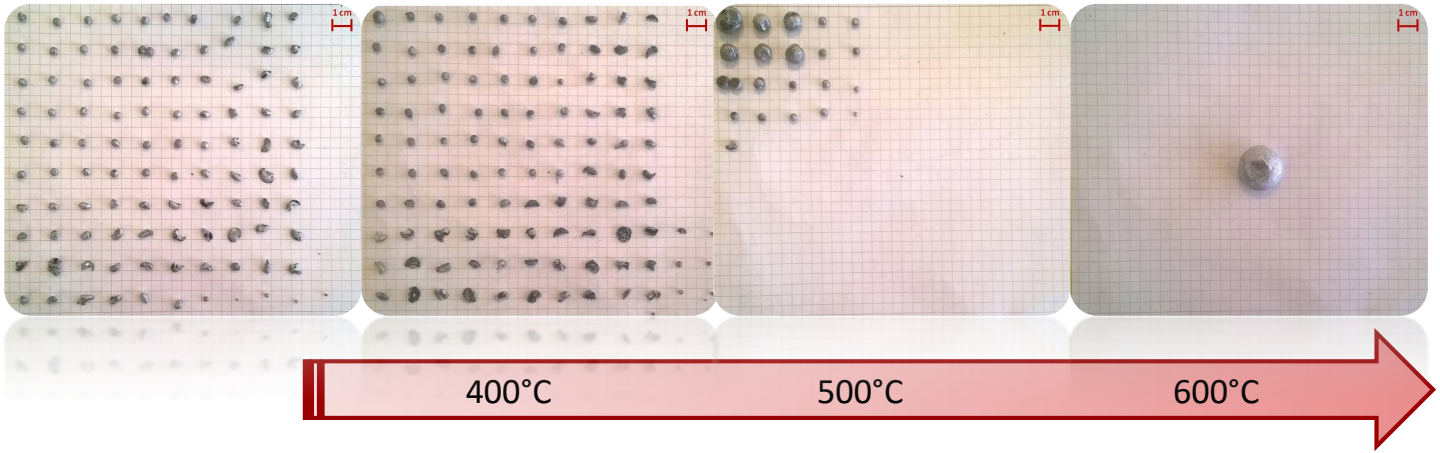
- Moisture
- Organics

Anne Kvithyld, PhD 2003, Stefano Cappuzzi, 2016

Results: de-coating black side



Results:



- No effects are evident if the de-coating temperature is too low
- Increasing the temperature, the percentage of spherical drops and the average diameter increase
- A completely coalescence is obtained if the de-coating treatment is complete

End of Life Product example - Fairphone Recyclability

the Recycling Flow Sheet

FAIRPHONE

Fairphone's Report on Recyclability

Does modularity contribute to better recovery of materials?

fairphone.com

Let's bring in the experts: An analysis using the Recyclability Index

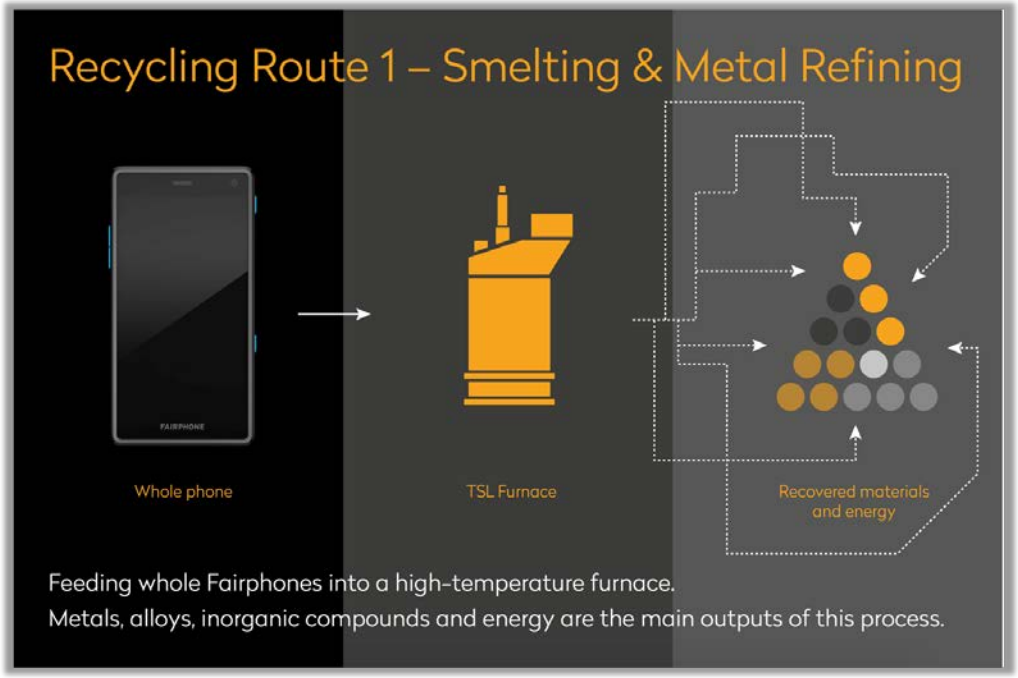
To help us gain a better understanding of the different issues related to electronics recycling, we turned to two very bright minds: Dr. Antoinette van Schaik (MARAS B.V.) and Prof. Dr. Dr. h.c. Markus A. Reuter (Freiberg, Germany), both renowned experts in recycling, sustainable technologies for metallurgy and digitalizing the circular economy. We commissioned them to investigate the recyclability of the Fairphone 2 using the Recyclability Index and Material Flower developed by van Schaik and Reuter.

After the completion of the study, we have identified at least 45 different elements (or materials).

With this study, our aim was to research the potential recovery of all these materials in every part of the phone – from the external housing down to the tiniest capacitor.

M. Ballester, A. van Schaik, M.A. Reuter (2017): https://www.fairphone.com/en/2017/02/27/recyclable-fairphone-2/

Fairphone Recyclability – the Recycling Flow Sheet



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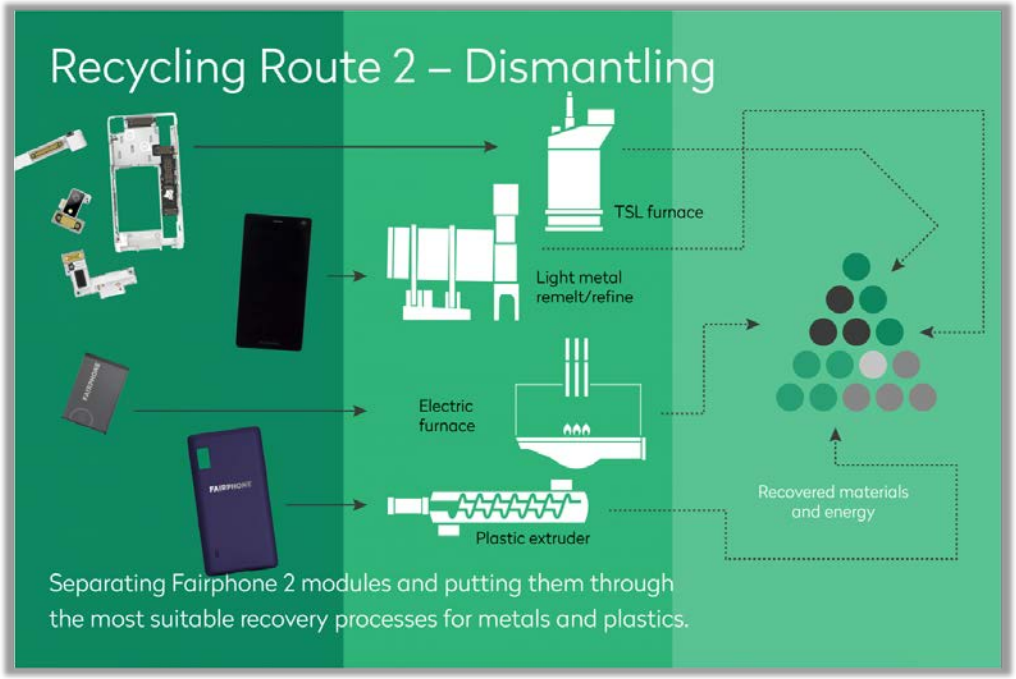

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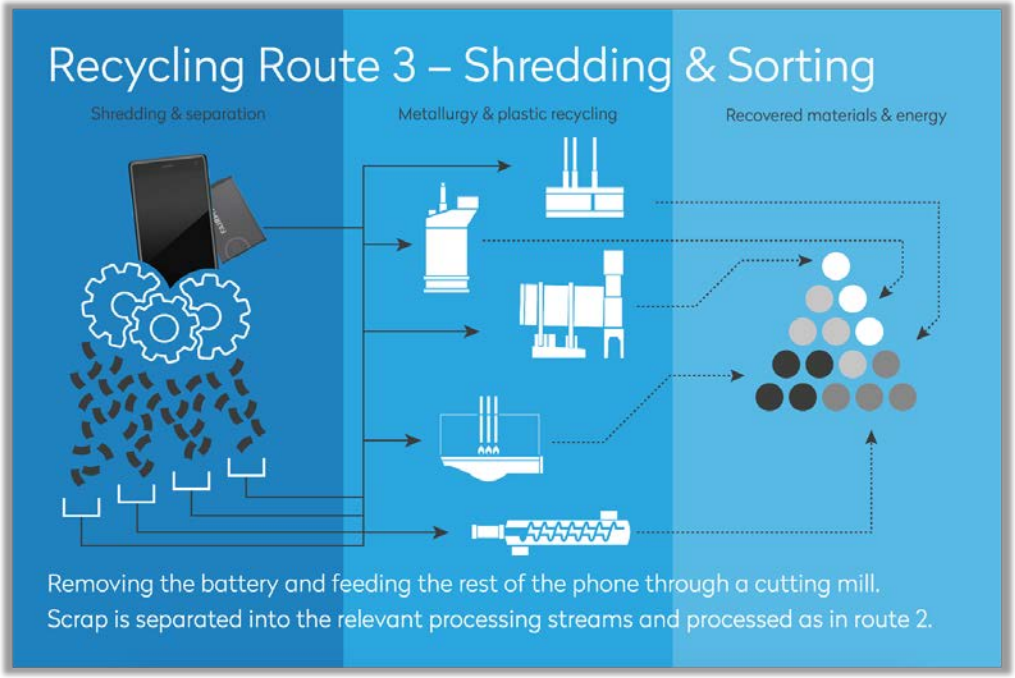
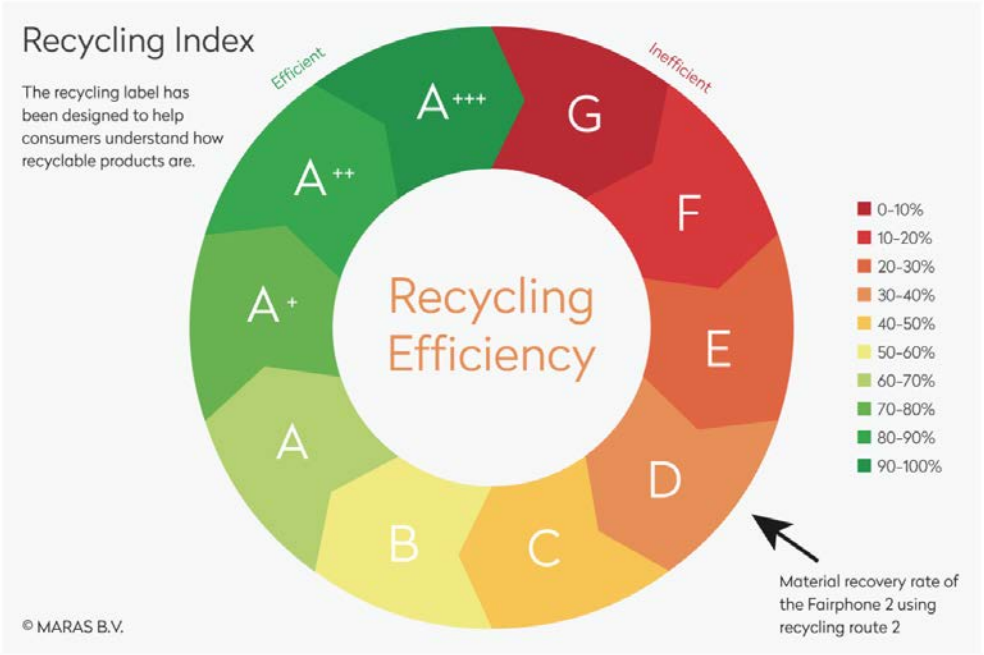


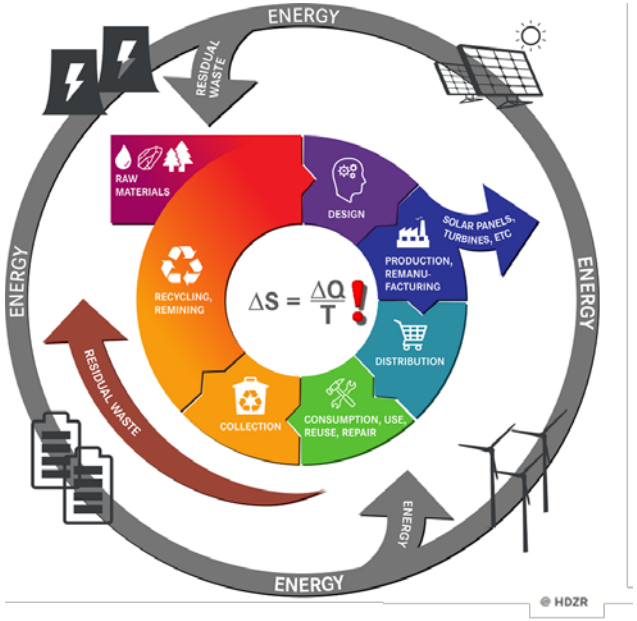
Fairphone Recyclability – The Result

Dismantling



Circular Economy

Metallurgical Perspective



The limits of Circular Economy!