SUSTAINABLE RESOURCE MANAGEMENT IN EUROPEAN STEEL SUPPLY CHAINS

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This project has received funding from the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement No 675153.
A DECISION SUPPORT TOOL

CONTEXT

INSIGHTS FOR THE EUROPEAN STEEL INDUSTRY

POLICY SUGGESTIONS FOR THE EUROPEAN COMMISSION

RECOMMENDATIONS FOR FUTURE RESEARCH

PUBLICATION #1:

INTEGRATING LIFE CYCLE ANALYSIS INTO

SYSTEM DYNAMICS: THE CASE OF STEEL IN EUROPE
OVERVIEW

- INTRODUCTION
  WHY LCA AND SD?
- QUESTIONS
- CASE STUDY
- METHODOLOGY
  DESIGN, MODEL, DATA & RUNS
- RESULTS
- CONCLUSIONS
- NEXT STEPS
WHY LCA AND SD?

OPPORTUNITIES FROM LITERATURE + SWOT ANALYSIS:

**SD > LCA (FLEXIBILITY):**
- CIRCULARITY
- LONG-TERM PERSPECTIVE
- MACRO ANALYSES POTENTIAL

**LCA > SD (OBJECTIVE REPRESENTATION):**
- STAKEHOLDER INVOLVEMENT
- RELIABILITY FOR MICRO ANALYSES
- APPLICATION ACROSS MANAGERIAL LEVELS

EUROPE + CIRCULAR ECONOMY, VIA LCA

BRING SD CLOSER TO INDUSTRIAL ECOLOGY
QUESTIONS & CASE STUDY

1. CAN THE INTEGRATION OF LCA INTO SD REPRODUCE THE RESULTS OR BEHAVIORS PREVIOUSLY OBSERVED IN STUDIES THAT USED LCA OR SD INDEPENDENTLY?

2. WHAT POTENTIAL BENEFITS DERIVE FROM THIS INTEGRATION TOWARD DECISION-MAKING ON THE BIOPHYSICAL ASPECTS OF LONG-TERM MATERIALS SOURCING?
CASE STUDY

BOUNDARY: WORLDSTEEL EU28 (84%)

APPROACH: CRADLE-TO-CRADLE

STANDARD: ILCD & ISO

FUNC. UNIT: 1 TON OF STEEL
METHODOLOGY: DESIGN

MODULAR • ESCALABLE • BIOPHYSICAL

1. Business Process Mapping (BPM)
2. Causal Loop Diagram (CLD)
3. Flow Chart (FC) Modelling
4. Data Collection & Parameterizing
5. Model Testing & Simulations
6. Analyses and Evaluation
METHODOLOGY: MODEL (CLD)

PUSH/PULL DYNAMICS • LEVELS OF AGGREGATION • 20 MODULES
METHODOLOGY: MODEL (FC)
METHODOLOGY: DATA & RUNS

DATA SOURCES: (e.g.) WORLDSTEEL, EUROSTAT, EUROFER, EUROSLAG, RREUSE, NFDC, BIR, WSSTP

BASE RUN: 200 YEARS, UNS30400

RUN A: 6 MOST PRODUCED

RUN B: LINEAR BFBOF TO EAF

RUN C: A + B
RESULTS (QUESTION 1)

**Biophysical Depletion of High-Grade Ore**
Sverdrup & Ragnarsdottir (2014)

**Supply Chain Resource Retention**
Asif et al. (2015)
Nuss & Blegenini (2018)

**Iron as a Bottleneck for European Steel Economy**
Ansari & Seifi (2012)
RESULTS (QUESTION 1 CONT.)

CO$_2$ eq EMISSIONS: 837,41 kg/FU$_{EAF}$ & 2,255,39 kg/FU$_{BFBOF}$
BURCHART-KOROL (2013)

SLAG GENERATION: 121,17 kg/FU$_{EAF}$ & 459,84 kg/FU$_{BFBOF}$
RENZULLI ET AL. (2016)

EMISSIONS COMPOSITION
WORLDSTEEL LCI (2017)
RESULTS (QUESTION 2)

SD CONTRIBUTED TO LCA:

CIRCULARITY
(MINOR) GATE-TO-CRADLE DYNAMICS VISIBILITY INCREASE

LONG-TERM PERSPECTIVE
(MAJOR) TIMESPAN INCREASE + ENDOGENOUS FEEDBACKS & DELAYS

MACRO ANALYSES POTENTIAL
(MAJOR) MULTIPLE PRODUCTS + READY FOR MARKET DYNAMICS
RESULTS (QUESTION 2 CONT.)

LCA CONTRIBUTED TO SD:

STAKEHOLDER INVOLVEMENT  
(MAJOR) OBJECTIVE REPRESENTATION, PRECISE ACCOUNTING

RELIABILITY FOR MICRO ANALYSES  
(MINOR) GRANULARITY INCREASE

APPLICATION ACROSS MANAGERIAL LEVELS  
(MAJOR) ONE MODEL FROM SHOPFLOOR TO MANAGING BOARD
CONCLUSIONS

▪ SUCCESSFUL INTEGRATION

▪ LCA’S CONTRIBUTIONS WERE MORE TANGIBLE THAN SD’S

▪ NO DETRIMENTAL METHODOLOGICAL INTERFERENCES, BUT...

▪ LCA’S INDICATORS NEED MORE WORK (e.g. ReCiPe, IPCC GWP)

▪ REMINISCENT OF MFA AND INDUSTRIAL METABOLISM
NEXT STEPS

▪ OTHER TCE’S AS DRIVERS
▪ RENEWABLE ENERGY SOURCES FOR THE EAF OPERATIONS
▪ SUBSTANCE REINTRODUCTION INTO BIOSPHERE
▪ MARKET DYNAMICS
▪ SUPPLY CHAIN INTEGRATION
THANK YOU

The authors would like to thank Mr Gregor Wernet, Executive Director of Ecoinvent, for his methodological insights during the development of this study.

This project has received funding from the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement No 675153.