

# K1-MET Overview

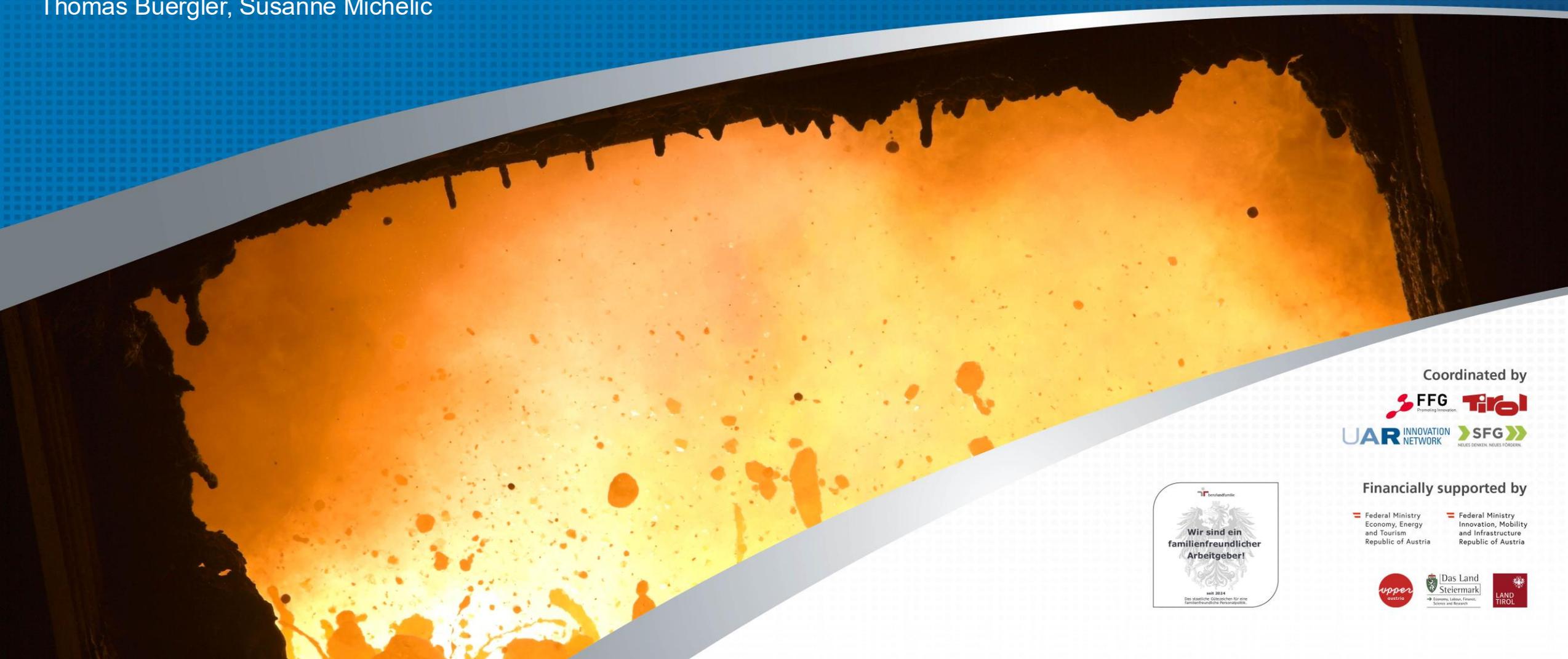
SusMet4Planet (2023 – 2027)

Linz, 1 July 2023

Thomas Buergler, Susanne Michelic



metallurgical competence center



Coordinated by



Financially supported by



# K1-MET at a glance

international metallurgical research competence center

- focus on ferrous and nonferrous metallurgy
- founded in July 2015 as a limited liability company
- 84 employees (as of 1 July 2023)
- partially funded by an Austrian competence center programme
- annual revenue of 10 million €
- 100 projects and associated partners from industry and science
- 28 Company Partners
- 13 Scientific Partners

Current research programme 2023 – 2027

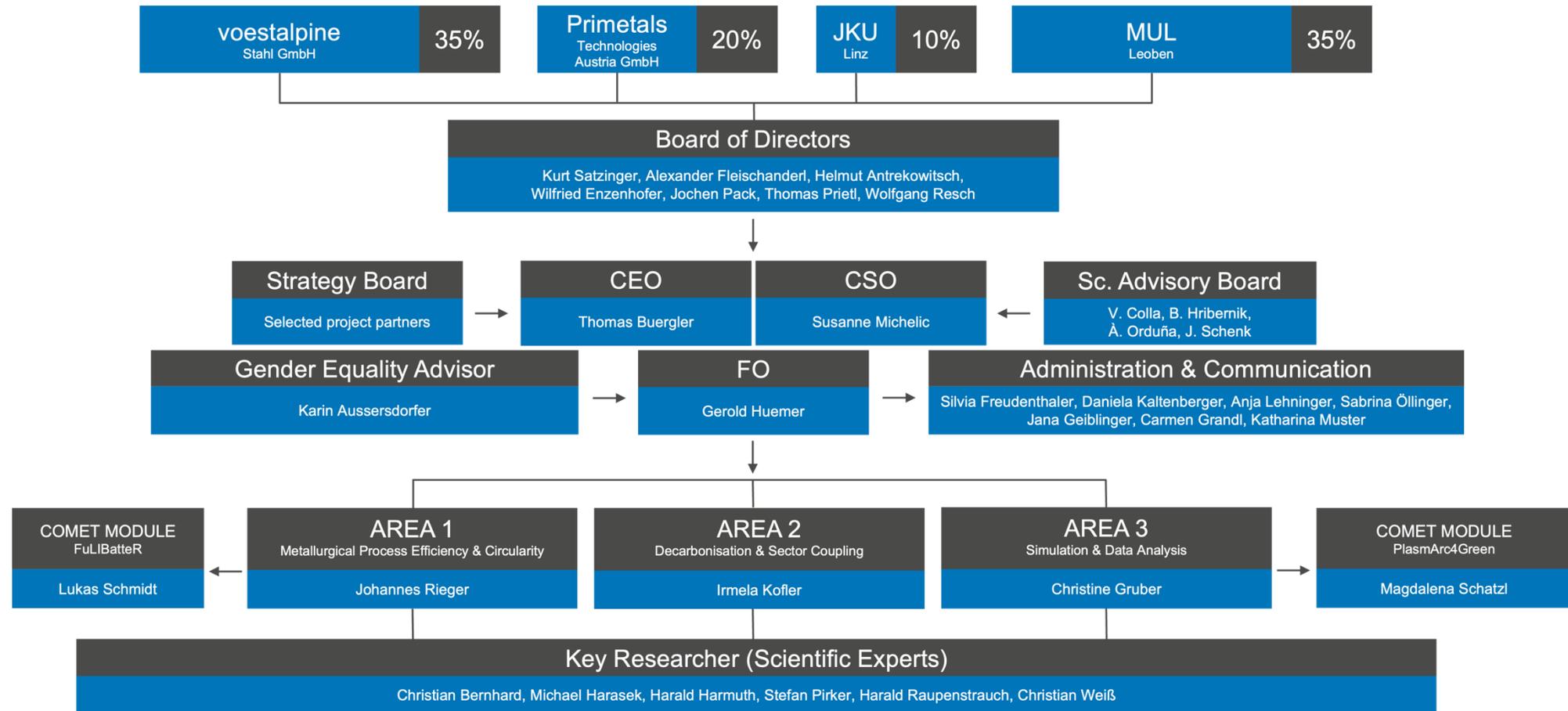


# K1-MET

## and some partner locations

<p><b>LEOBEN</b> Technical University of Leoben (Branch office)</p> 	<p><b>WELS</b> University of Applied Sciences Upper Austria</p>  	<p><b>GRAZ</b> Graz University of Technology</p>  	 
<p><b>LEOBEN</b> K1-MET GmbH (Branch office Riverside)</p>    	<p><b>LINZ</b> K1-MET GmbH (Headquarter HUB)</p> 	 	<p><b>LINZ</b> Primetals Technologies Austria GmbH</p> 
<p><b>LINZ</b> voestalpine Stahl GmbH</p> 	<p><b>VIENNA</b> Vienna University of Technology</p>  	 	<p><b>LINZ</b> Johannes Kepler University Linz</p> 

# Organizational structure of K1-MET GmbH

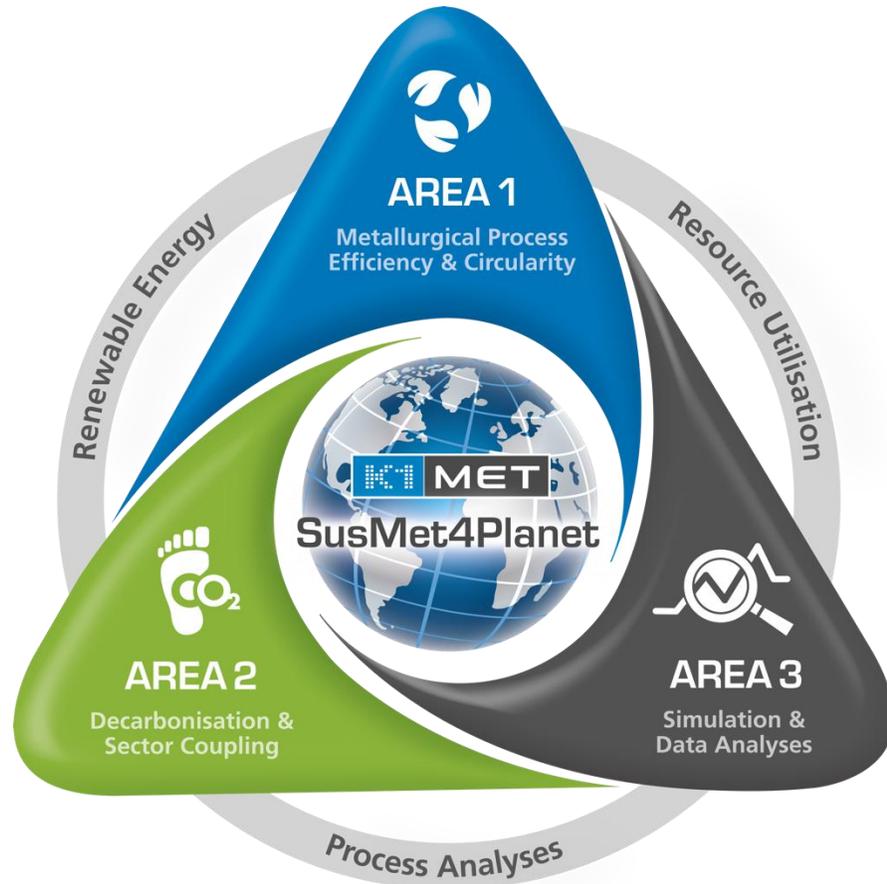


# Sustainable Development Goals (SDGs)

## Contribution of K1-MET towards a sustainable economy & society

- K1-MET is in accordance with the SDGs
- SDGs related to environmental (climate) impact
  - Energy efficiency and clean energy technologies – SDG 7
  - Increase resource efficiency in metallurgical processes – SDGs 8 & 9
  - Enhance utilization and recycling of metallurgical residues – SDG 12
  - Reduce CO<sub>2</sub> emissions – SDG 13
- SDGs related to human resources
  - Gender equality – SDG 5
  - Female employees in all organizational levels and uniform salary scheme
  - Current female share of K1-MET staff: 40 %
- Decent work and economic growth – SDG 8
  - 80 full time equivalents (full configuration)
  - 18 PhD Researchers planned (20 in total)
  - 10 Master students planned (40 in total)





## “Sustainable digitalized Metallurgy for a climate neutral and resource efficient Planet”

K1-MET addresses the challenges of the metallurgical industry in staying competitive and reaching climate neutrality

### Area 1: Metallurgical Process Efficiency & Circularity

Enhancement of process efficiency and product quality through analytics and treatment of raw and secondary materials

### Area 2: Decarbonisation & Sector Coupling

Solutions for climate neutral metallurgy and CO<sub>2</sub> as a source for the carbon cycle

### Area 3: Simulation & Data Analyses

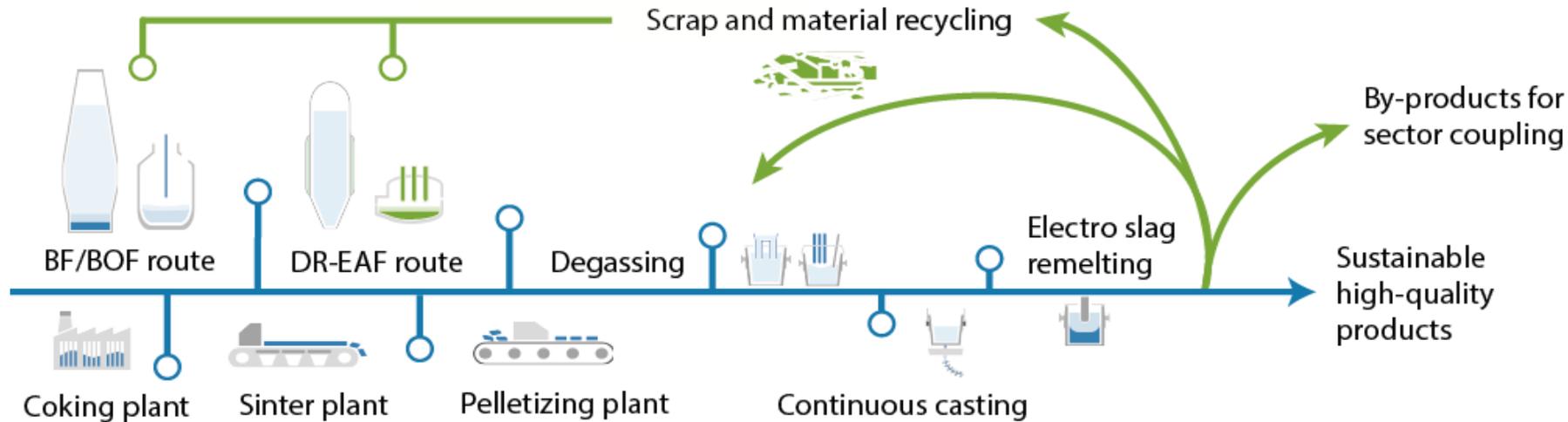
Application of modelling approaches to new and existing metallurgical processes and data analysis for an increase of process efficiency

- cross-sectorial consortium of 42 excellent national and international company and scientific partners from all over the world
- contribution to sustainability, efficient processes and climate neutrality for all energy intensive industry sectors, supported with increasing digitalization and superior product qualities
- Objectives:
  - Strategic goal 1: Increase process efficiency and strengthen circularity in metallurgy
  - Strategic goal 2: Push forward the decarbonisation of the metallurgical industry and sector coupling
  - Strategic goal 3: Generate and use of metallurgical process knowledge through digital technologies

# Area 1

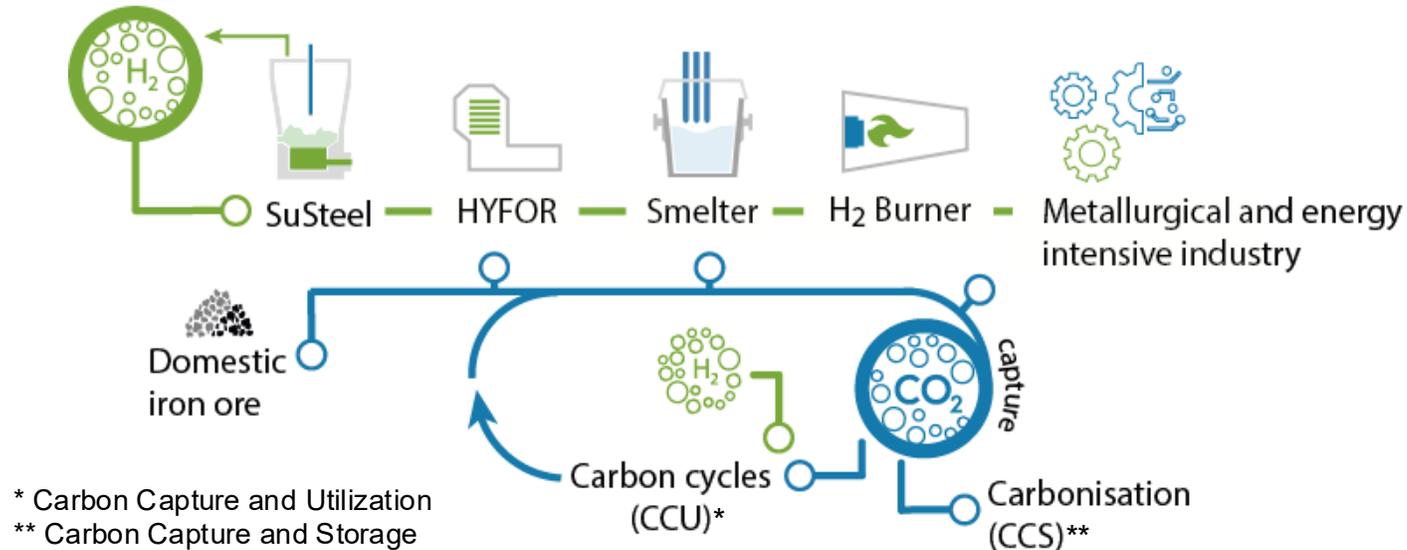
## Metallurgical Process Efficiency & Circularity

- Enhancement of resource and process efficiency for ferrous and nonferrous metal production/refining



- Advanced analytics of raw and recycled materials
- Sustainable sinter and low-emission BF-process
- Resource efficient copper refining process
- Sustainable continuous casting process
- Inclusion removal and steel cleanliness
- Sustainable processing of solid residue streams
- Valorisation of steelmaking slags
- Insights into metallurgical processes (experiments and thermodynamics)

- Carbon direct avoidance (CDA) and carbon capture and utilisation/storage (CCU/S) processes for climate neutrality in 2050



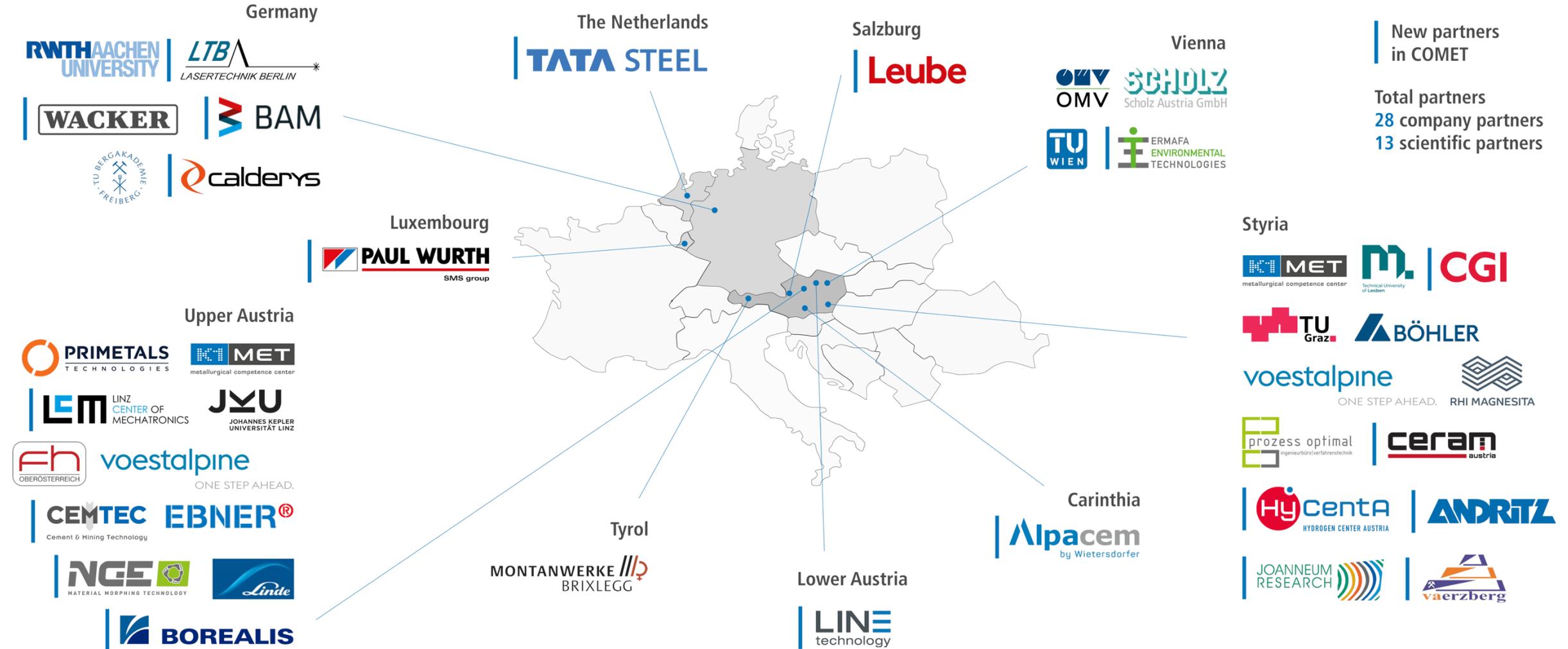
- Continuous H<sub>2</sub> Plasma Smelting Reduction (HPSR) process development
- Domestic ore for green steel
- Carbonisation
- Energy efficient CCU process
- Green smart furnaces
- Smelter development for net zero-carbon steelmaking
- Flowsheet modelling for CO<sub>2</sub> reduction
- Alternative iron and carbon sources

- Application and implementation of insights for process optimization in metallurgical processes:
  - Development of simulations and simulation methodology and application to steelmaking
  - Extended process data analyses (big data and machine learning)
  - Connection to domain knowledge for industrial process optimization
- Multiphase fluid modelling and simulation
- Multi-scale and reactive granular flows
- Advancement of simulation acceleration for process applications
- Hybrid modelling



# Partners and locations of the COMET programme

## Austria and Central Europe



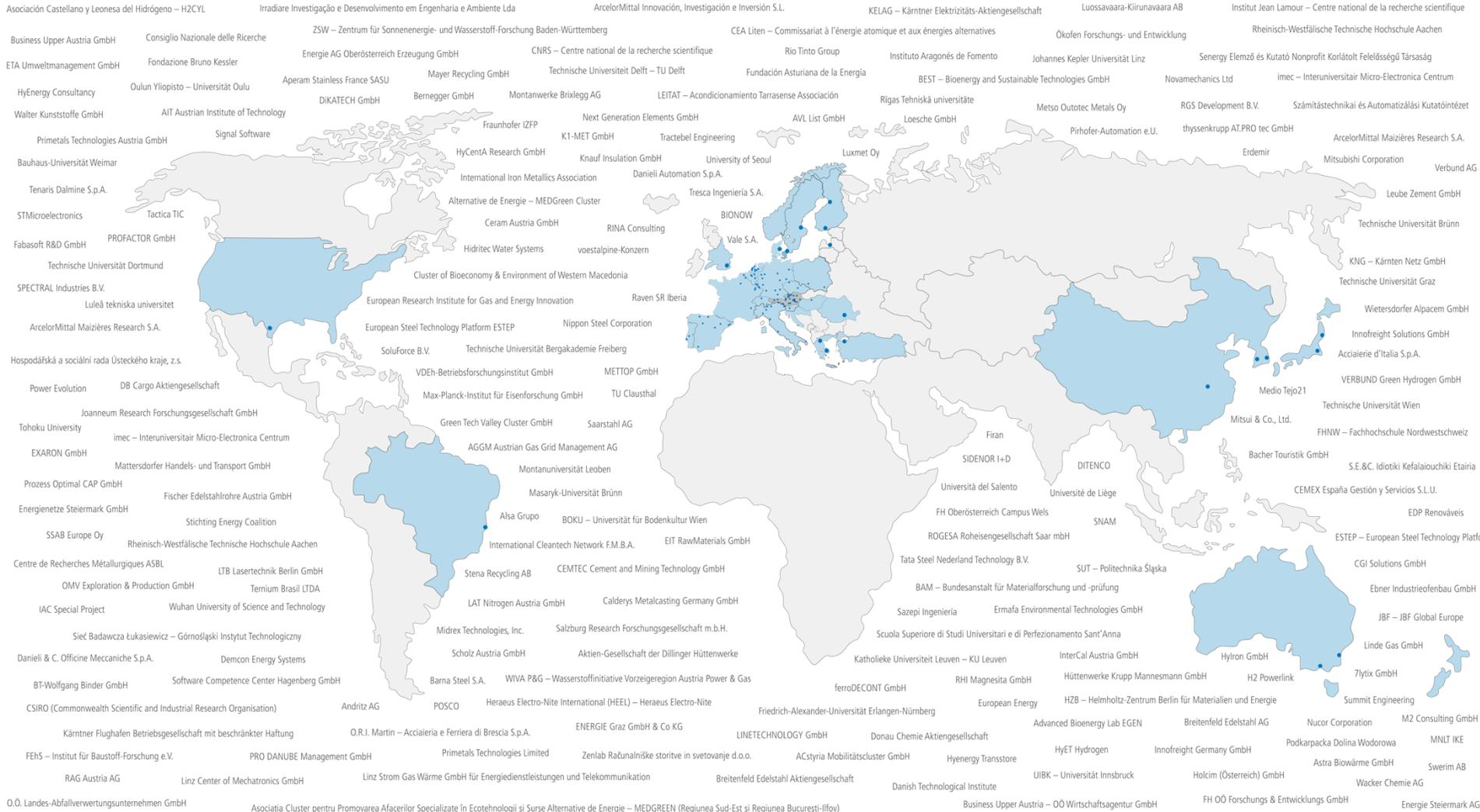
# Partners and locations of the COMET programme

## Northern Europe and South America



# Partners of K1-MET and locations

## Cooperations around the World



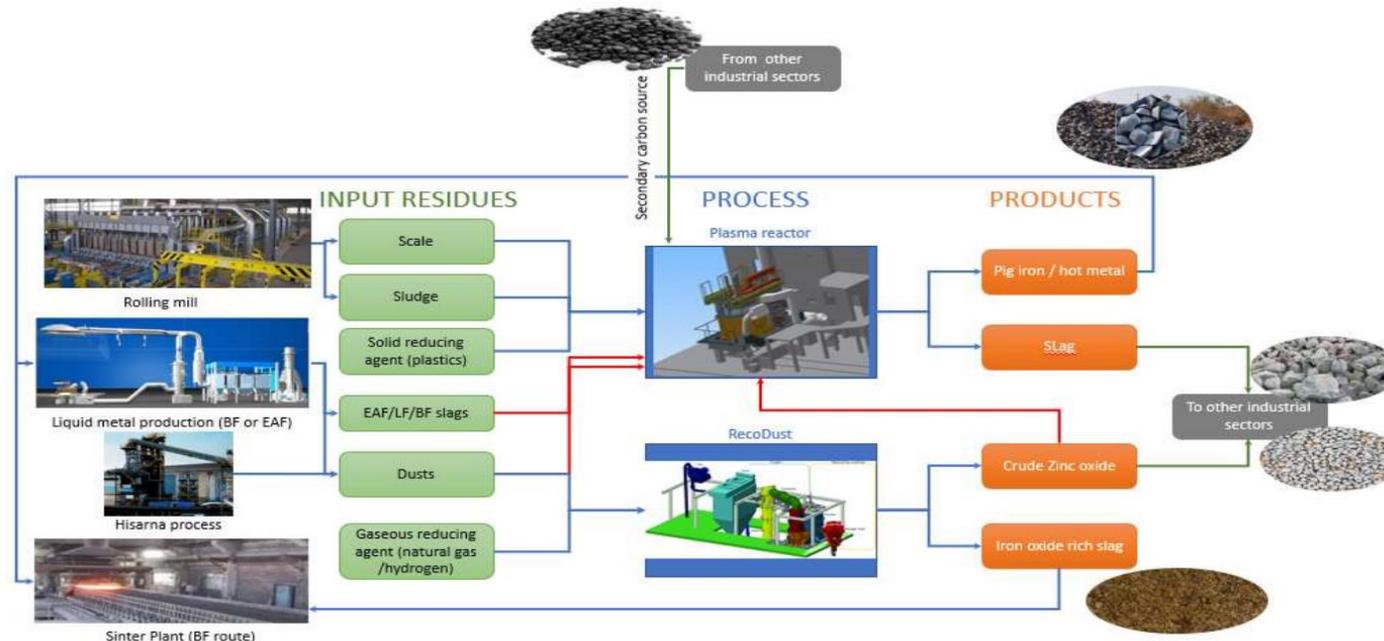
232  
PARTNERS

# EU funded project ReMFra

Horizon Europe/Clean Steel Partnership (HEU/CSP)

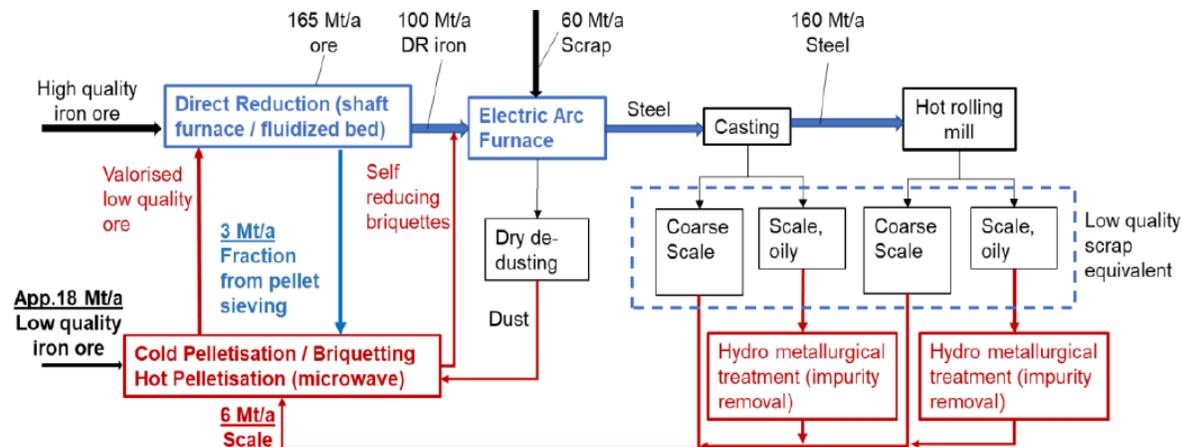


- “Recovering metals and mineral fraction from steelmaking residues”
- Demonstrate and qualify a complete system for the recovery and the valorization of the metal and mineral fractions contained in steel making processing residues
- **Project consortium:** Tenaris, Tenova, RINA-CSM, ESTEP, FEhS, thyssenkrupp Steel Europe, Tata Steel, Celsa, voestalpine Stahl, K1-MET



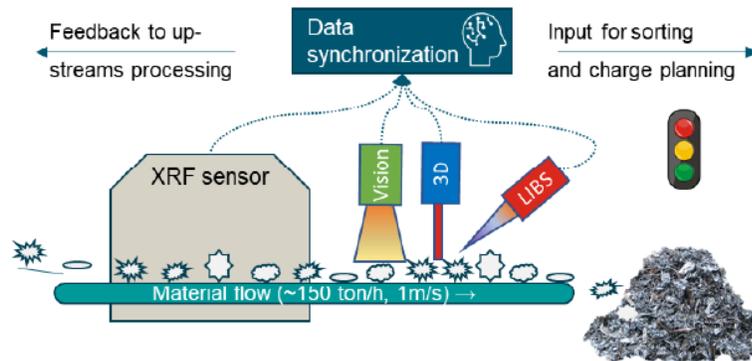


- „Upgrading of low-quality iron ores and mill scale with low carbon technologies”
- Concepts for the use of low-quality iron ore and mill scale
- New/alternative treatment technologies and material use decision support tool based on Life Cycle Assessment for low-grade ores and residues (see Figure below, parts being in the focus of the project marked in red)
- Project consortium:** Luxemburg Institute of Technology, BFI, Celsa, University of Valencia, Inceinmat, Dillinger Huettnerwerke, Instituto de Soldadura e Qualidade (ISQ), ESTEP, Advanced Management Solutions, Lukasiewicz Research Institute, CSIC, K1-MET





- „Purity improvement from scrap metal”
- Increase the purity of shredded old scrap through a coupled optical and spectroscopic analyses at the scrap yard and use of artificial intelligence for optimized data synchronization
- Demonstrate the suitability regarding the use of the sorted old scrap to produce standard quality steel grades
- **Project consortium:** SWERIM, SSAB, Redwave, SSSA, Danieli, Lulea University, Spectral Industries, TU Dortmund, voestalpine Stahl Donawitz, Stena Recycling, ESTEP, K1-MET



# RFCS Project InSGeP

## Investigations of Slags from Next Generation Steel Making Processes

The InSGeP project aims to understand the potential impact of next generation steel production on the resulting slag. Thus, their chemical, mineral, ecological and physical properties are analyzed and evaluated.



### Partner

The consortium consists of 5 steel plants, 6 RTOs and 2 plant manufactures from Austria, Belgium, France, Germany, Italy and Spain.

### Project Duration



The project has a duration of 48 months starting from 01 July 2023.

### Project Activities



InSGeP involves 6 work packages, 23 tasks, 20 deliverables & 6 milestones.

### Funding



The project receives funding of the European Commission from the Research Fund for Coal and Steel.

INSTITUT FÜR  
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FORSCHUNG **FEhs**



saarstahl

tenova



sidenor



Bfi  
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PRIMETALS  
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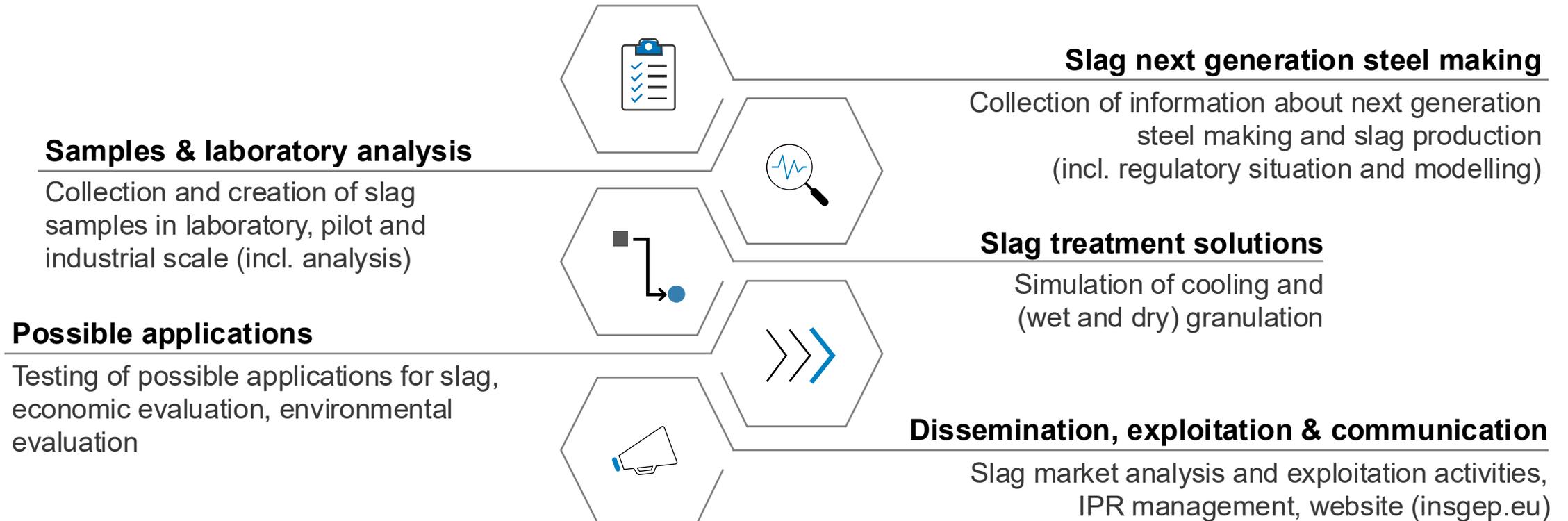
voestalpine  
ONE STEP AHEAD

K1 MET  
metallurgical competence center

Sant'Anna  
School of Advanced Studies - Pisa

RIA





## Hauptziele

- Phosphor durch biologische Laugung aus Klärschlammaschen herauslösen
- Ammoniumphosphatdünger herstellen
- Düngerwirkung an Modellpflanzen testen



### Partner

Das Konsortium besteht aus **4 wissenschaftlichen Partnern** aus Österreich und Tschechien

### Projektlaufzeit



**36 Monate**, laufend seit 01.05.2024

### Förderung



Das Projekt wird aus **Mitteln des EFRE** gefördert (80% Förderquote)



**K1-MET:** Koordination, Laugungsexperimente und Herstellung des Phosphatdüngers



**BOKU, Institut für Abfall- und Kreislaufwirtschaft, Wien:** Biolaugungsversuche, Bewertung des Prozesses



**Masaryk Universität, Brunn:** Metallanalytik, Pflanzenversuche im Gewächshaus, Bodenuntersuchungen



**Technische Universität Brunn**  
Herstellung verschiedener Klärschlammaschen im Technikum

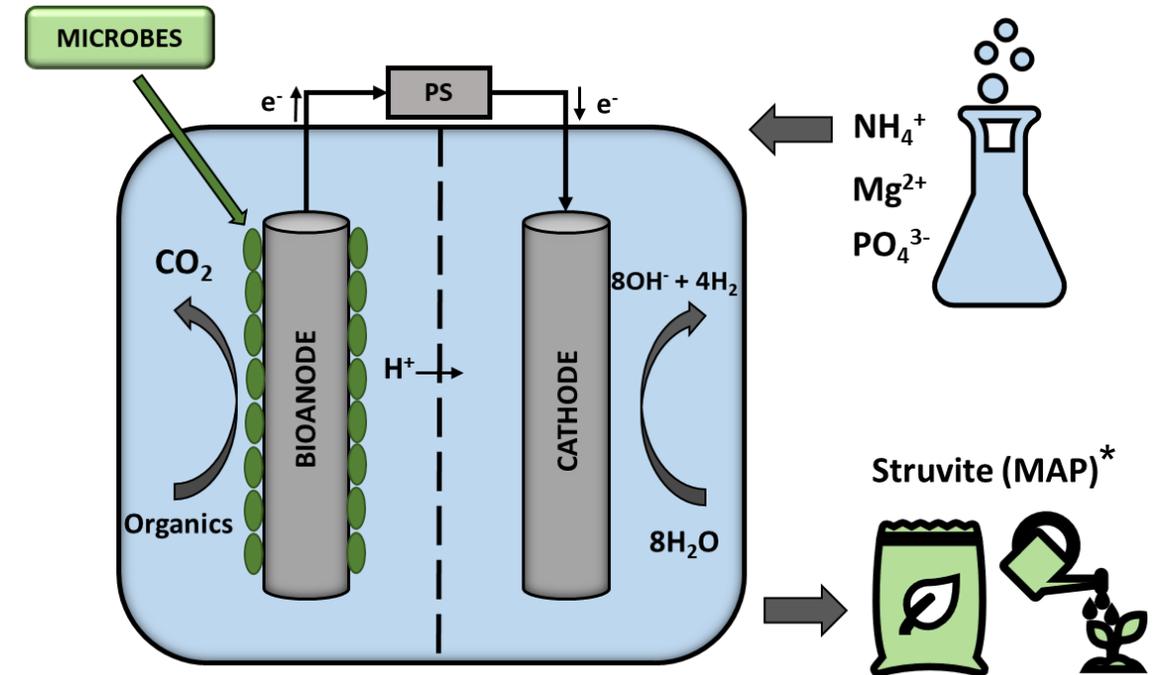
### Bioanode

- Besiedelt von elektroaktiven Mikroorganismen
- Oxidieren organische Substanzen (z.B. Abwasser)
- Elektronen werden von Mikroorganismen an Anode abgegeben



### Kathode

- Reduktion von Wasser, pH Anstieg
- Phosphorrückgewinnung als Struvit (Mg-Ammonium-Phosphat) durch Fällung mit Mg und N bei pH 8-10



\* Magnesium-Ammonium-Phosphat



## Future Lithium Ion Battery Recycling for Recovery of Critical Raw Materials

Module within the **COMET** – Competence Centers for Excellent Technologies Program focusing on:

- Waste management and waste technological approaches for lithium-ion-battery (LIB) recycling
- Pyrometallurgical processing of LIBs and black matter
- Bio-hydrometallurgical treatment of LIB residues

**Project Period:** 01/07/2022 – 30/06/2026

Financially supported by:

Federal Ministry Economy, Energy and Tourism Republic of Austria

Federal Ministry Innovation, Mobility and Infrastructure Republic of Austria



Company partners:



*Saubermacher*



voestalpine

ONE STEP AHEAD.

Scientific partners:



Coordinated by:



# COMET Modul FuLIBatteR

Future Lithium-Ion Battery Recycling for Recovery of Critical Raw Materials



## Module Consortium



B·R·A·I·N

EBNER®



RHI MAGNESITA

Saubermacher



voestalpine

VTU



Technical University  
of Leoben



acib



Coventry  
University

## Funding

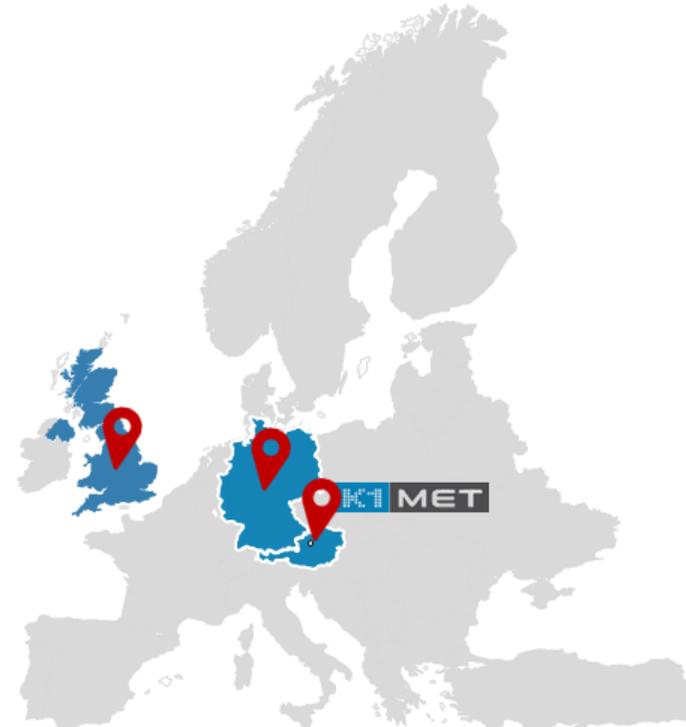


Federal Ministry  
Economy, Energy  
and Tourism  
Republic of Austria

Federal Ministry  
Innovation, Mobility  
and Infrastructure  
Republic of Austria



UAR INNOVATION  
NETWORK

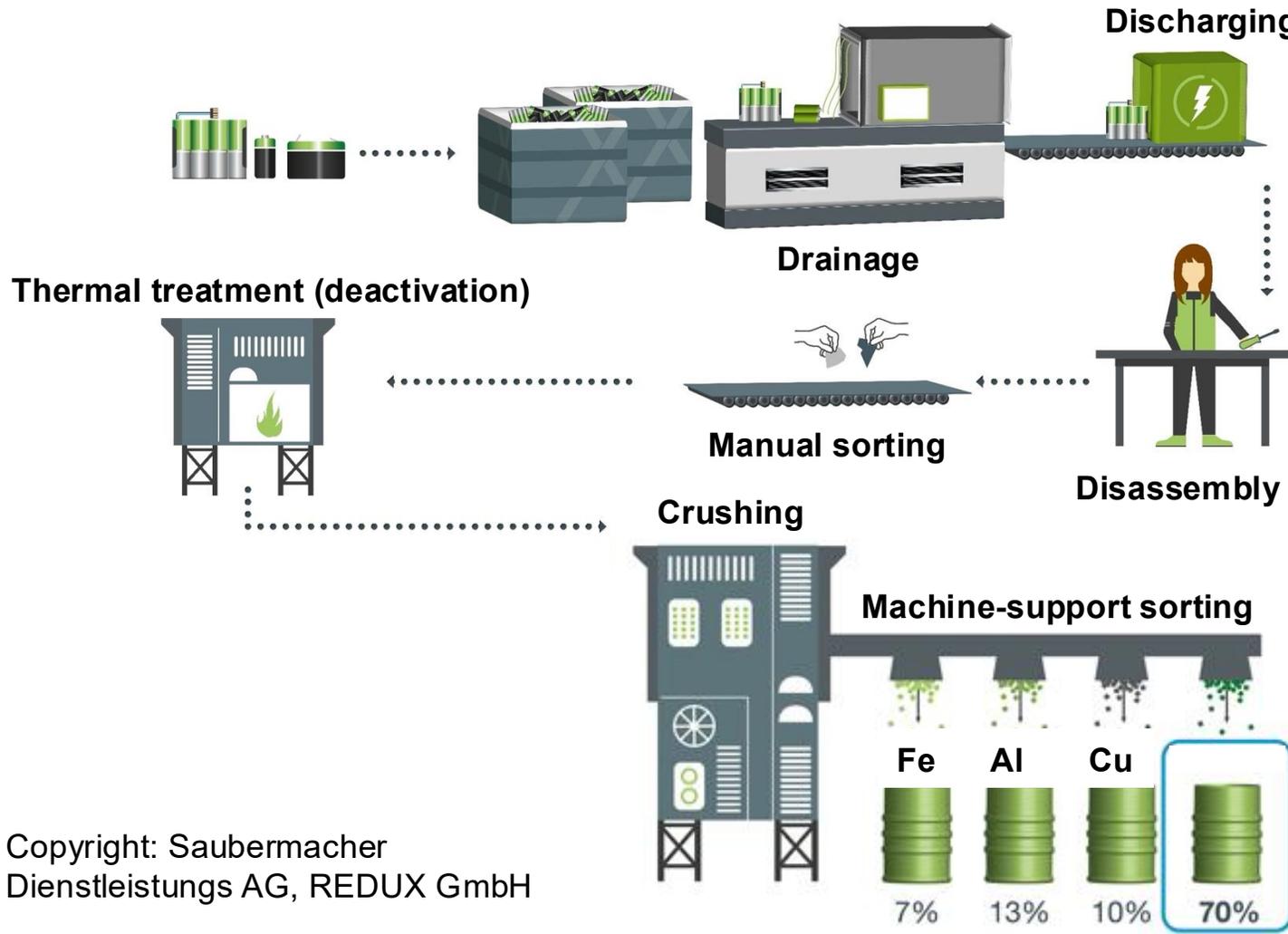


# Batteries as a source for secondary alloys

Austrian funded project „FuLIBatteR“



## Future Lithium Ion Battery recycling to recover critical raw materials



Federal Ministry  
Economy, Energy  
and Tourism  
Republic of Austria

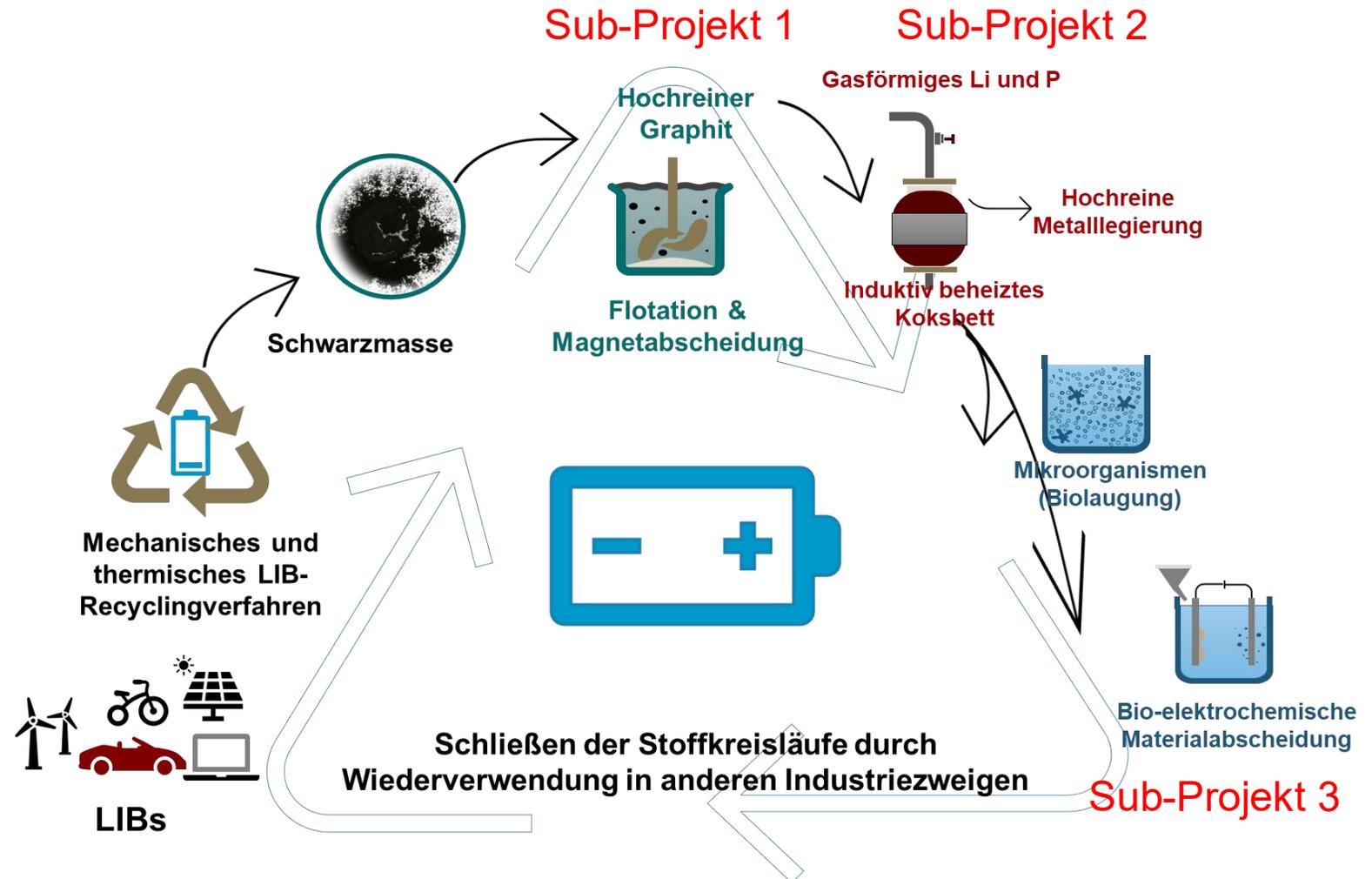
Federal Ministry  
Innovation, Mobility  
and Infrastructure  
Republic of Austria

- Austrian funded project (3.8 M€, 2022-2026)
- Fundamental project to **selectively recover (critical) raw materials** Li, Cu, Ni, Co, P, C from the active material
- **Different approaches**
  - Physical separation (flotation)
  - Pyrometallurgical treatment
  - Bioleaching and electrochemical metal separation



**Active material**  
(= starting point)

- Feinkörniges **Aktivmaterial (Schwarzmasse)** nach dem thermisch-mechanischen Batterierecyclingprozess als Startpunkt
  - Macht rund 70% des Batteriegewichts aus und enthält bis zu 40 Gew.-% Graphit sowie Li, Co, Mn und P
  - Derzeit noch keine Verfahren zur (möglichst) **selektiven Rückgewinnung von Wertstoffen**



# Zero emissions through sector coupling

## Industrial symbiosis



Type:	Flagship project
Costs:	16.7 M€
Funding:	7.6 M€
Funding Agency:	Climate and Energy funds
Duration:	10/2023 - 09/2027 (4 years)



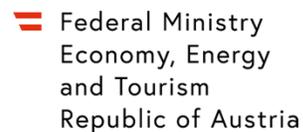
### Project Goals

- Cost-optimized **green hydrogen** production to **balance the electricity grid**
- Demonstration of **CO<sub>2</sub>-capture and utilization (CCU)** process chains at TRL=7 to close the **CO<sub>2</sub>-cycle**
- Accelerate **technology transfer** into practice
- Identify **synergies** between **energy intensive** industries
- **Techno-economic** analysis

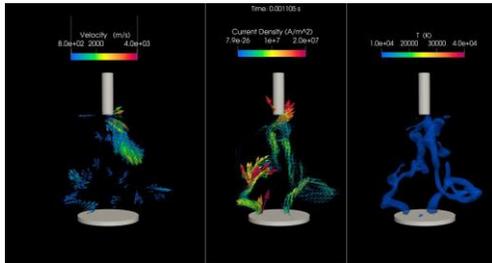


## SIMULATION, MODELLING AND MONITORING OF PLASMA AND ARC BASED PROCESSES FOR GREEN METAL PRODUCTION

<b>Project Budget:</b>	3 750 000 €
<b>Funding:</b>	3 000 000 €
<b>Module Duration:</b>	01 July 2024 – 30 June 2028
<b>Funded by:</b>	BMK, BMAW as well as federal provinces of Upper Austria, Styria and Tyrol

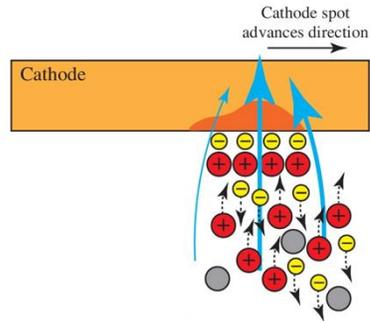


- Project 1 – Bulk Plasma Properties and Dynamics



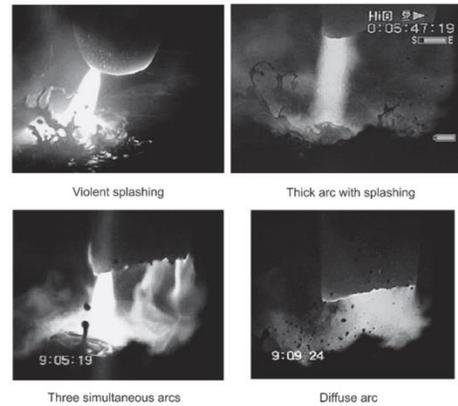
[Reference: A. Kharicha]

- Project 2 – Plasma-solid interaction

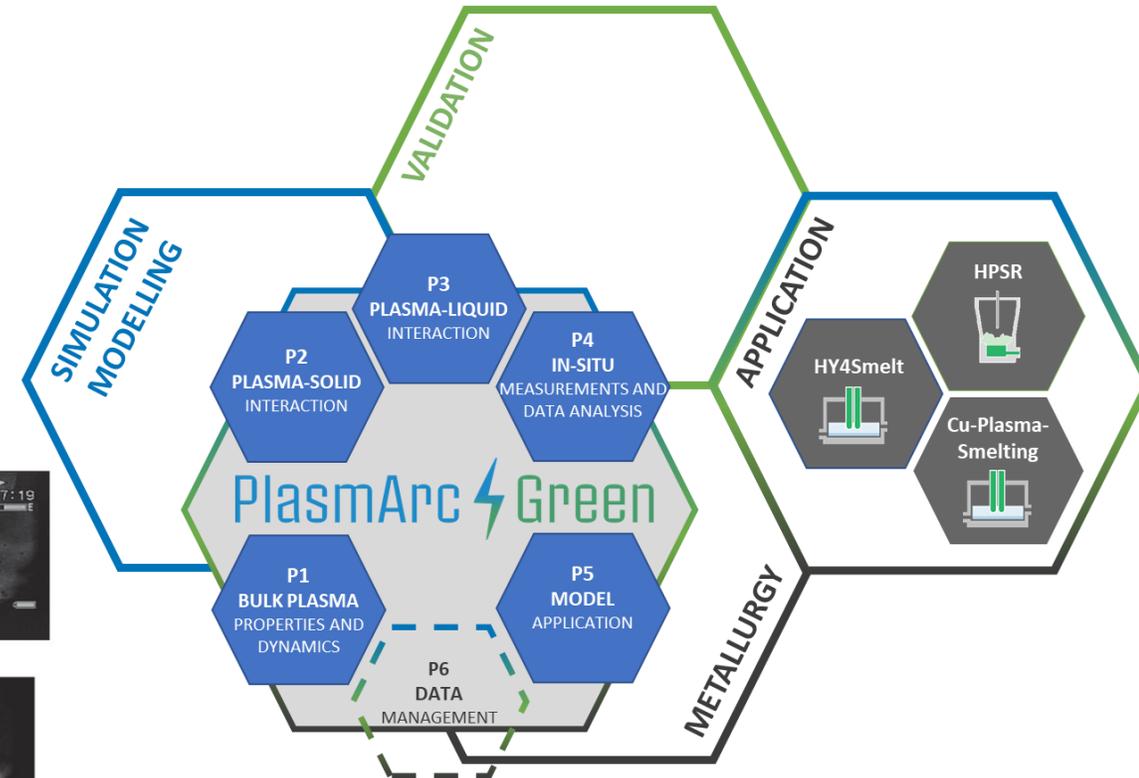


[Z. Ren et al, 2022]

- Project 3 – Plasma-liquid interaction



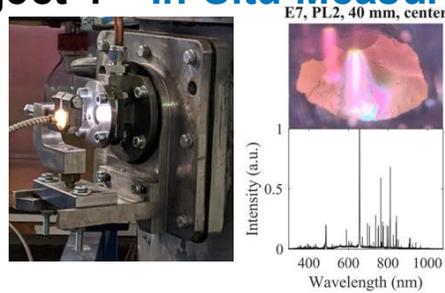
[Jones et al., Minerals Engineering, 2002]



# COMET Module – PlasmArc4Green

## Plasma modelling and experimental validation

### Project 4 – In-Situ Measurements and Data Analysis



[Pauna et al., 2022]

### Project 5 – Model Application

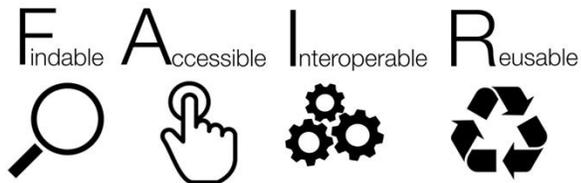


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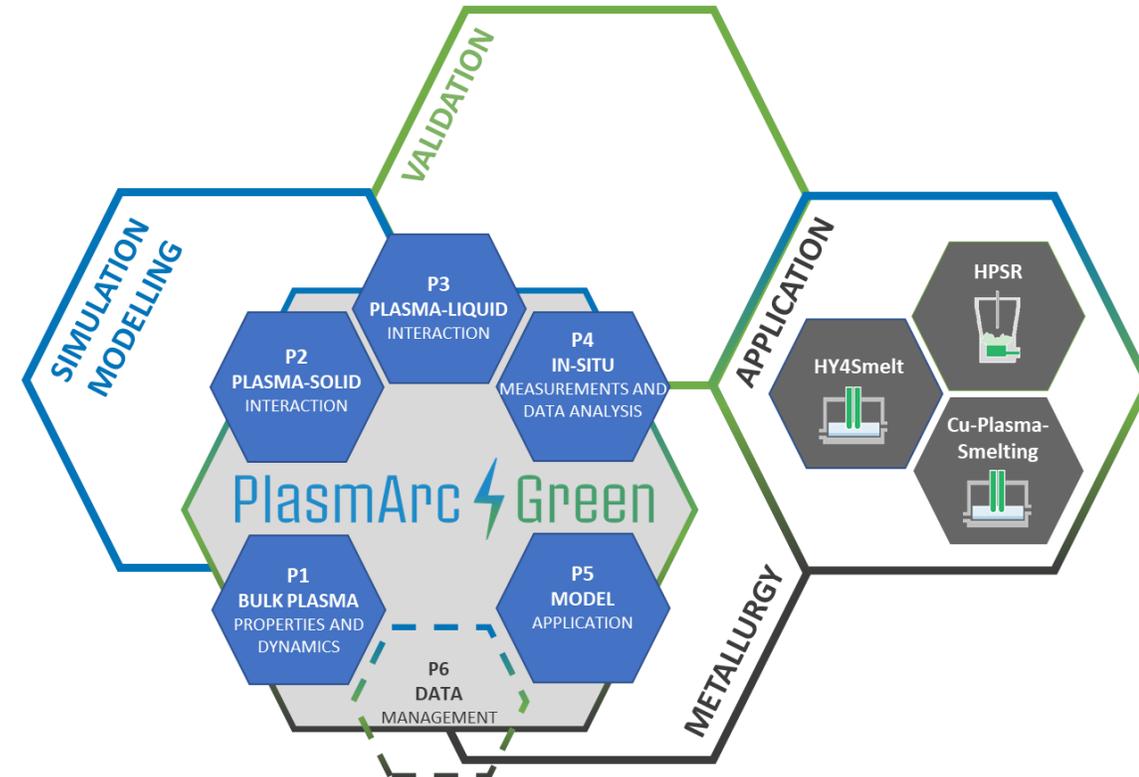


Reference: voestalpine

### Project 6 – Data Management



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(<https://creativecommons.org/licenses/by-sa/4.0/>)]

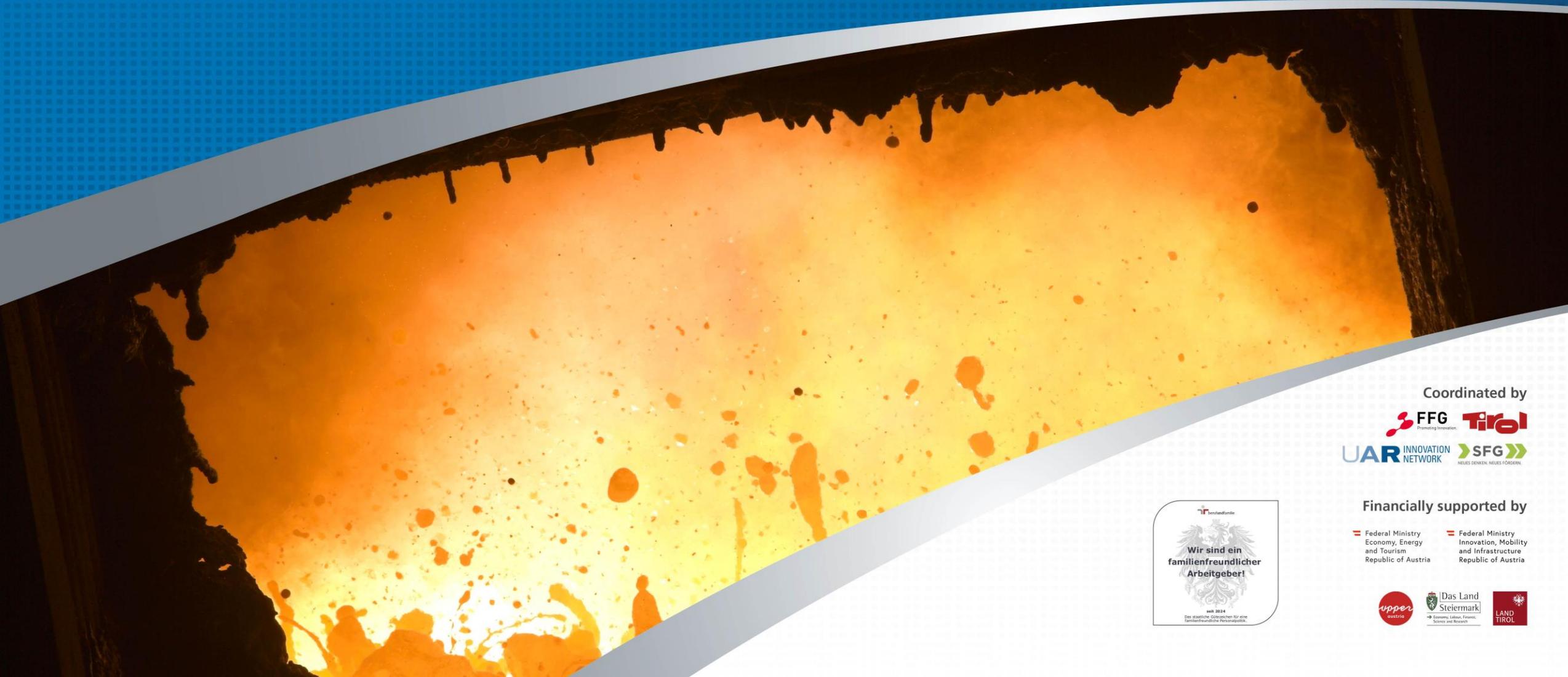


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