ecometals

Coupling simulation of mineral processing with Life Cycle Assessment

To assess the environmental impacts of copper production

Speakers:
Antoine Beylot (BRGM)
Augustin Chanoine (Deloitte sustainability)

8th International Conference on Life Cycle Management
LCM 2017, 3-6 Sept 2017, Luxembourg
http://lcm-conferences.org/

SPONSORED BY THE
Federal Ministry of Education and Research
COORDINATED BY
HZDR
HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

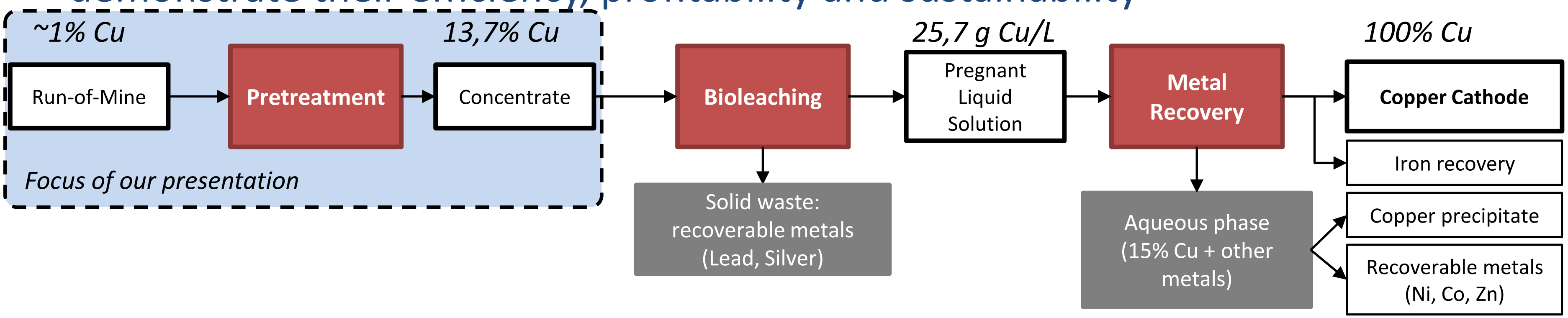
Context and objectives of the study

In Europe, most of the primary sources w/ high or moderate grades, reasonable accessibility and that are easy to process are exhausted.

- Primary resources: still available resources are polymetallic, lower-grade ores
- Secondary resources: mining waste contains residual quantities of valuable metals

Focus on copper: need for alternative extraction processes of copper. **Bio-hydrometallurgical technologies** have the potential to: 1/ better adapt to lower-grade ores, 2/ extract metals in copper mining waste and 3/ lower the environmental impact of the mining industry

→ Objective of German-French **EcoMetals project:** to develop bioleaching, pretreatment and metal recovery techniques for copper extraction and demonstrate their efficiency, profitability and sustainability



SPONSORED BY THE
Federal Ministry of Education and Research
ANR
PtJ
FONA
COORDINATED BY
brgm
HZDR
HELMHOLTZ

“Coupling” process simulation with LCA: concept

Operational and experimental data →

Building the model on a Case Study
- Coherent material balance calculation
- Model calibration

→ **Scenarios Modelling**
- Modification of input parameters

USIM PAC

↓
- *Reconciliated mass balances*
- *Intermediate exchanges*
- *Elementary flows*

LCA + LCC
- Life Cycle Inventory modelling
- Environmental impact and economic assessment

ecoinvent Centre
SimaPro

↓

Process chain environmental impacts

Redesigning the process (feedback to operational and experimental data)

Scope of the study

- Case study: exploitation of a Kupferschiefer copper ore at Lubin mine (Poland)
- Lithotypes and chemical composition
  - Carbonates: 17,6 wt% in share, with 1,50% Cu
  - Shale: 13,2 wt% in share, with 2,78% Cu
  - Sandstone: 69,2% wt% in share, with 0,91% Cu
- Functional Unit
  - To produce 1 ton of Cu in 13,7% Cu concentrate
- System boundary
  - From Run-of-Mine (RoM) ore to copper concentrate
- Life Cycle Inventory dabatase
  - ecoinvent 3.3
- Environmental impact categories
  - Selection of a restricted list of 6 mid-point impact categories assessed with recognized characterization methods:
    - UseTox 2 for toxicity indicators + latest PEF recommendations for other impact categories

Model construction: Mass Balances

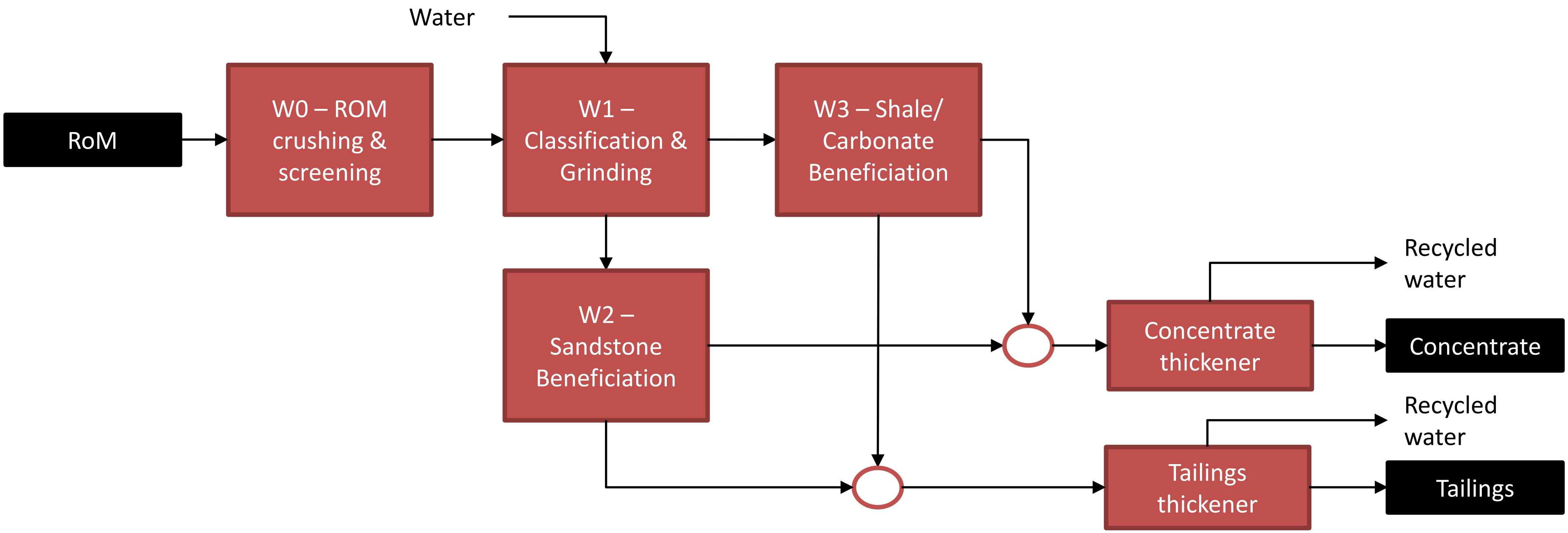
- Initial raw data on mass balances
  - On-site operational data completed with hypotheses
  - Global mass flows and substance flows (Cu, C_{org} and C_{inorg})
  - Inconsistent mass balances:

    Mass in ≠ Mass out

- Reconciliation of mass balances
  - i.e. finding estimators which are:

  - Consistent with mass balance constraints
  - Close to initial values, as a function of the data accuracy

  - Lowering the uncertainty of global mass balances by benefiting from the higher accuracy on substance flows



Model construction: Implementing standard models

- Energy consumption
  - Bond Formula, as a function of:
    - ✓ Crushability of lithotypes
    - ✓ Particle size distribution
- Steel and reagents consumption
  - Steel as a function of abrasion indices of lithotypes

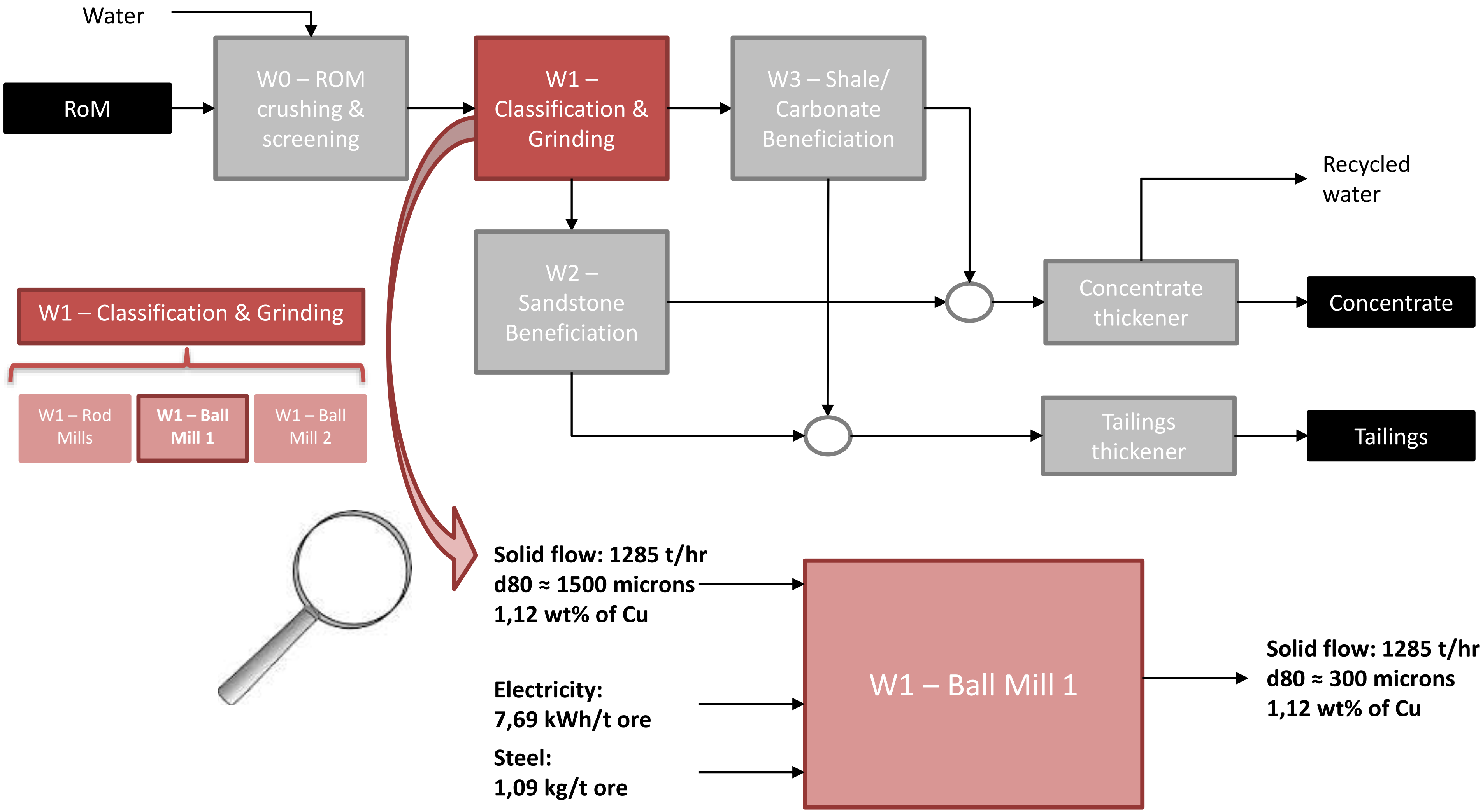
Lithology	**Shale**	**Carbonate**	**Sandstone**
Work Index (kWh/t)	16,2	7,6	20,2
Abrasion Index (kg/kWh)	0,02	0,32	0,6

Data from UVR (German partner in Ecometals project)

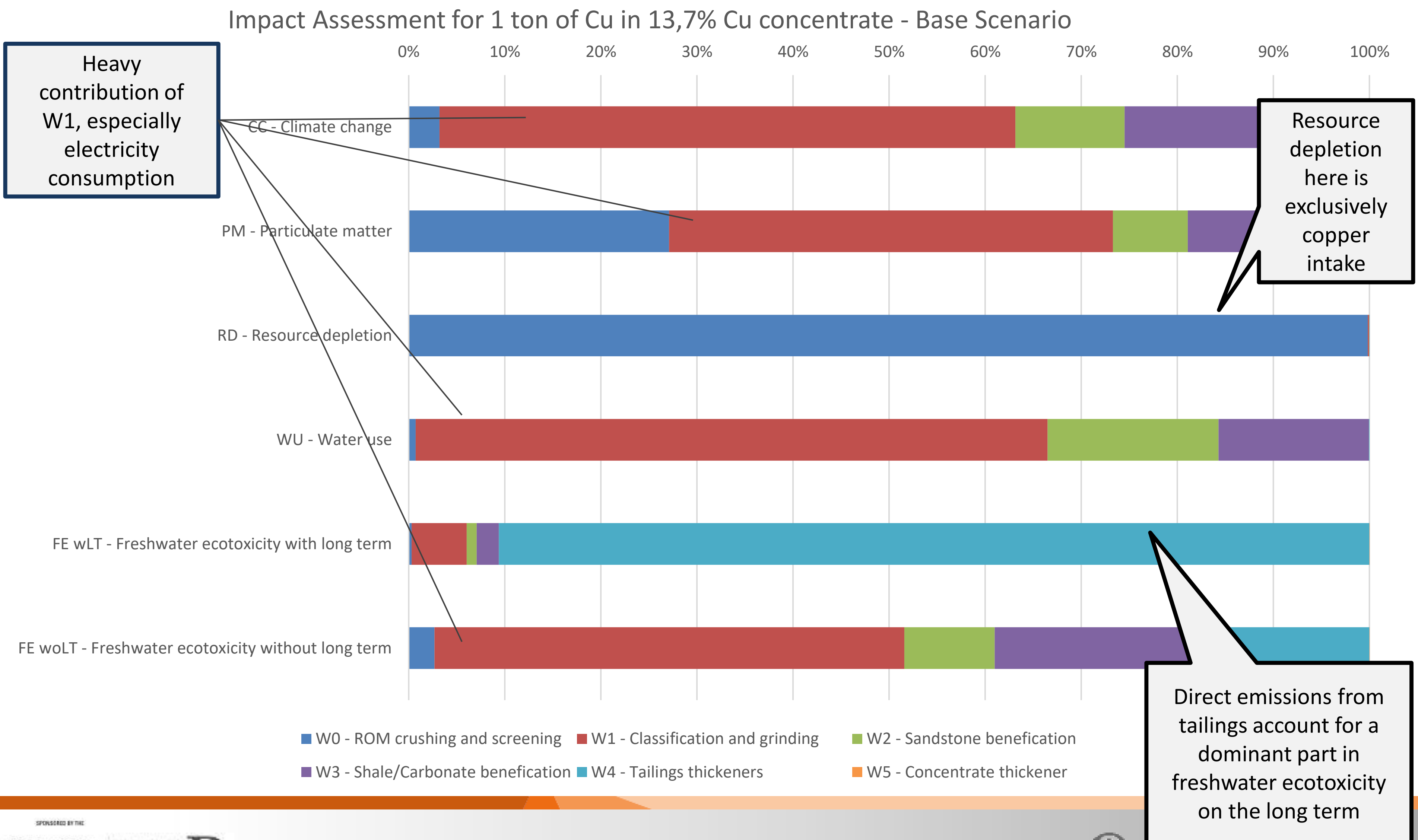
- Air emissions
  - Dust and CS_2 emission factors drawn from the literature

Descriptive models ≠ Predictive models

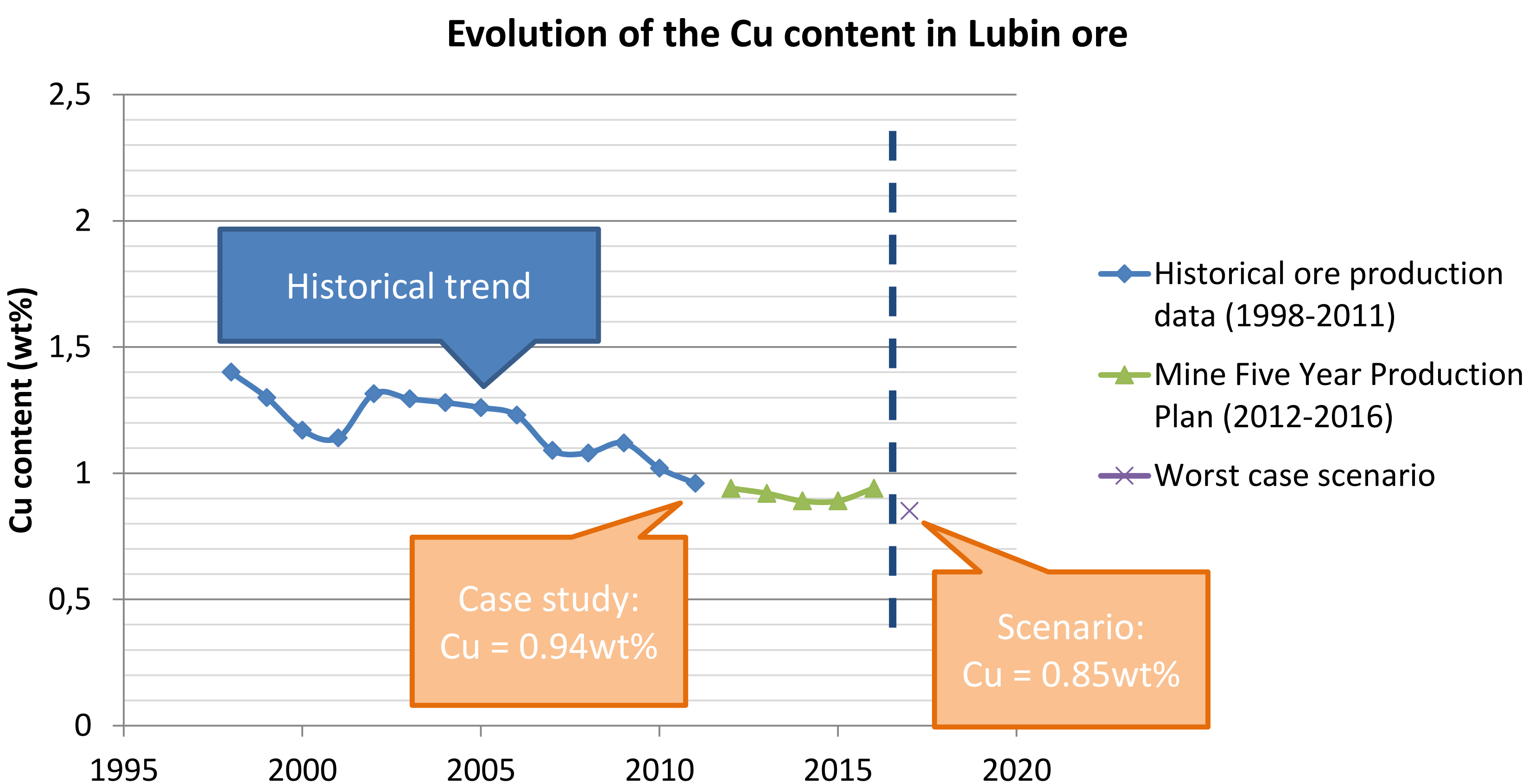
Case study: Inventory of inputs and outputs



Case study: impact calculation

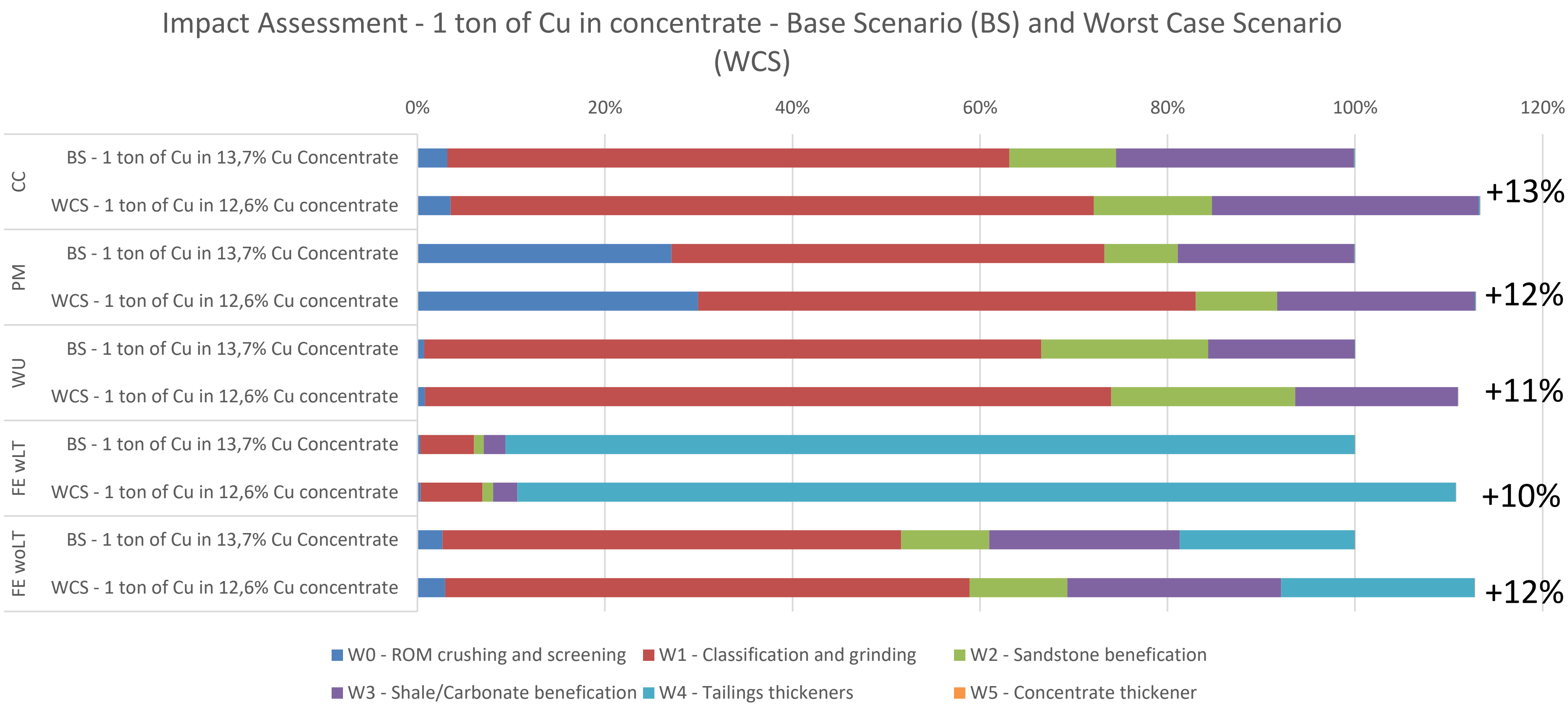


Scenario modelling



Figures from MICON TECHNICAL REPORT ON THE COPPER-SILVER PRODUCTION OPERATIONS OF KGHM POLSKA MIEDŹ S.A. IN THE LEGNICA-GLOGÓW COPPER BELT AREA OF SOUTHWESTERN POLAND (Feb. 2013)

Scenario: impact calculation



→ A RoM initially 9% poorer in copper requires >13% more energy to produce the same amount of copper concentrate. It also generates more emissions to air and more waste.

→ Most impacts rise by 10 to 13%.

Conclusions and outlook

- Elaboration of a joint process and environmental simulation applied to the mineral industry:
  - Provides gains in robustness and time spent for mass balance's calculations
  - Direct link between process performance and environmental impacts
  - Highlights key unit operations to be improved/optimized on both technical and environmental viewpoints
- Applicability proven using "descriptive" process models in a prospective case study
- Complementarity / coupling to be improved by:
  - Implementing a "hard" software connection between process simulation software and LCA software
  - Using "predictive" process models in relation with equipment sizing and upscaling data

THANK YOU FOR YOUR ATTENTION!
ANY QUESTIONS?

Study team (WP5 contribution):

BRGM: J. Bodin, J. Villeneuve, A. Beylot, K. Bru, F. Bodénan
Deloitte: A. Chanoine, P.A. Duvernois, C. Tromson, J. Bitar

www.ecometals.de

ECOMETALS Partners

Project Coordination

HZDR HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

brgm Géosciences pour une Terre durable

Project Partners

Aurubis

AIR LIQUIDE

BGR

Deloitte.

B·R·A·I·N

KGHM Cuprum

cnrs GeoRessources

G.E.O.S.

KGHM POLSKA MIEDŹ S.A.

Université de Pau et des Pays de l'Adour – Laboratoire de Thermique Énergétique et Procédés

MILTON ROY Mixing

TECHNISCHE UNIVERSITÄT BERGAKADEMIE FREIBERG
Die Ressourcenuniversität. Seit 1765.

UVR FIA