LCA of microwave absorbers obtained from copper slags

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PROJECT LIFE10 ENV/IT/419

WASTE 3
A NATURAL HABITAT
EXCELLENT SUSTAINABILITY

Partners involved:

- Industries: Ceramica Fondovalle S.p.A. and Micro Energy S.r.l.
- University of Trento
- University of Modena and Reggio Emilia

General goal:
Energy free valorisation of copper metallurgical waste

Objectives

- ✓ Diminution of the environmental load

1ton Cu → ton Cu slags

- ✓ Strengthen the slags market through its valorisation

concrete additive, anti-freeze layer in road construction, mineral abrasive…

↓

Producing new materials as:

- heating elements

- semiconducting glazes (residential applications)

- MW absorbers

Vs traditional materials: less energy
less raw materials

MW ABSORBERS

Bulk with *copper slags (CS)*

- Powder (65-70wt%)
- Waste glass (15-20wt%)
- Other oxides (10wt%)

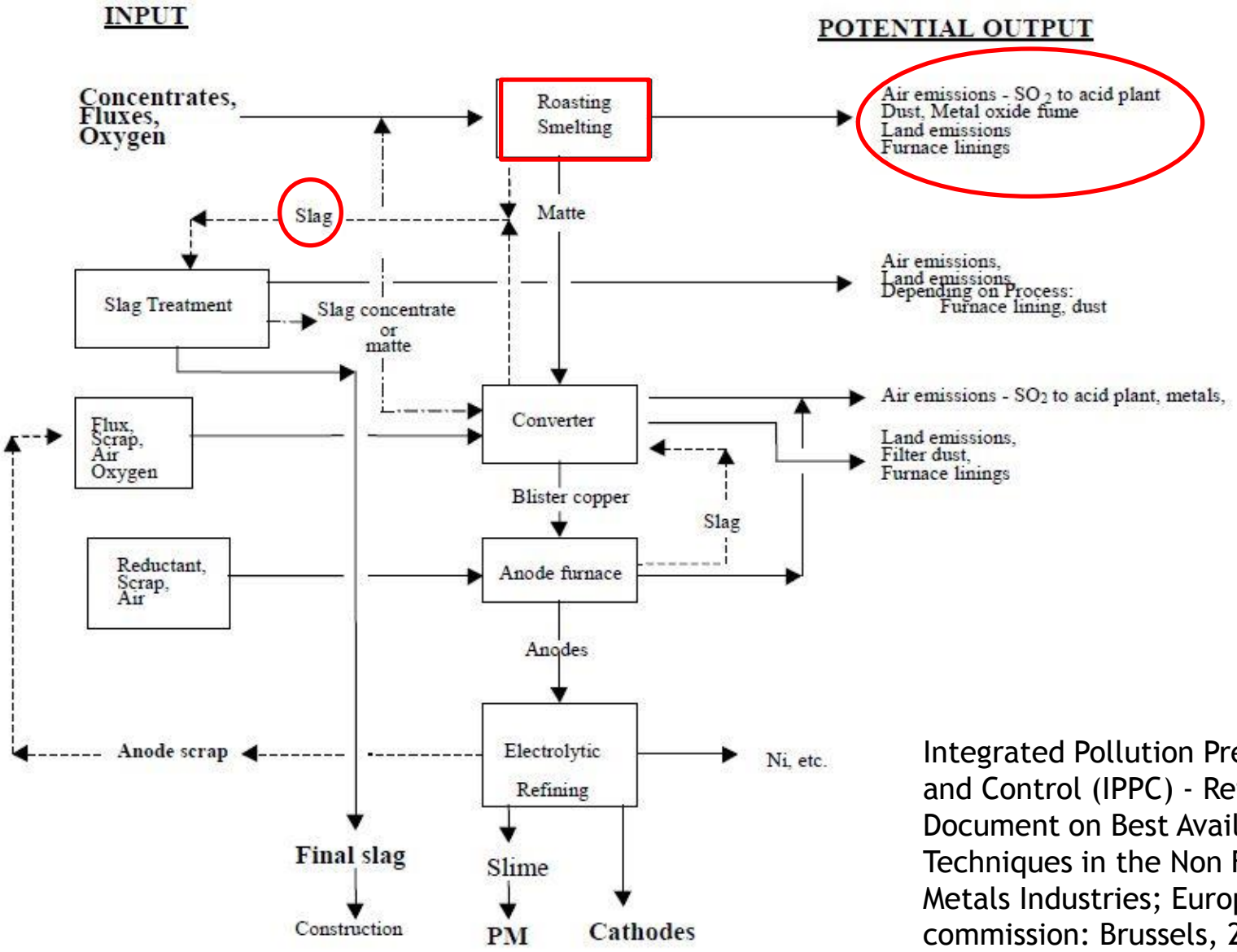
Tile with *copper slags (CS)*

- Powder (60wt%)
- Clays (40wt%)

Silicone carbide (SiC) tile

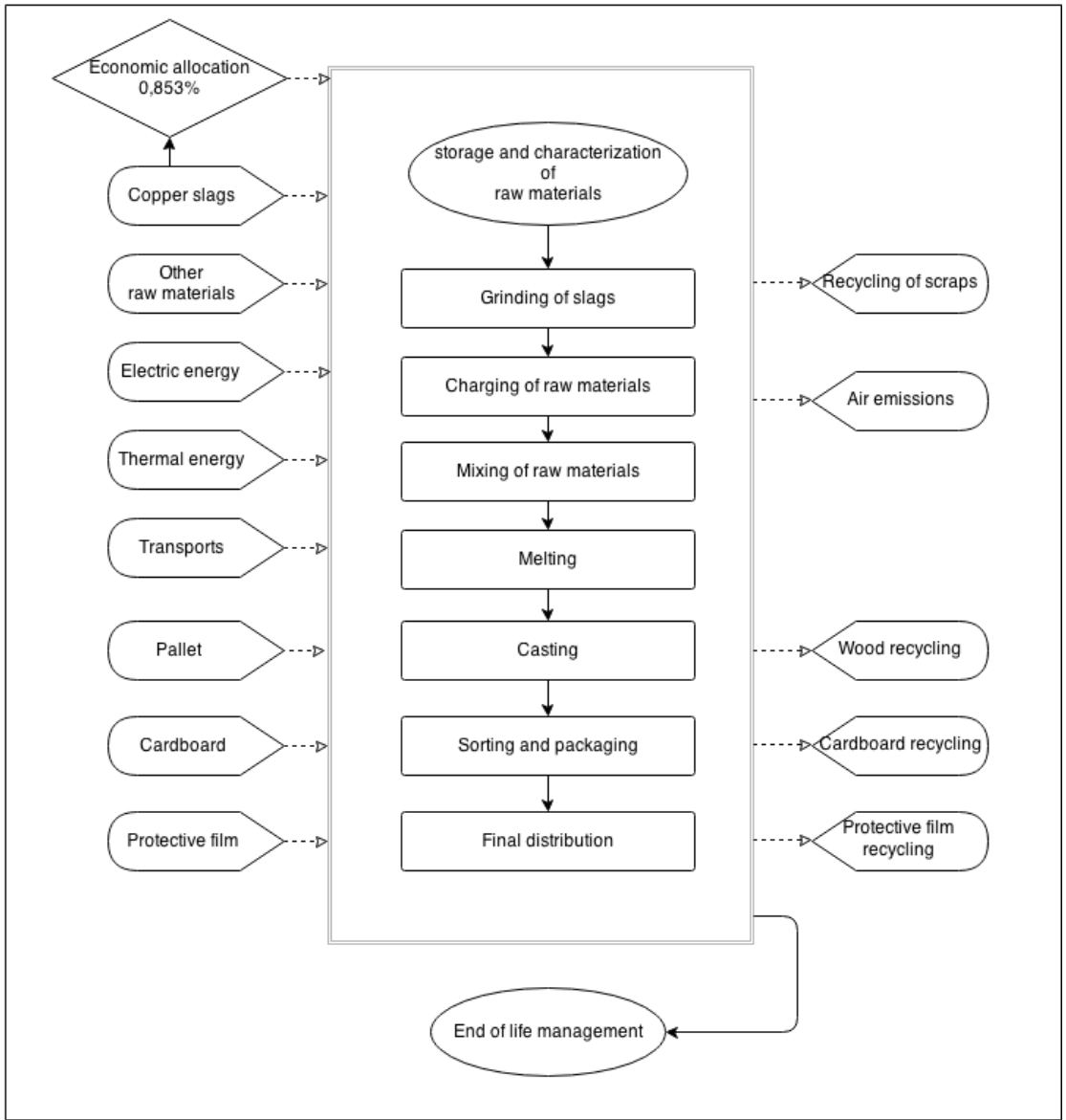
- SiC: 78%
- Bond: 20%
- Iron oxide: 0,9%
- Other oxides: 1,1%

Flow Chart Primary Production of copper (IPCC-BREF)

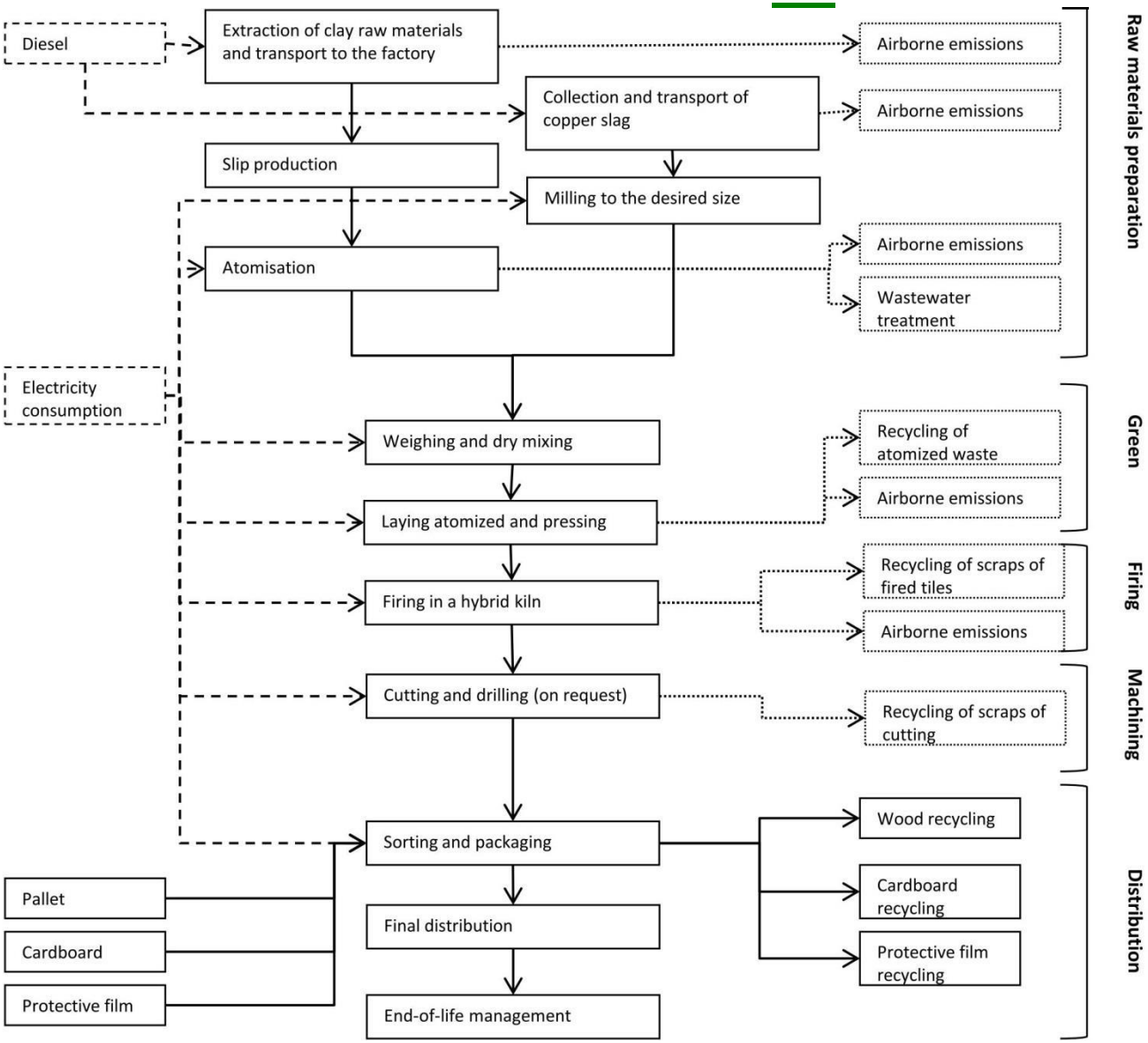


Integrated Pollution Prevention and Control (IPPC) - Reference Document on Best Available Techniques in the Non Ferrous Metals Industries; European commission: Brussels, 2001.

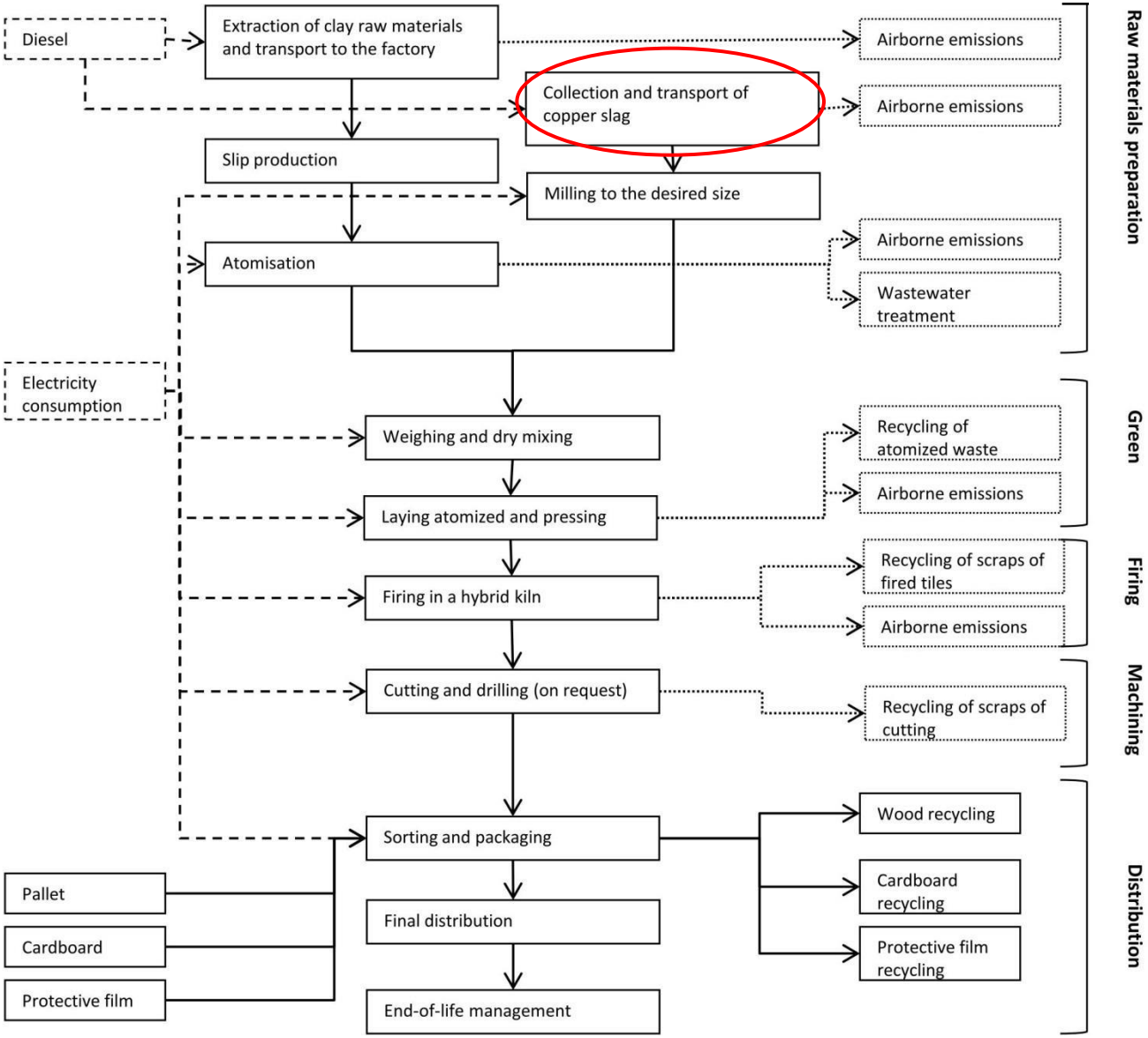
Flow Chart Bulk with *CS*



Flow Chart of tile with *CS*



Flow Chart of SiC tile



Microwave absorbers

Bulk with CS

325x325x10mm
2,28kg

Tile with CS

325x325x10mm
3kg
Microenergy Srl

SiC tile

325x325x10mm
2,01kg
Saint-Gobain Ceramics

Microwave absorbers

Bulk with CS

Tile with CS

SiC tile

Absorbers

→ release the absorbed heat, speeding up heating

→ contribute to the capture of microwave emissions

⇩

Dir. 2013/35/UE
Exposure Limit Value, ELV: 50 Wm^{-2}
6 GHz ≤ f ≤ 300 GHz

1. LCA of the bulk with ***CS***
2. LCA of the tile with ***CS***
3. LCA of the SiC tile

4. LCA comparative analysis of all 3 materials

Goal and scope 1)Assessment of the environmental impacts caused by the production of the bulk and the ceramic tile containing copper slags applied on industrial microwave. 2)Comparative analysis carried out between the innovative products and one commonly used in the target market (SiC tile).

Studied system a bulk and a ceramic tile both obtained using copper slags, compared to the traditional tile contained SiC.

Function of the system to attenuate microwave emissions in accordance with the provisions of the legislation (Dir. 2013/35/UE).

Functional unit mass of material produced, which represents one tile (325x325mm) required for the lifespan of one industrial microwave oven.

System boundaries all the stages of the product‘s life from-cradle-to-grave.

Data quality Primary data, literature data, database (Ecoinvent, Unimore-LWG)

Software SimaPro 8.0.2

Valution method Impact 2002+

Assumptions

Economic allocation

Copper slags are not considered as waste (K. Harn Wei 2013)

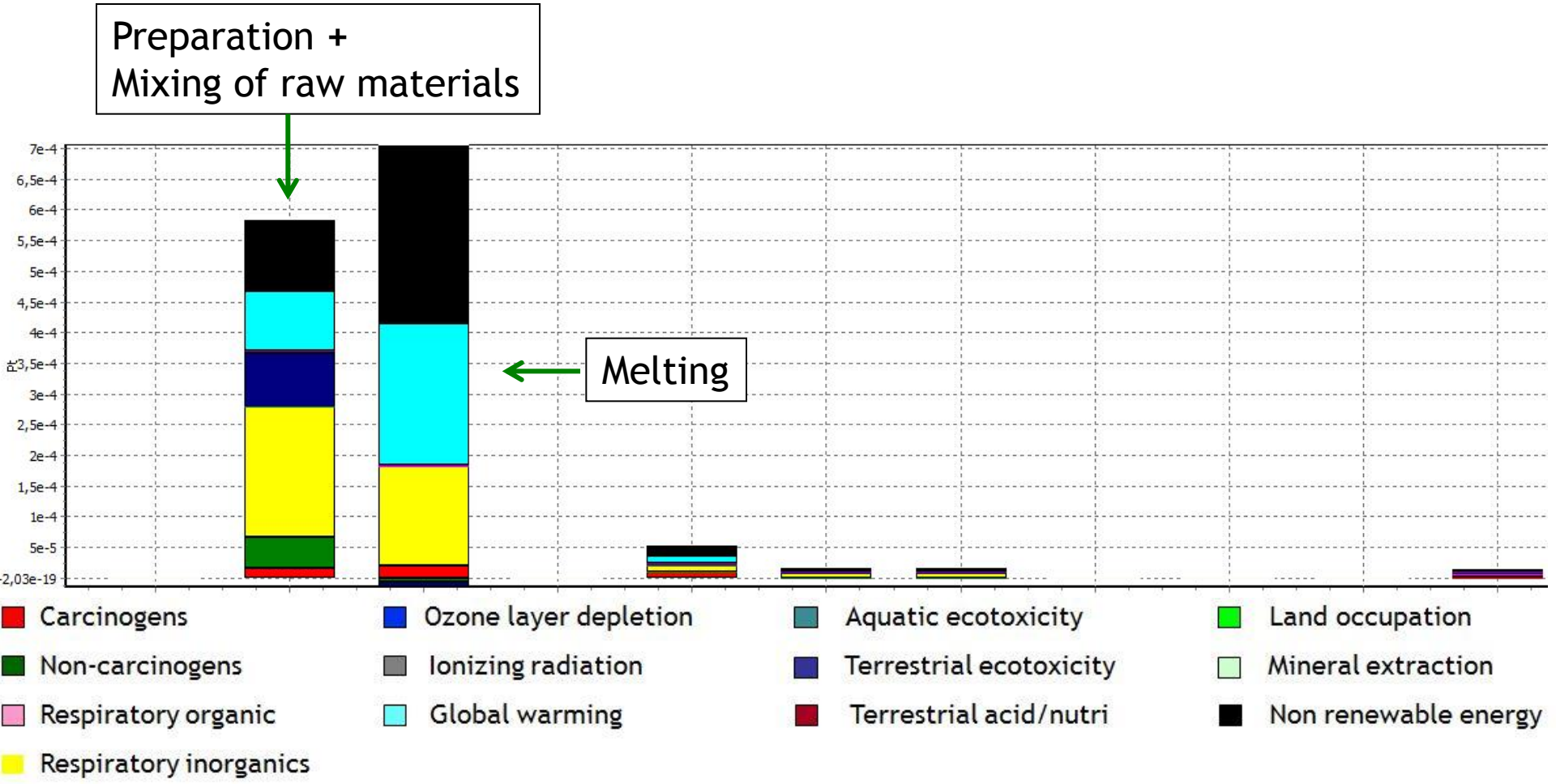
	Mass production	Price	Allocation
Copper	1 ton	5305 €/ton*	99,147%
Slags	1,63 ton	28 €/ton**	0,853%

Efficacy and duration

Same performance for the three materials examined

*London Metal Exchange (09-18-2013)
**Peute Baustoff GmbH, subsidiary of Aurubis AG (Hamburg)

Analysis of Bulk with *CS*



Analysis of Bulk with *CS*

- Functional Unit: 2,28kg
- Total Damage: 1,38E-3Pt
- Major process contribution:

  50% Melting

  42% Preparation raw materials → **36%** Respiratory inorganics *PM 2,5*; **19%** Non renewable energy *Oil*; **17%** Global Warming CO_2; **15%** Terrestrial ecotoxicity *Zinc*

- Major impacts on:

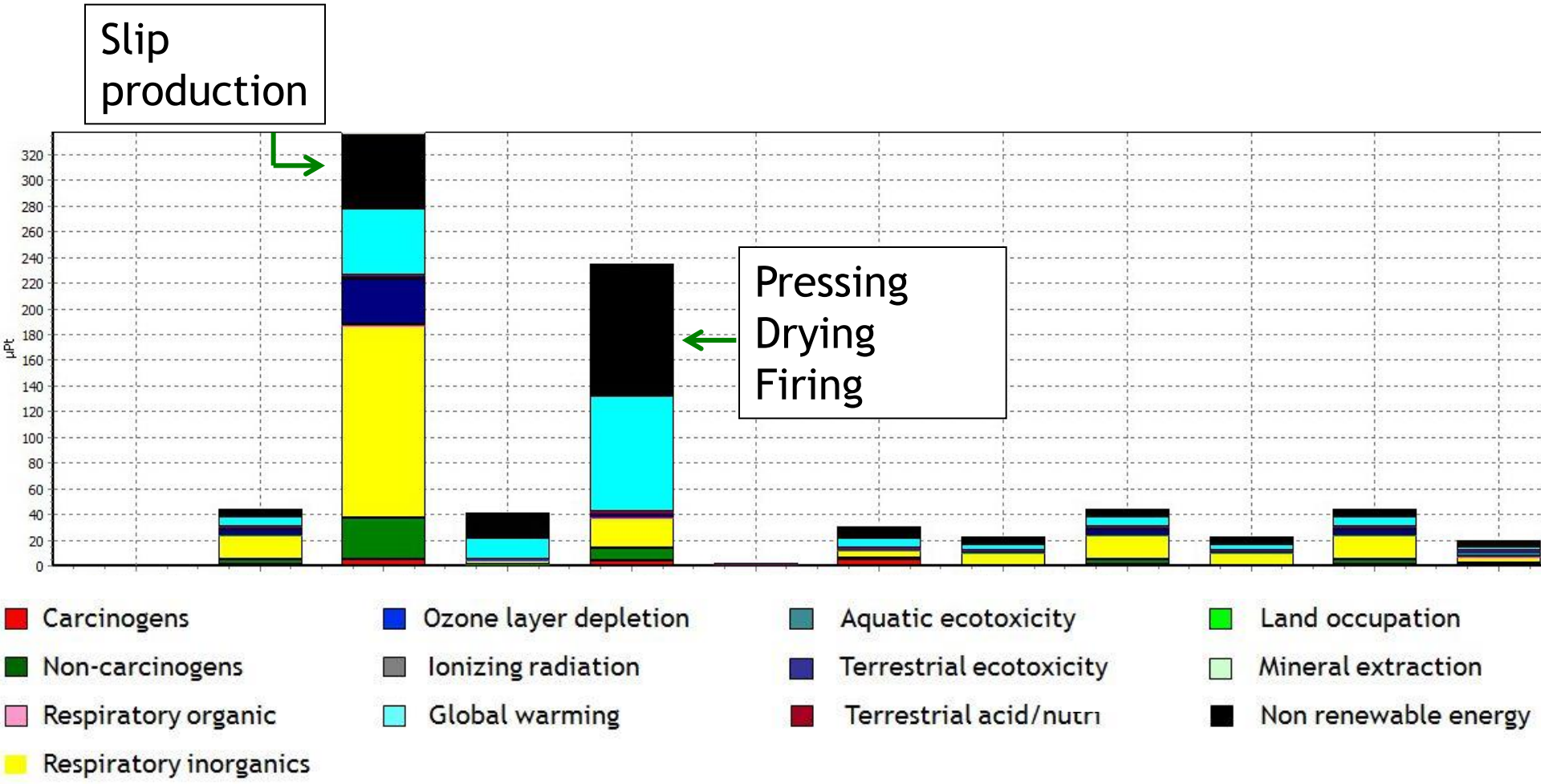
  32% Non renewable energy → *Natural gas*

  29% Respiratory inorganics → *PM 2,5*

  26% Global Warming → CO_2

  } Melting process

Analysis of Tile with *CS*



Analysis of Tile with *CS*

- Functional Unit: 3kg
- Total Damage: 8,53E-4Pt
- Major process contribution:

  40% Slip production

  28% Pressing-Drying-Firing

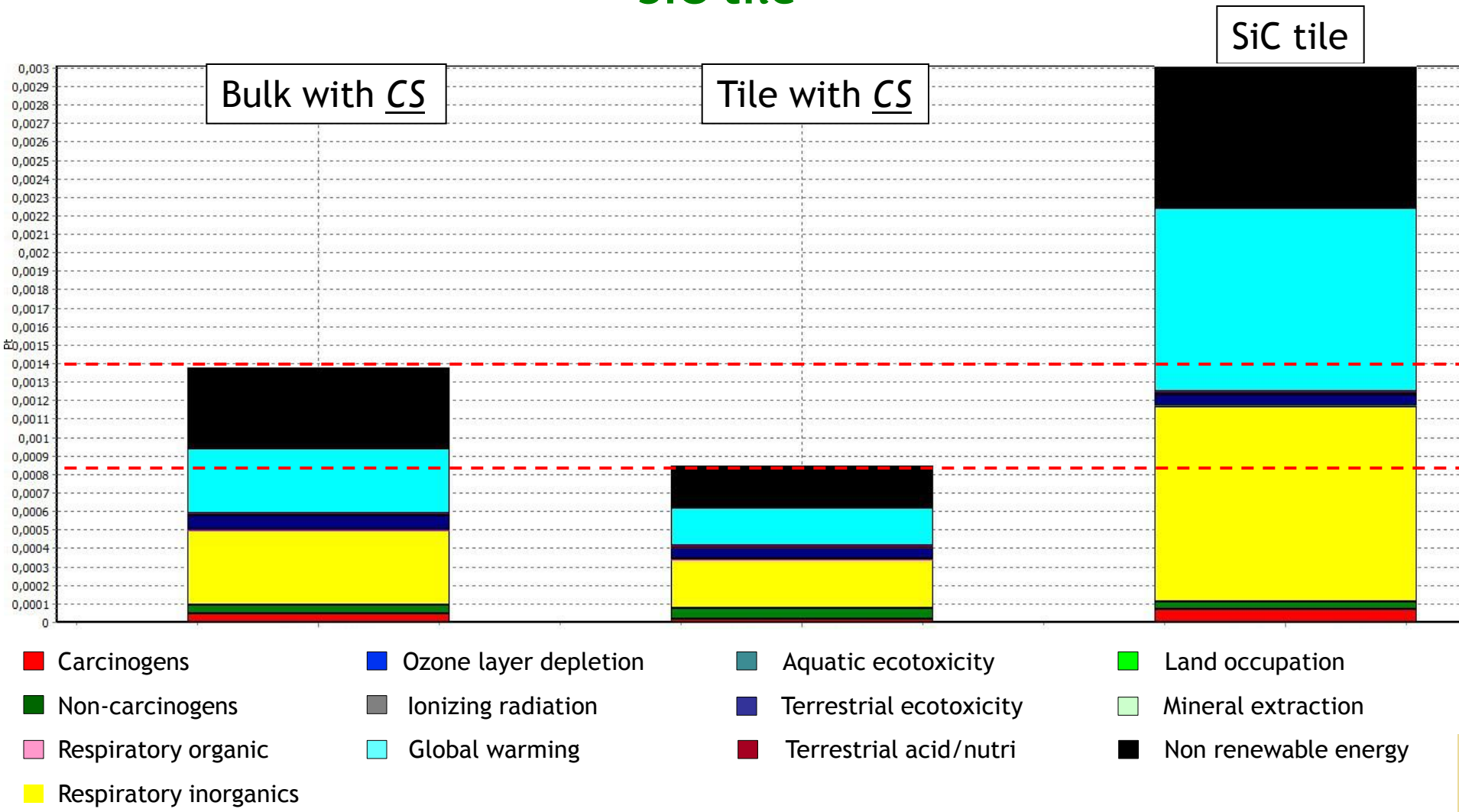
- Major impacts on:

  31% Respiratory inorganics → *PM 2,5* → Slip production

  27% Non renewable energy → *Natural gas* → Firing

  24% Global Warming → CO_2 → Firing

Comparison between Bulk with *CS*, Tile with *CS* and SiC tile

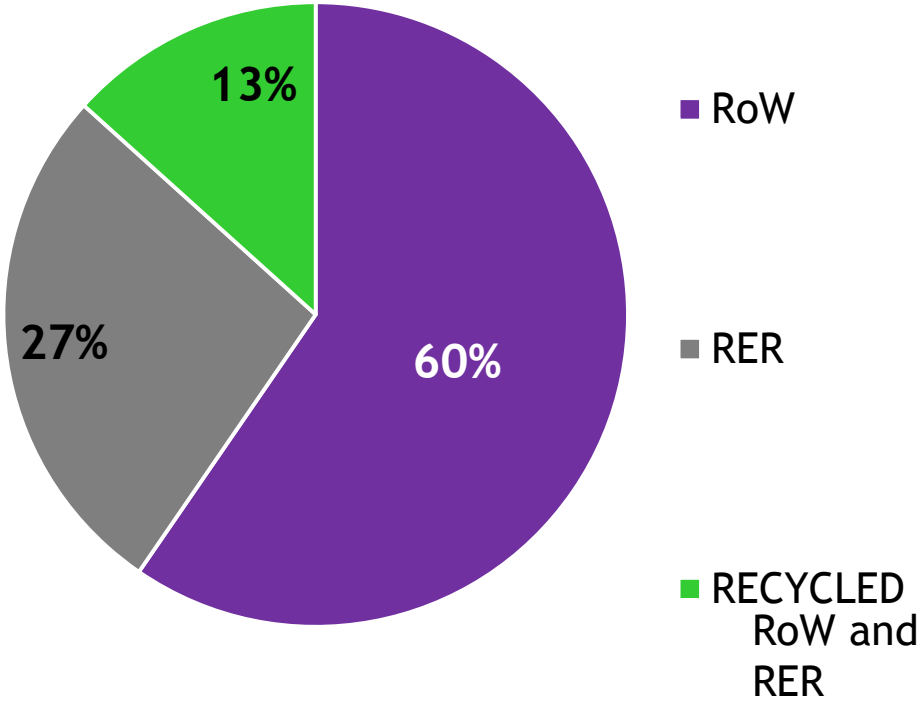


Comparison between Bulk with *CS*, Tile with *CS* and SiC tile

- Functional Unit: the necessary mass for one MW oven
- Total Damage Bulk with CS: 1,38E-3 Pt → **54%** lower than SiC tile
- Total Damage Tile with CS : 8,53E-4 Pt → **72%** lower than SiC tile
- Total Damage SiC Tile: 3,01E-3 Pt
- Major process contribution:
  83% Slip production → **94%** SiC production

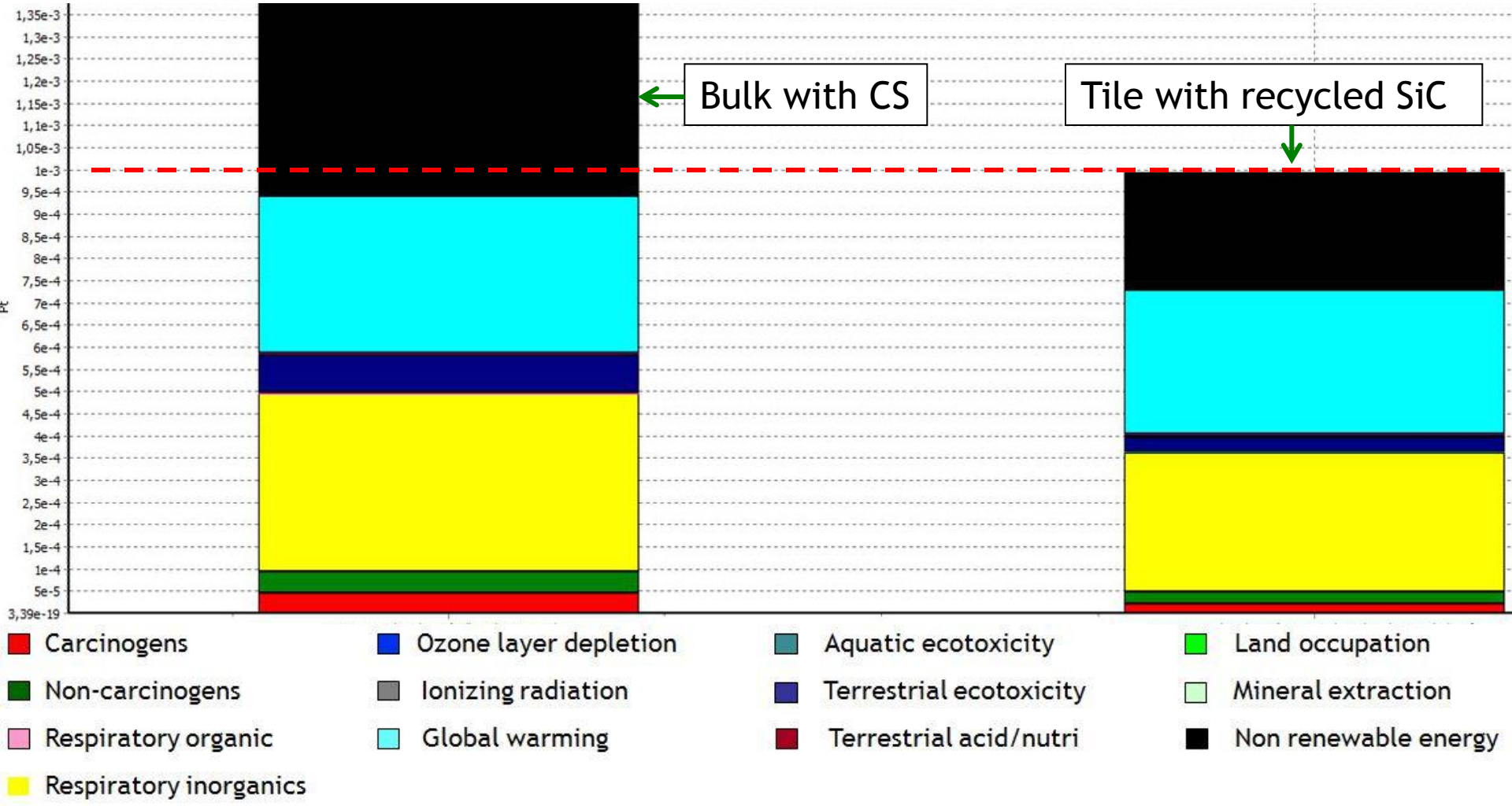
SiC production

Composition of 1kg of SiC
(Ecoinvent database)



RoW, Rest of the World
RER, European production
Recycled RoW and RER

Sensitivity analysis: Tile with *CS* and tile with only recycled SiC



Sensitivity analysis: Tile with *CS* and tile with only recycled SiC

- Functional Unit: the necessary mass for one MW oven
- Total Damage Bulk with CS: 1,38E-3 Pt
- Total Damage recycled SiC Tile: 9,17E-4 Pt

→ **28% higher** than recycled SiC tile !

CONCLUSIONS

Among the all MW absorbers analysed, the innovative material produced by Microenergy S.r.l shows the best environmental performance.

Valorisation of waste material

- 90% of waste raw materials have been used to produce the final bulk samples
- 60% of waste material have been used in the production of copper slags tile

Possible improvements

Copper slags	→	- Preferring national supply - opt for a transport with lower environmental impact
Assumptions of efficacy and duration	→	- Model a correlation factor - Assess the release of heat
More study on toxicity On environment and human health	→	- Assess an eventual release of slag components

Thank you for your attention