GreenTech Solutions Summit

Boostez votre transformation et votre entreprise

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Grande Région | Großregion

GREEN BUSINESS EVENTS.

GREATER GREEN

Modérateur

Caroline Muller

Luxinnovation

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Grande Région | Großregion

Industrie
Technologies de recyclage

Ralph Useldinger
Ceratizit Luxembourg

Michael Wahl
Hochschule Trier, Umwelt-Campus Birkenfeld

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GREATER GREEN
Grande Région | Großregion

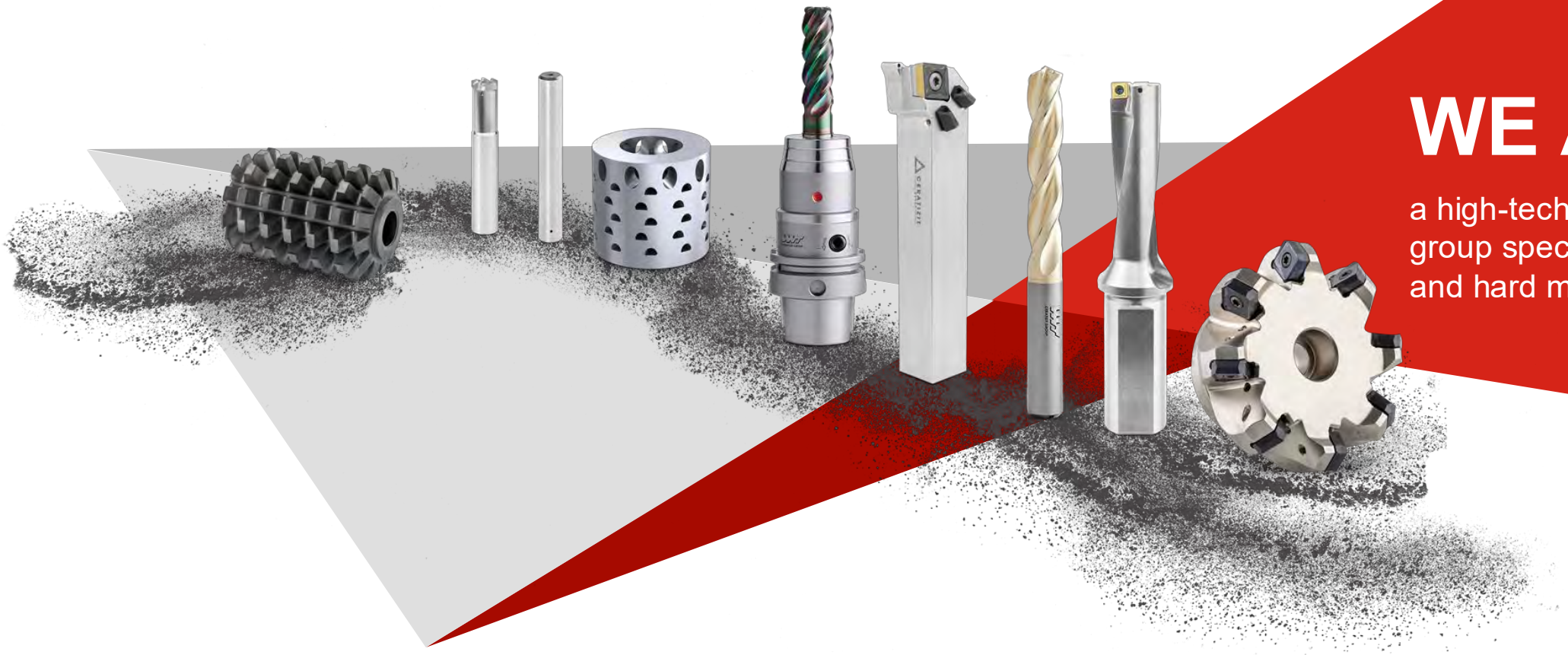
Sustainability considerations on hardmetals

R. Useldinger, U. Schleinkofer

CERATIZIT GROUP

Tooling a Sustainable Future – with passion

and a pioneering spirit for hard materials



WE ARE

a high-technology engineering group specialised in cutting tools and hard material solutions.

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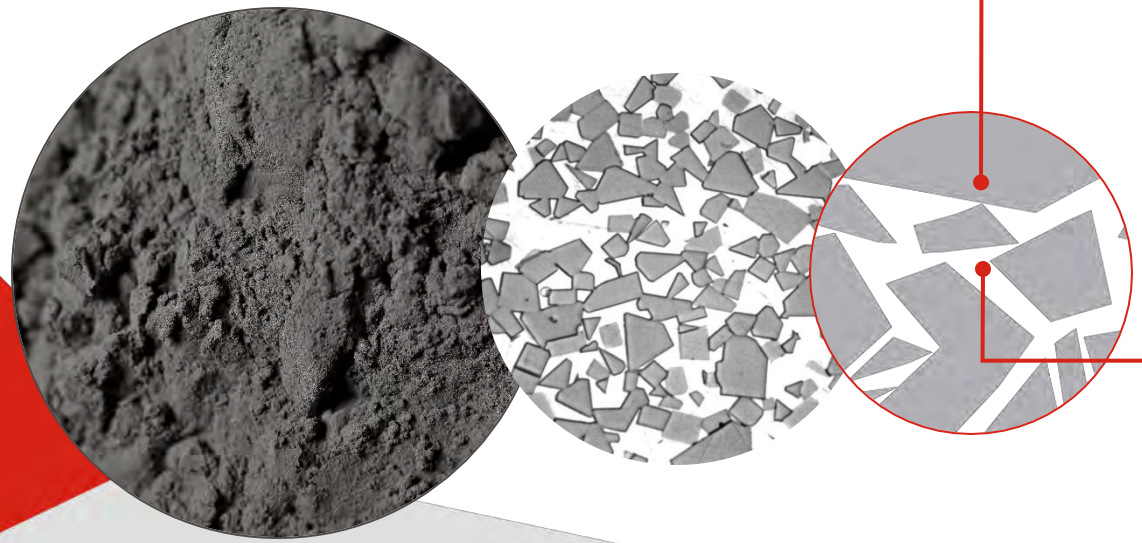
Public

Composition of cemented carbide

Hard phase and binder phase



Hard phase

(tungsten carbide, WC)

Hard material provides

- wear resistance
- hardness

Binder phase

(cobalt, Co)

The binder provides

- toughness

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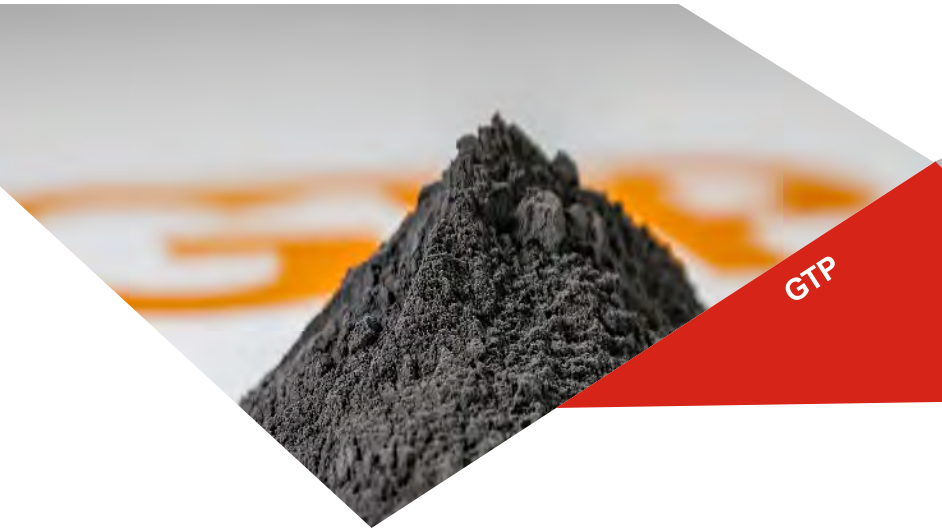
CERATIZIT

Three divisions – together #4!

Headquarters
Mamer, Luxembourg

Our vision: *#3 of the carbide industry*



GTP

Cutting Tool Solutions

Hard Material Solutions

€1.5 bn turnover

30 production sites

7 000 employees

100 000 products

25 innovation awards

80 countries in which we are active

200 R&D employees

1 000 patents & utility models

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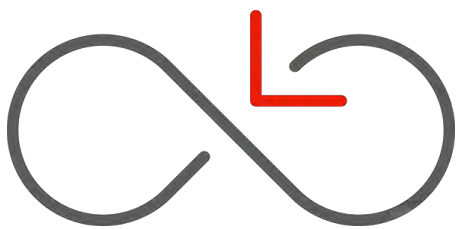
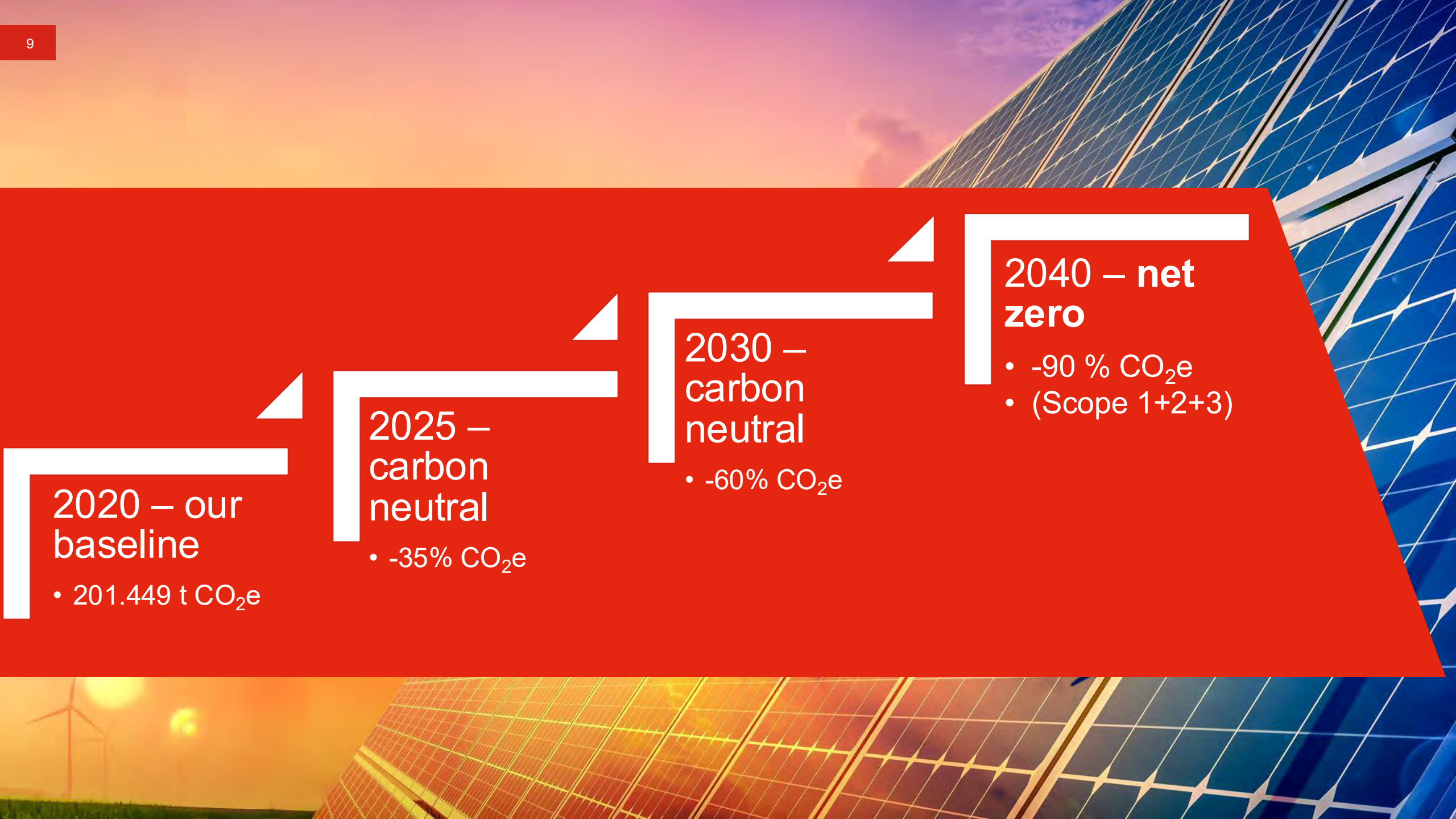
Closing the loop



Public



2020 – our baseline

- 201.449 t CO_2e

2025 – carbon neutral

- -35% CO_2e

2030 – carbon neutral

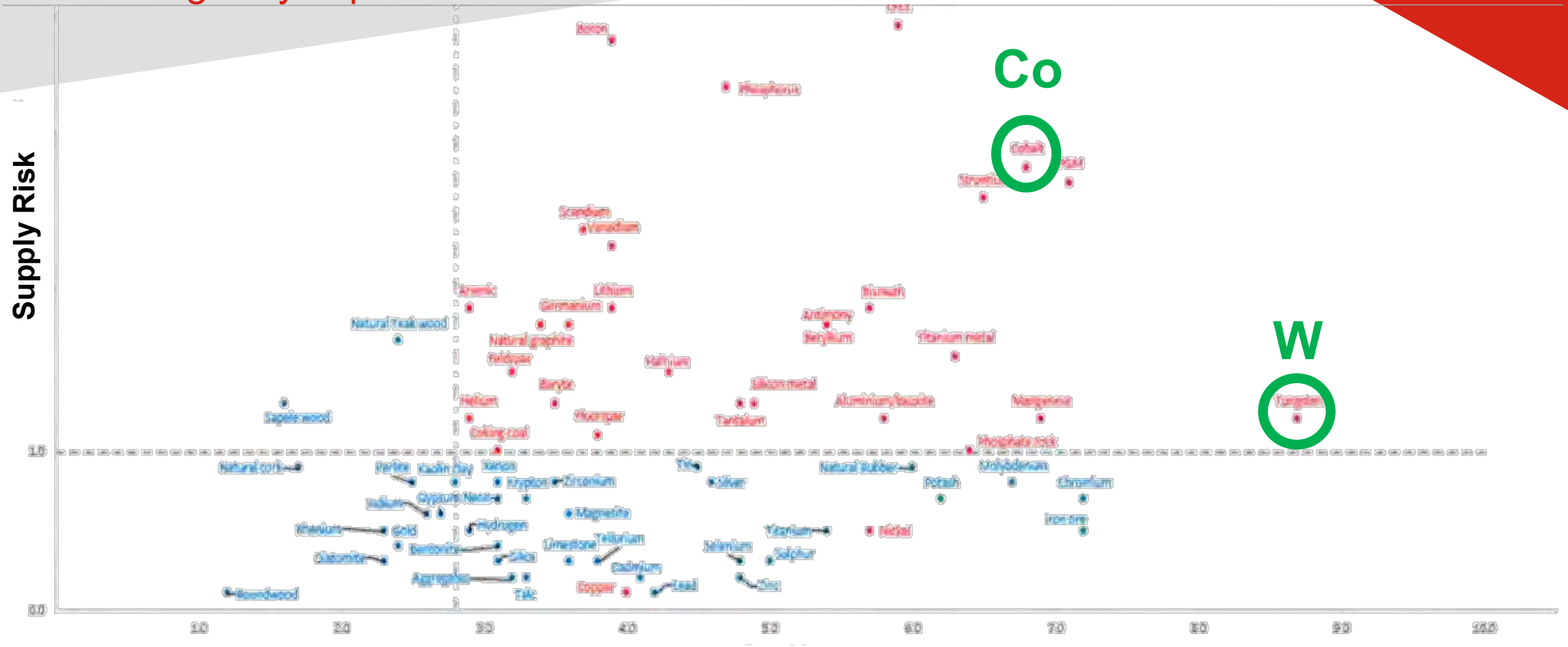
- -60% CO_2e

2040 – **net zero**

- -90 % CO_2e
- (Scope 1+2+3)

Tungsten (and Cobalt)

Strategically important raw material



Study on the Critical Raw Materials for the EU, European Union, 2023 doi:10.2873725585/

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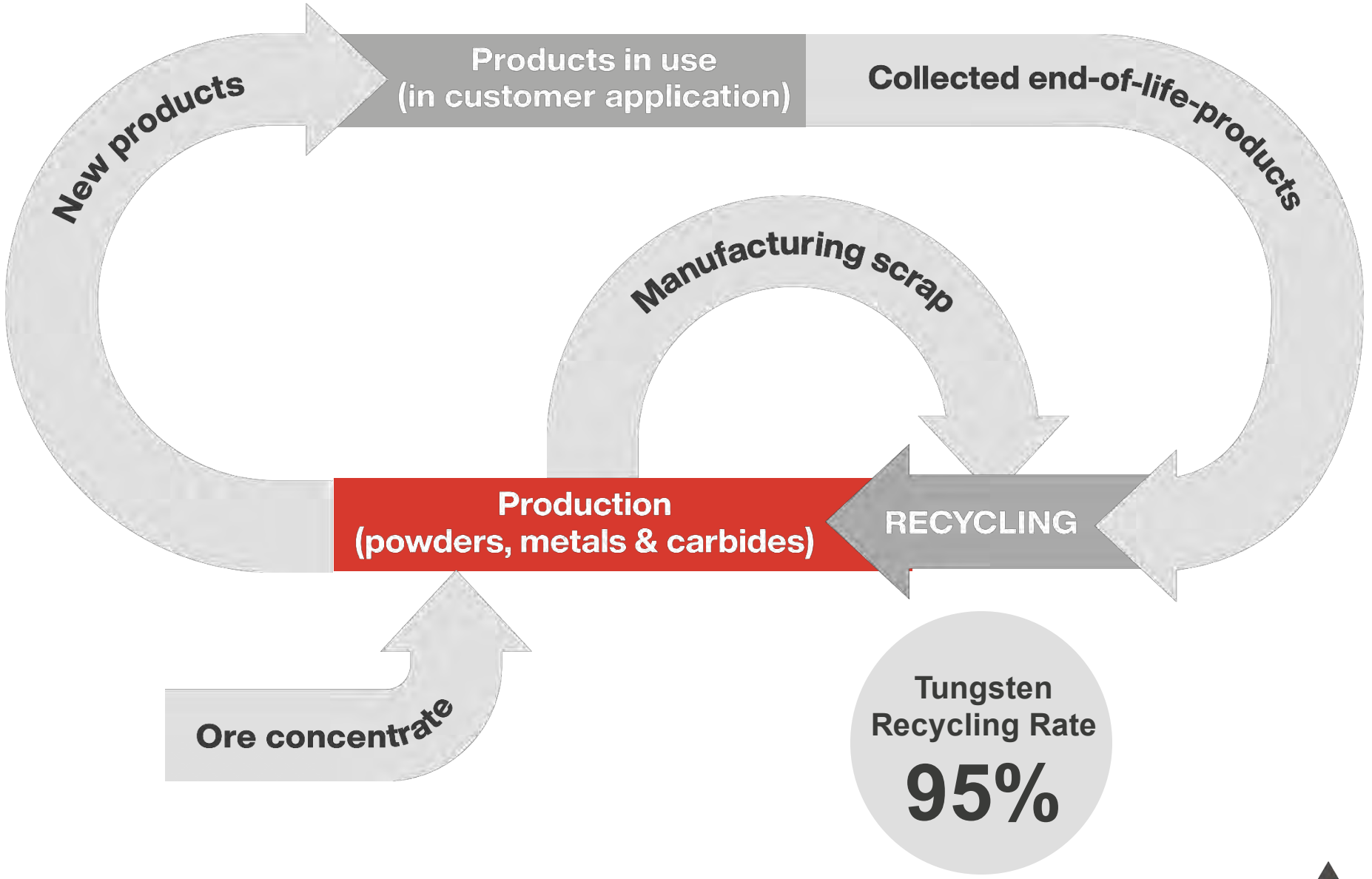
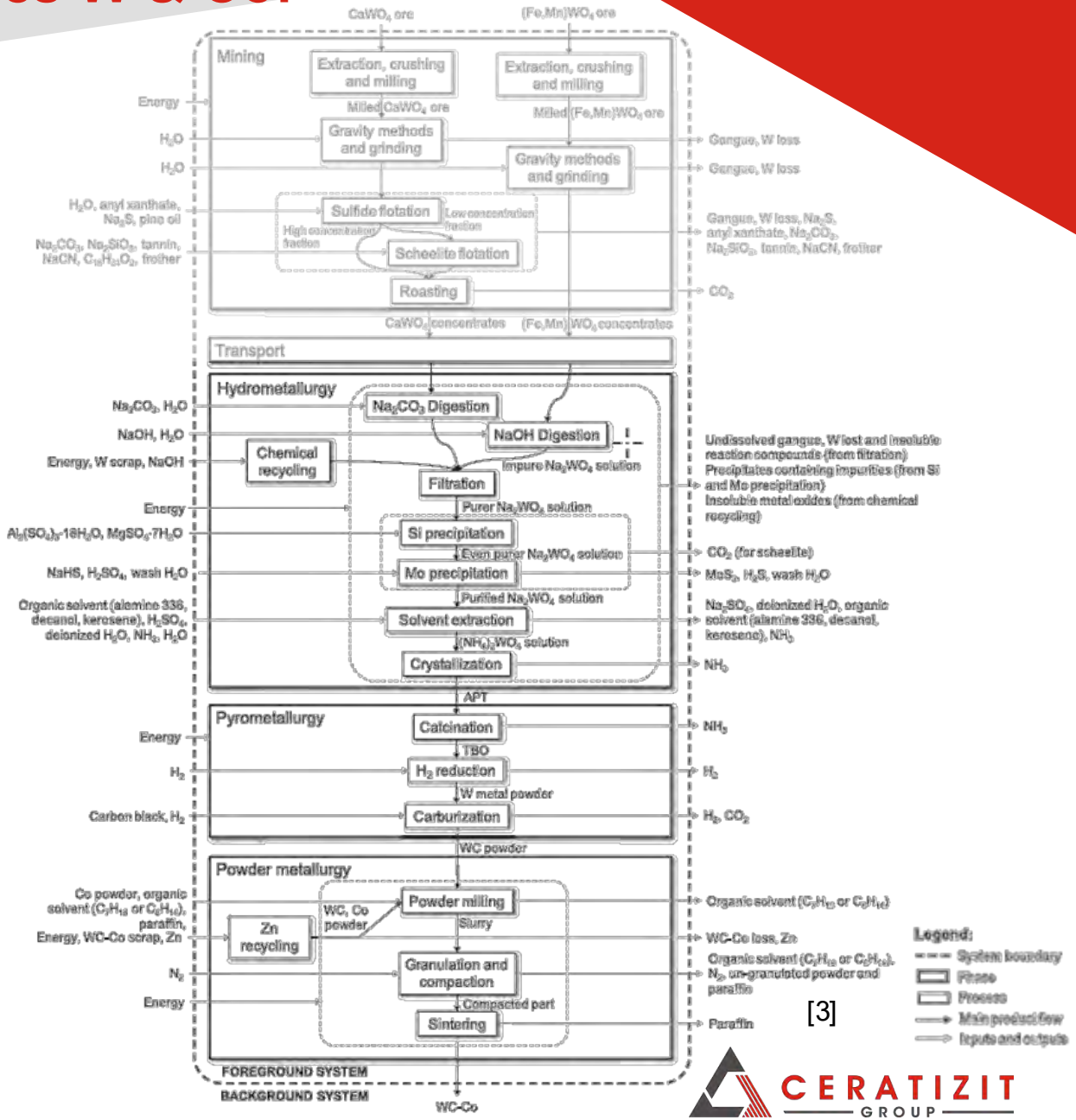
Closing the loop



Public

Conserving the limited natural resources W & Co:
Tungsten

- Tungsten is very scarce in the earth crust and has a very long process chain
- Recent technologies allow to extract W from natural resources in an economically viable way down to **0.06wt.%** [1]
  → To obtain **1 ton of tungsten**, **500 tons of ore** have to be mined and processed (typical ore 0.2%W content [2]).
  → Depending on the grade of cemented carbide, **1.1 to 1.54 tons of cemented carbide** can be produced from this



[1]: Qian Wen-Lian (Ed.), Technical Development in Processing Low Grade Tungsten Materials, 21st AGM ITIA, Xiamen Tungsten Co. Ltd, Xiamen, 2008
[2]: Leal-Ayala et al., Mapping the global flow of tungsten to identify key material efficiency and supply security opportunities, Resources, Conservation and Recycling 103, 2015, 19-28
[3]: Furberg a. et al, Environmental life cycle assessment of cemented carbide (WC-Co) production, Journal of cleaner production 209, 2019, 1126-1138

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Public

Conserving the limited natural resources W & Co

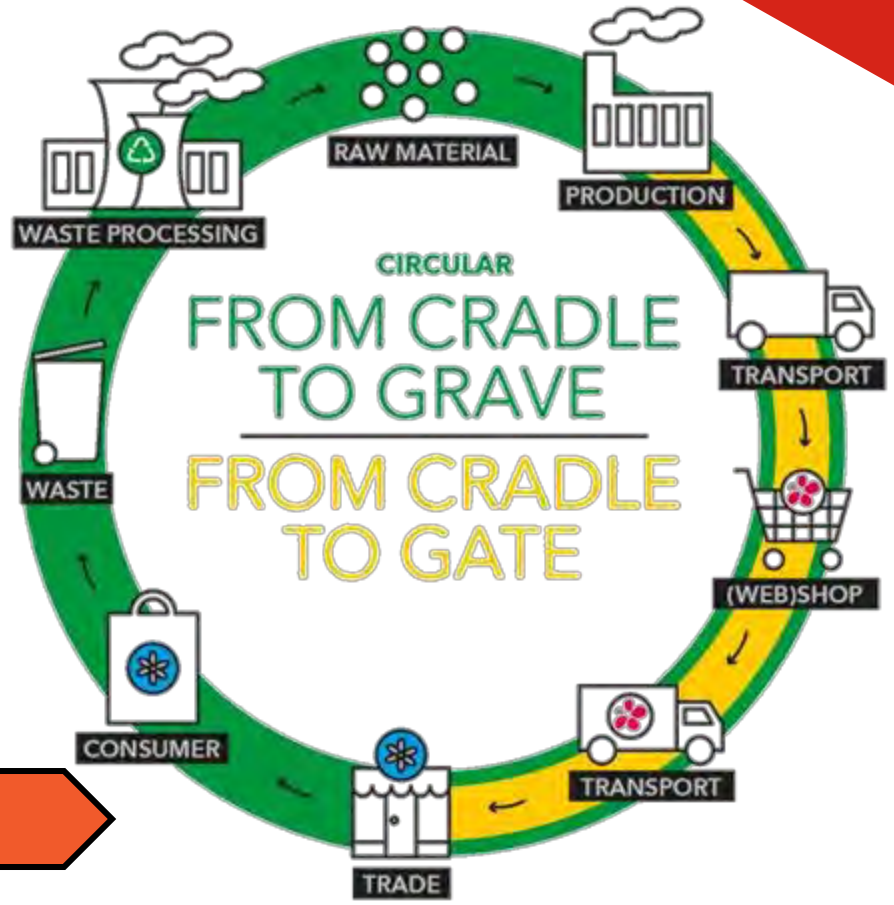
“3R” approach

Most preferable

Least preferable

Focus

- Prevention
- Reduction
- Reuse
- Recycling
- Energy Recovery
- Disposal



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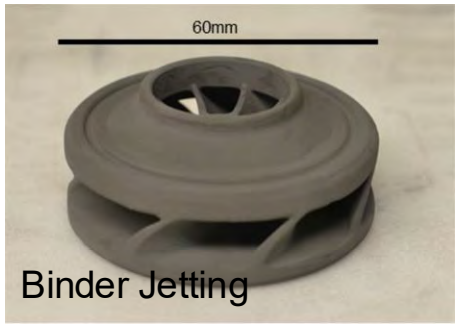
Conserving the limited natural resources W & Co

“3R” approach

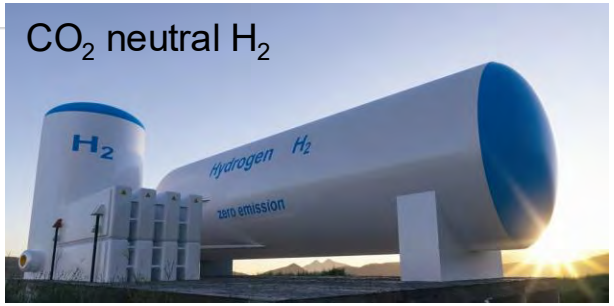
Reduction

- through near net shape production
- energy consumption & CO_2 reduction through better production processes
- material consumption through better product

→ **Doing more using less material**

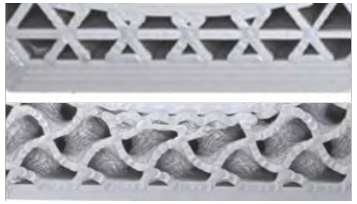


Binder Jetting



Examples:

- cutting inserts with multiple cutting edges and smaller size
- high performance products
- optimization of production through simulation
- 3D-printing


FFM

Conserving the limited natural resources W & Co

“3R” approach

Reuse

- reconditioning of worn tools

Examples:

- regrinding a worn rotary cutter to a slightly smaller diameter
- re-sharpen the cutting edge of a drill or circular saw to use it again

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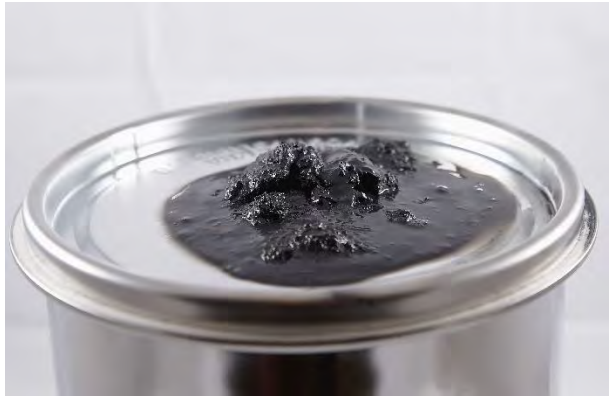
Conserving the limited natural resources W & Co

“3R” approach

Recycling

- Recover material from End-of-Life products
- Recover material from processing scraps



Examples:

- Hard scrap of used tools (coated and uncoated)
- Grinding sludge

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Conserving the limited natural resources W & Co

W recycling processes

- Recycling
  - APT production
  - Zinc processing
  - Binder leaching
- Downcycling
  - Hardmetal grit for hardfacing
  - W-source for HSS

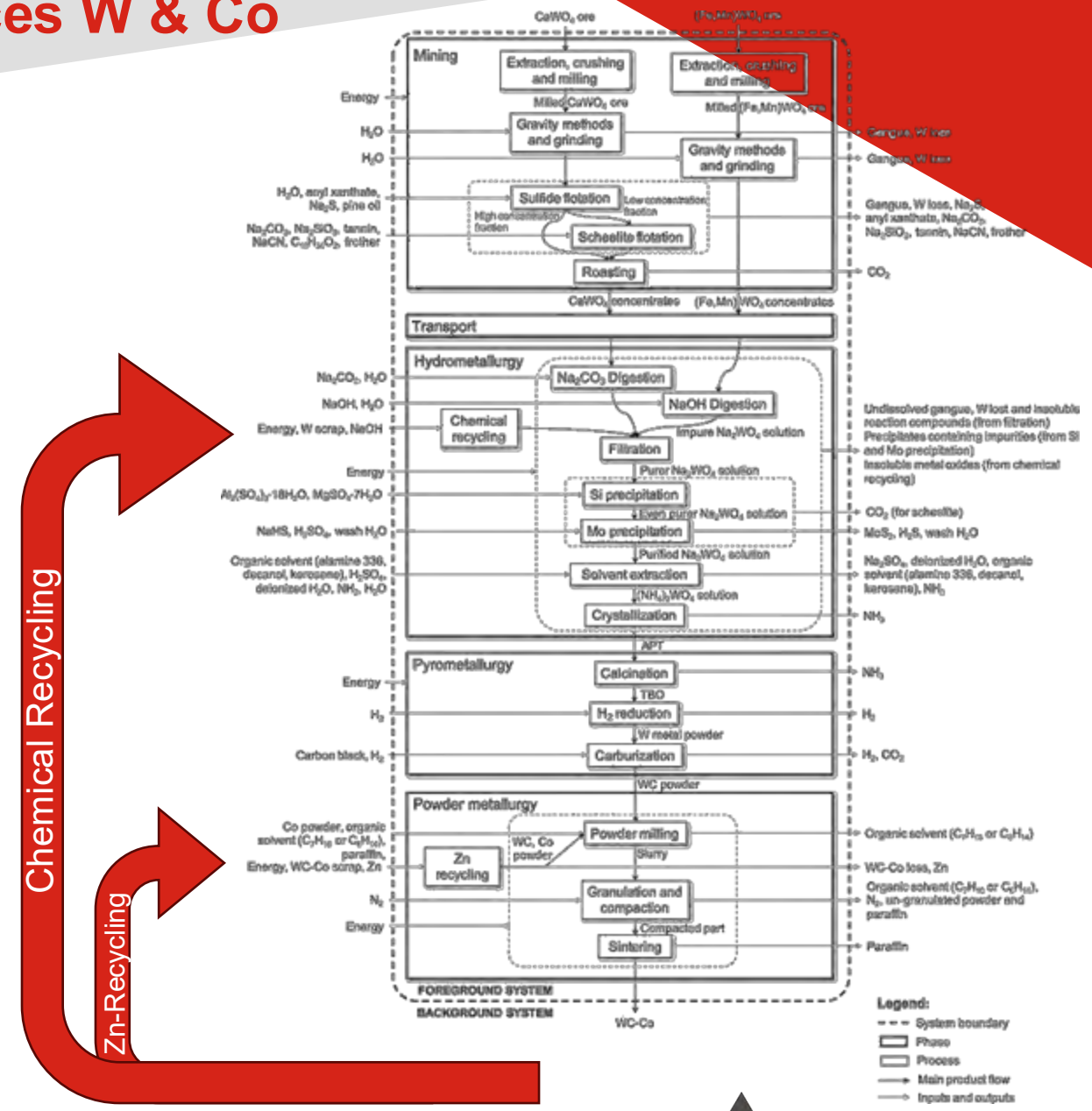
Furberg a. et al, Environmental life cycle assessment of cemented carbide (WC-Co) production, Journal of cleaner production 209, 2019, 1126-1138

Conserving the limited natural resources W & Co

W recycling processes

- Recycling
  - APT production
  - Zinc processing
  - Binder leaching
- Downcycling
  - Hardmetal grit for hardfacing
  - W-source for HSS
- Collection, processing, and trade of secondary raw materials, specializing in hard metal scrap.

METALLE · Handel & Aufbereitung
STADLER
CERATIZIT GROUP



Furberg a. et al, Environmental life cycle assessment of cemented carbide (WC-Co) production, Journal of cleaner production 209, 2019, 1126-1138

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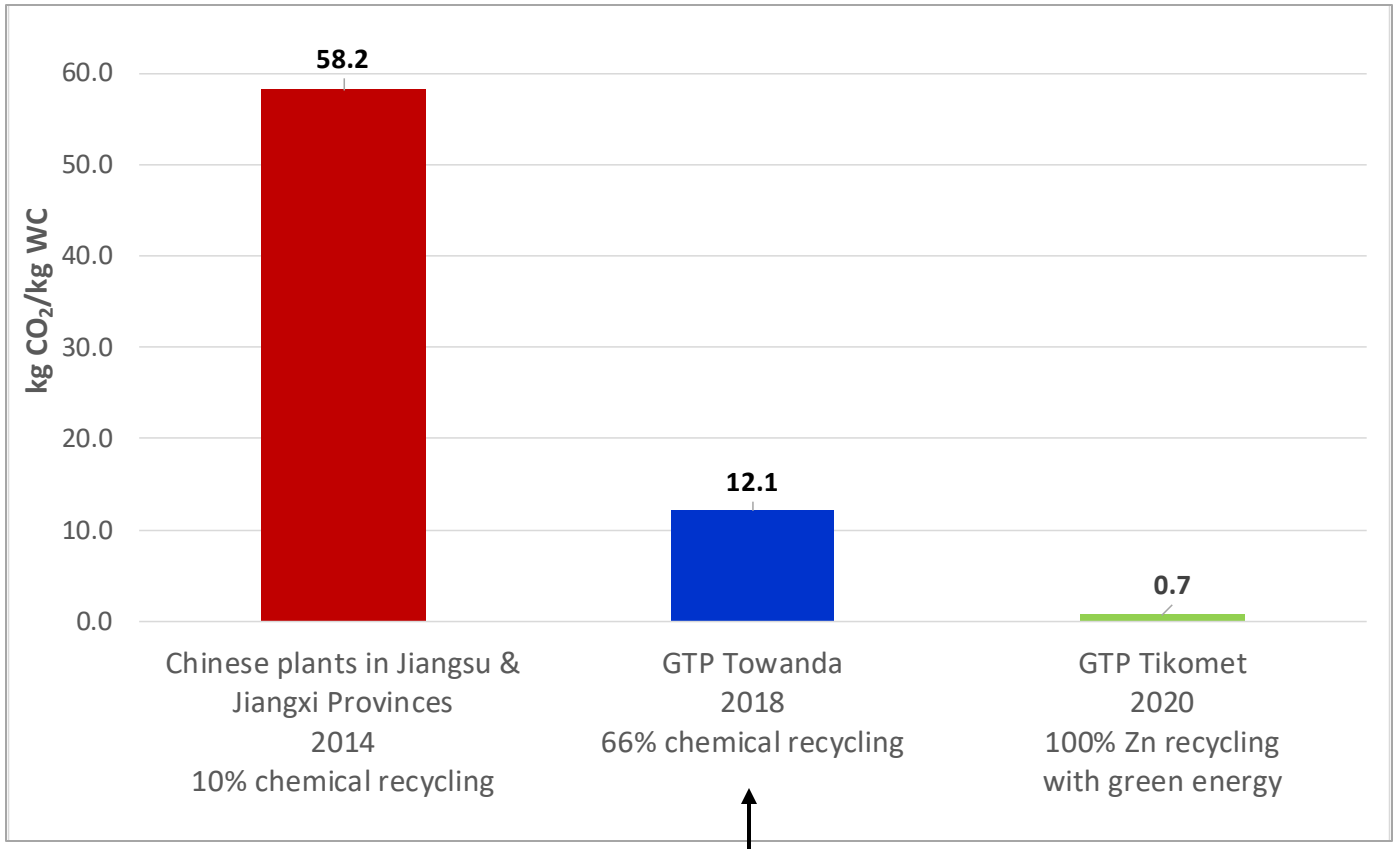
Conserving the limited natural resources W & Co

Why so important in raw material production?



10.8 kg for pyrometallurgy and hydrometallurgy

- For comparison, the emission factors of some other materials:
  - Steel: 0.4-2.7 kg CO2e *
  - Aluminum: 5-20 kg CO2e **
  - Copper: 2-8 kg CO2e ***

*Hasanbeigi et al, Global Efficiency Intelligence, 2019

** Saevarsdottir et al, Journal of sustainable metallurgy, 2021

*** Nilsson et al, Minerals, 2017

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Conserving the limited natural resources W & Co

W recycling processes: Zn-processing

Sorted, cleaned hard metal scrap.

>

HM-Scrap + Zn

>

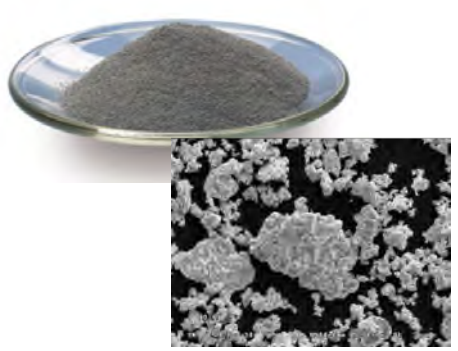
Zn-processing

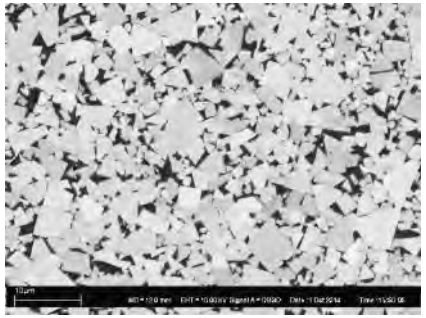
>

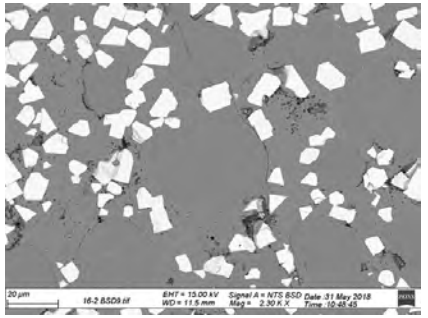
HM-Scrap after Zn-processing

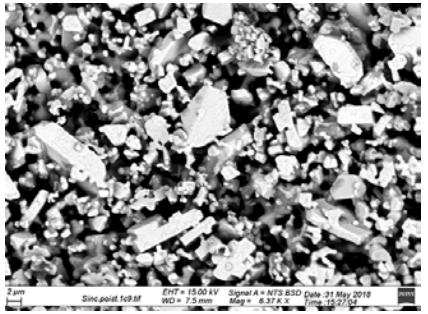
>

Recovered crushedpowder









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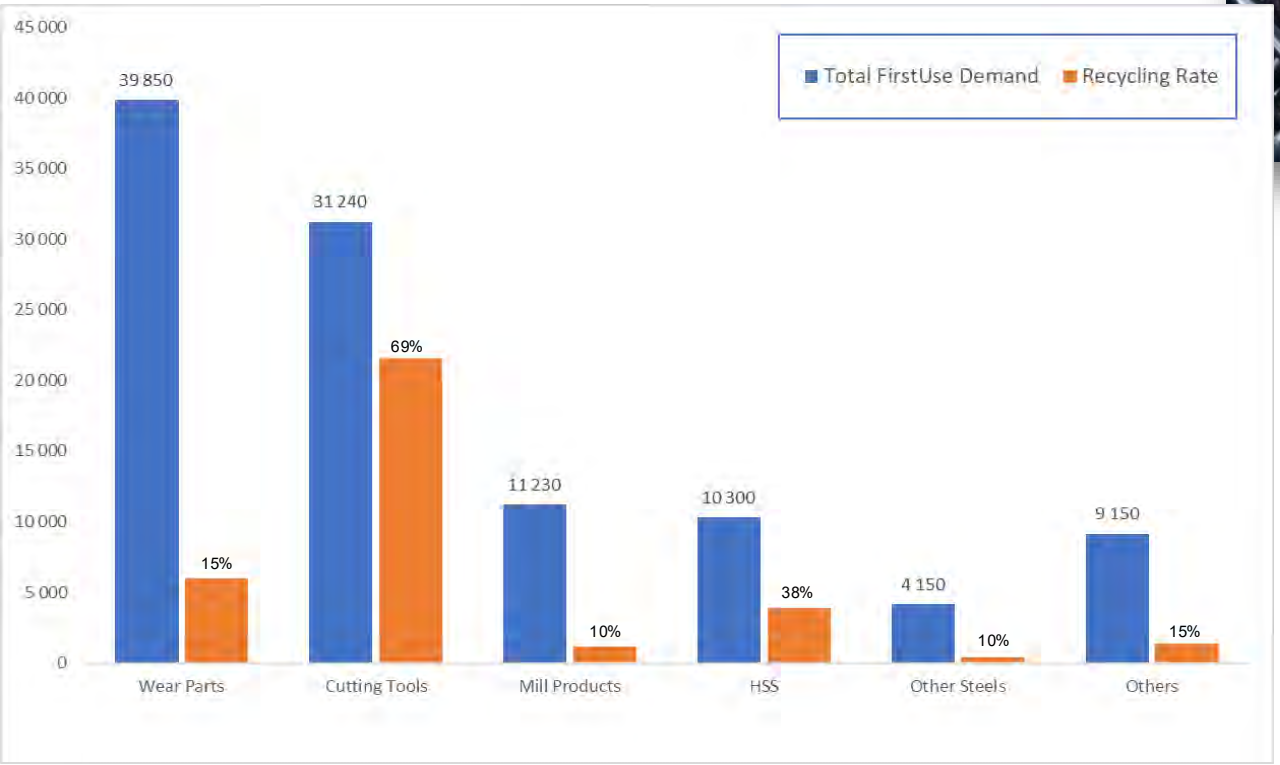
Conserving the limited natural resources W & Co

W recycling processes: Zn-processing

- More than 160 different grades at CERATIZIT
- More than 100 000 active products



Recycling Rate by First Use industry
Source, ITIA 2019

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Recycling
RESQTOOL

- Goal: Enhance sorting efficiency and thereby recycling rate → increase sustainability

- By:
  - Utilizing a state-of-the-art QR code to determine the optimal recycling/recycling class of each individual piece
  - Enhancing the sorting
  - Improving the efficiency of the recycling process (e.g., used energy)
  - Ensure that the powder is usable to produce high quality products

RESQTOOL

Project: 101138144
HORIZON-CL4-2023-RESILIENCE-01-05

Co-funded by the European Union

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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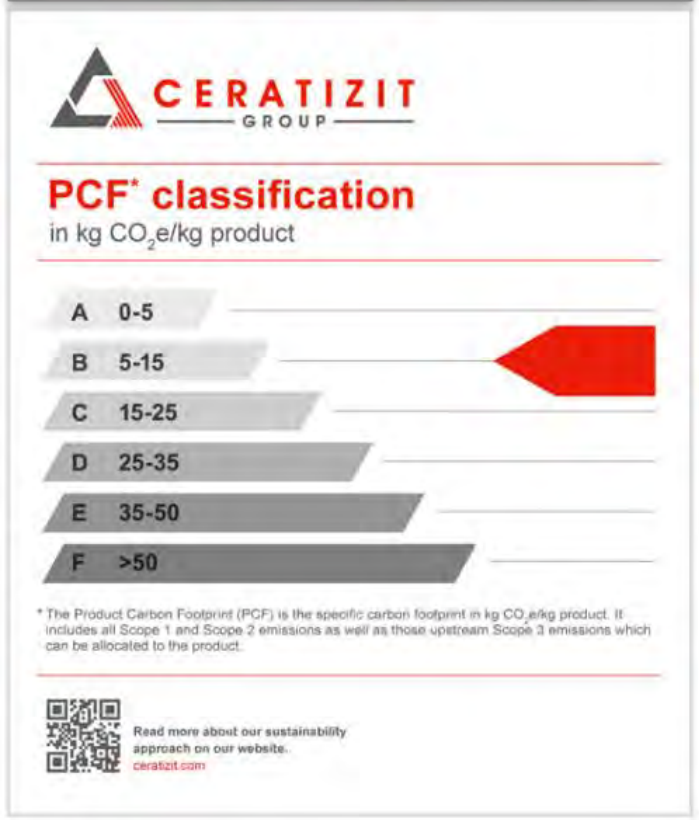
Product carbon Footprint

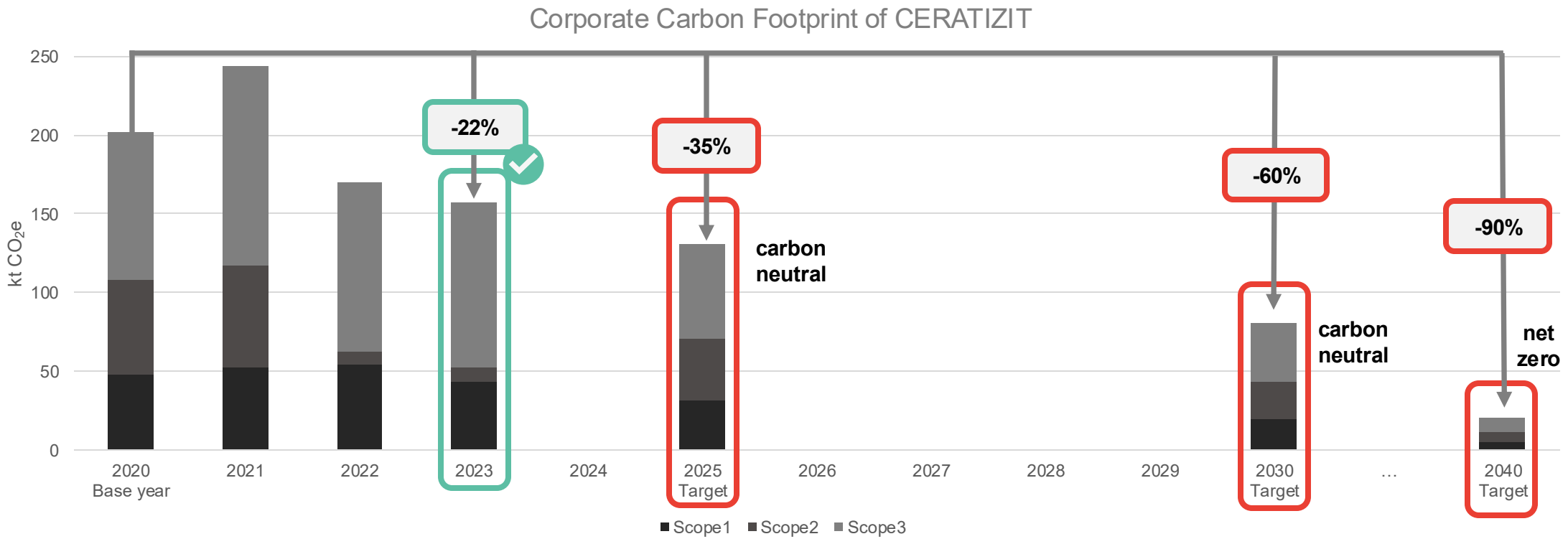
First calculation model for classification for Product Carbon Footprint

- First Product Carbon Footprint standard for cemented carbide
- Scoring and Classification System with increased transparency
- Calculation model in accordance with ISO 14067:2018
- Certified by external auditors



Our development and targets

GOLD | Top 5%
ecovadis
Sustainability Rating
SEP 2024



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Public

CERATIZIT GROUP

Thank you

Any questions?

Recycling technologies for the additive manufacturing

Prof. Dr.-Ing. Michael Wahl,

Greater Green +
26.09.2024, Luxembourg

Umwelt-Campus Birkenfeld | HOCHSCHULE TRIER

iBT Institut für Betriebs- und Technologiemanagement
Institute for Operations and Technology Management

overview

- Working group

- Plastics recycling for additive manufacturing
  - Filament
  - Direct use of recycling material

- Cooperation | contact

Umwelt-Campus Birkenfeld

Umwelt-Campus Birkenfeld | HOCHSCHULE TRIER

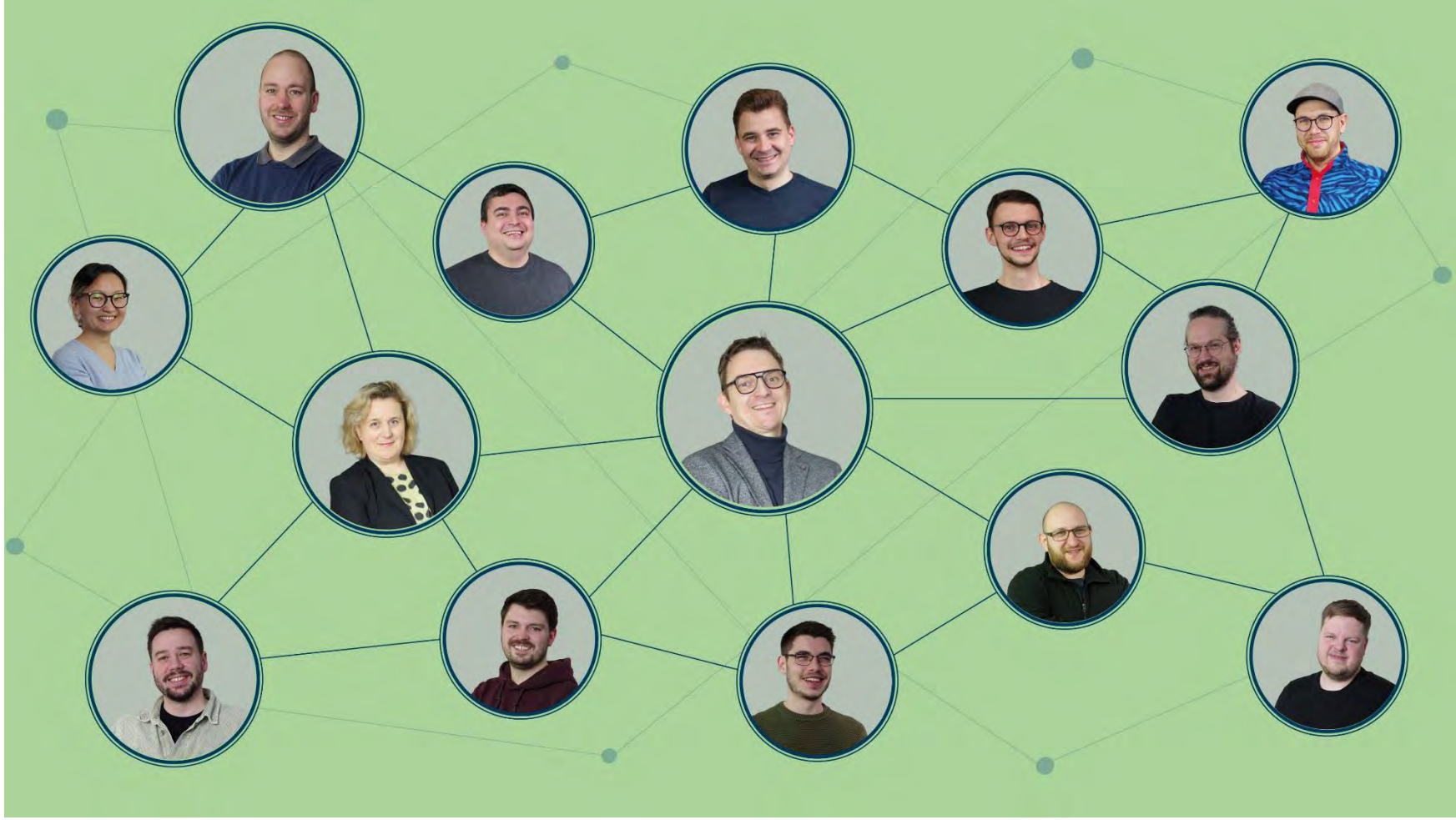
iBT Institut für Betriebs- und Technologiemanagement
Institute for Operations and Technology Management

Working group

Prof. Dr.-Ing. Michael Wahl

mechanincal engineering:

Development and constructiion
Additive manufacturing
Gebäude 9916 | 150
m.wahl@umwelt-campus.de
https://www.umwelt-campus.de/mwahl
06782 – 17 1313



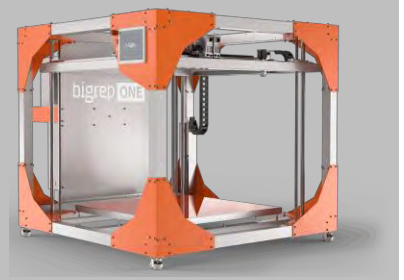
Working group:
13 employees,
7 scientific assistants

Research areas

Umwelt-Campus Birkenfeld | Hochschule Trier

Product development | process development | design | simulation | prototyping

AM plastic

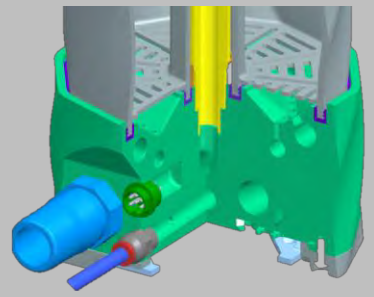


Highlights:
> 40 printers
- up to 1m³ volume
- various plastics
- plastic recycling

AM metall

Highlights:
- 2 (+1) printer
- Post-processing

Bioreactor construction



Highlights:
- Construction of Reactors in laboratory and pilot plant scale

Analyse

Highlights:
- 6 x 3D-scanner
- Analyse: REM | EDX
- mech. values

Makerspace

Highlights:
- INNODIG
- Mobiler Makerspace

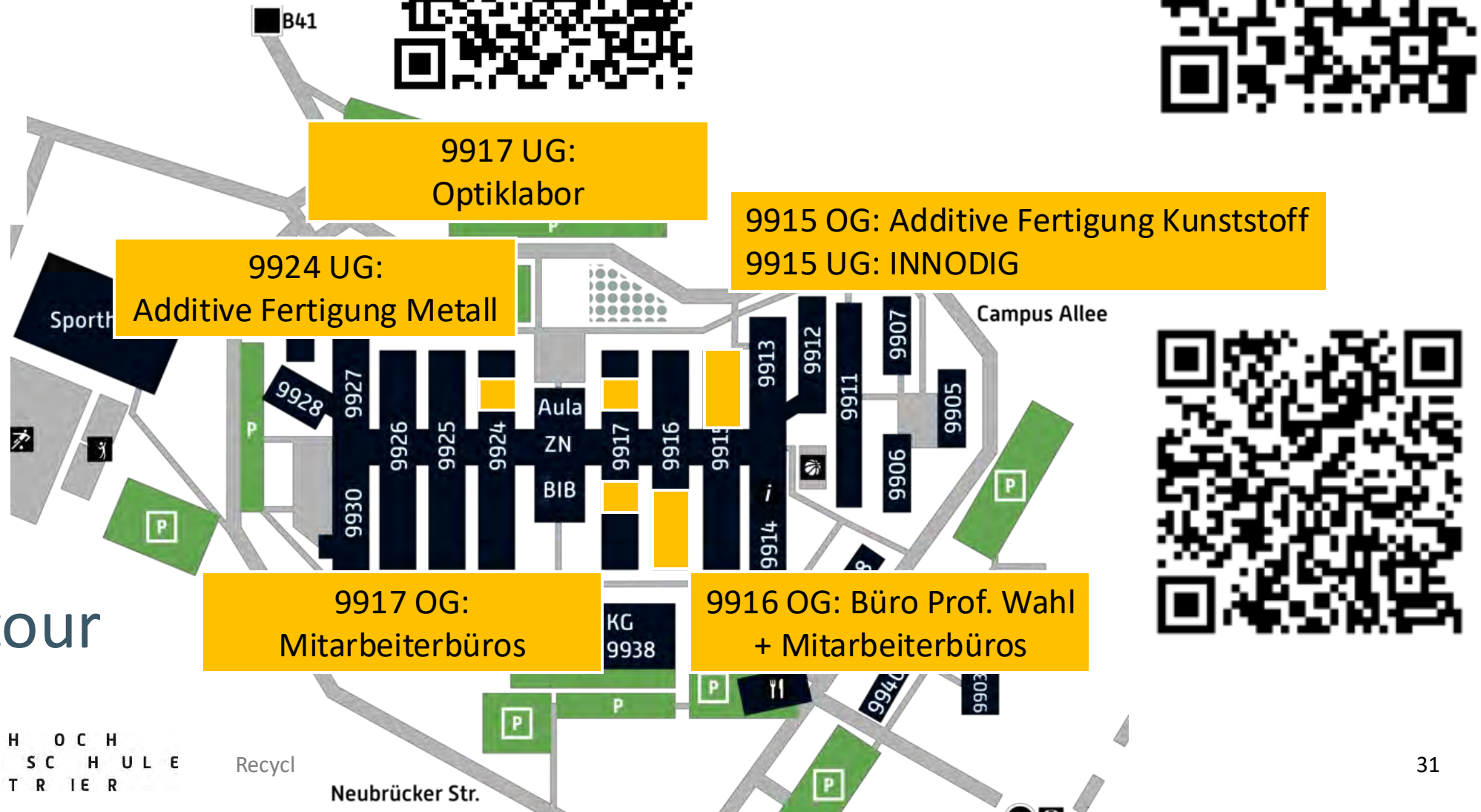
GREATER GREEN | RheinlandPfalz Ministerium für Wirtschaft, Verkehr, Landwirtschaft und Weinbau

Interreg Grande Région | Großregion

KIGenF | OMAS | AddBrenn H2plus | DigiBio-Reakt | Wirksens | ParaMorpho Pharm | Mobiler Makerspace

Carl Zeiss Stiftung | Bundesministerium für Bildung und Forschung | ZIM Zentrales Innovationsprogramm Mittelstand | RheinlandPfalz Ministerium für Wissenschaft und Gesundheit | Carl Zeiss Stiftung | RheinlandPfalz Ministerium für Wissenschaft und Gesundheit | RheinlandPfalz Ministerium für Bildung

Working group



9917 UG:
Optiklabor

9924 UG:
Additive Fertigung Metall

9915 OG: Additive Fertigung Kunststoff
9915 UG: INNODIG

9917 OG:
Mitarbeiterbüros

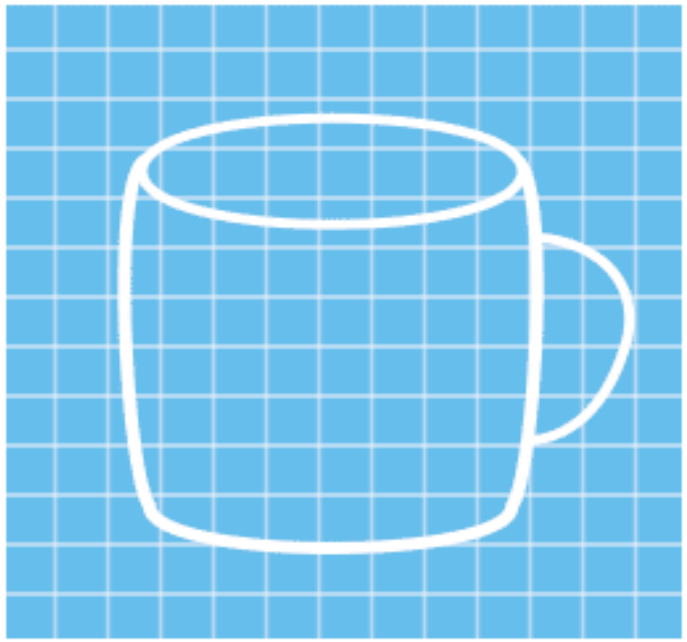
9916 OG: Büro Prof. Wahl
+ Mitarbeiterbüros

Digital labtour

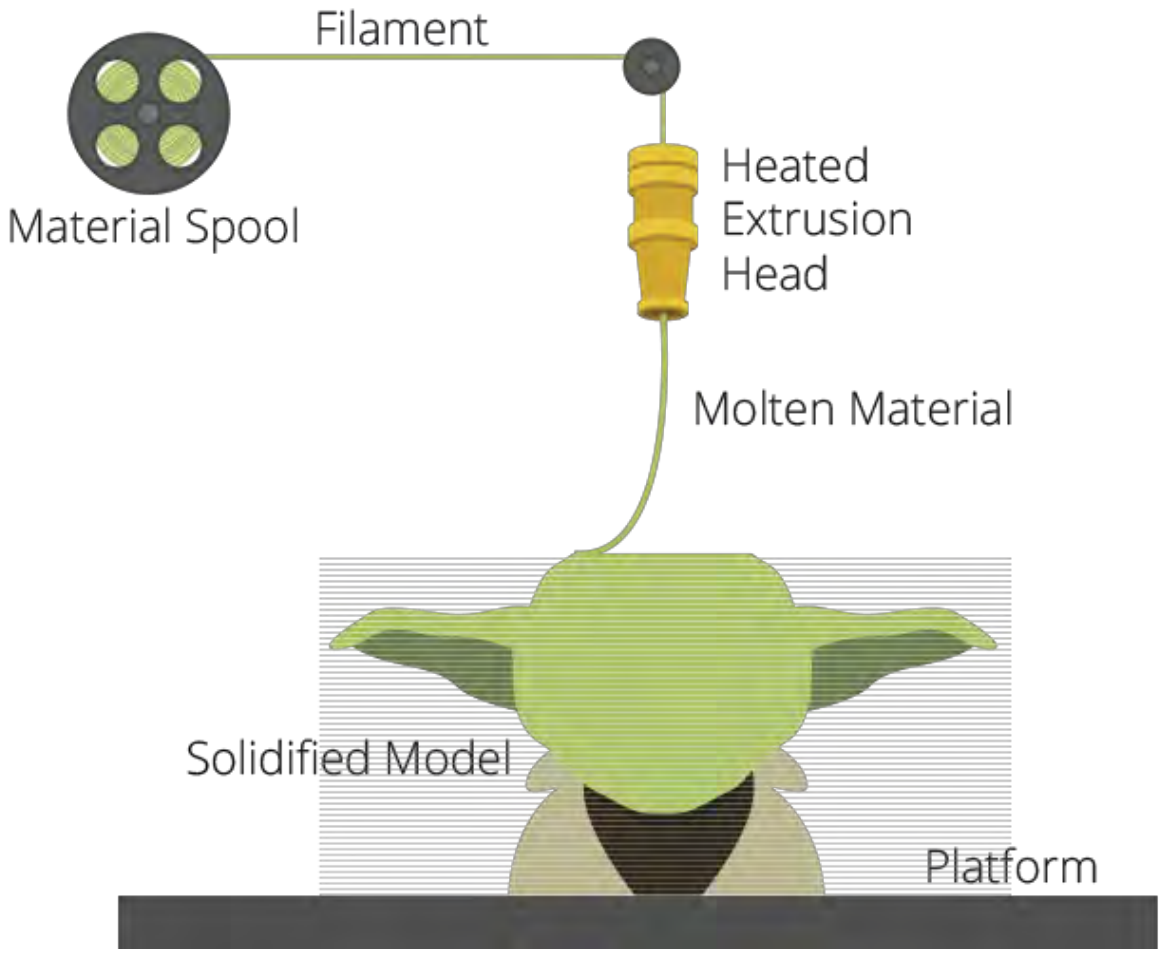
Overview

- Working group
- Plastics recycling for additive manufacturing
  - Filament
  - Direct use of recycling material
- Cooperation | contact

Plastics recycling for additive manufacturing



Start with a 3D CAD file either by creating the 3D model or scanned with a 3D scanner



Quelle: 3dprintingindustry.com

Plastics recycling for additive manufacturing

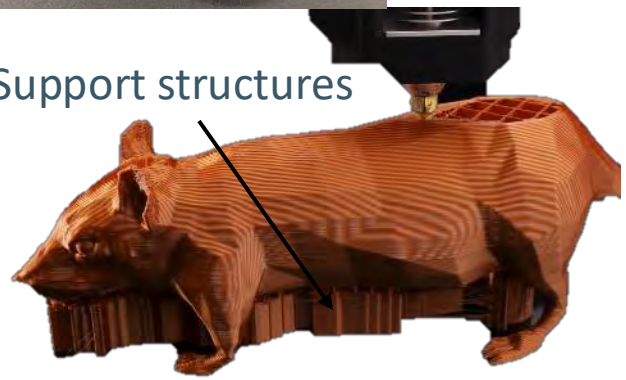
Misprint

Industrial plastic waste

Sorting + shreddering

Flakes

Support structures



Plastics recycling for additive manufacturing

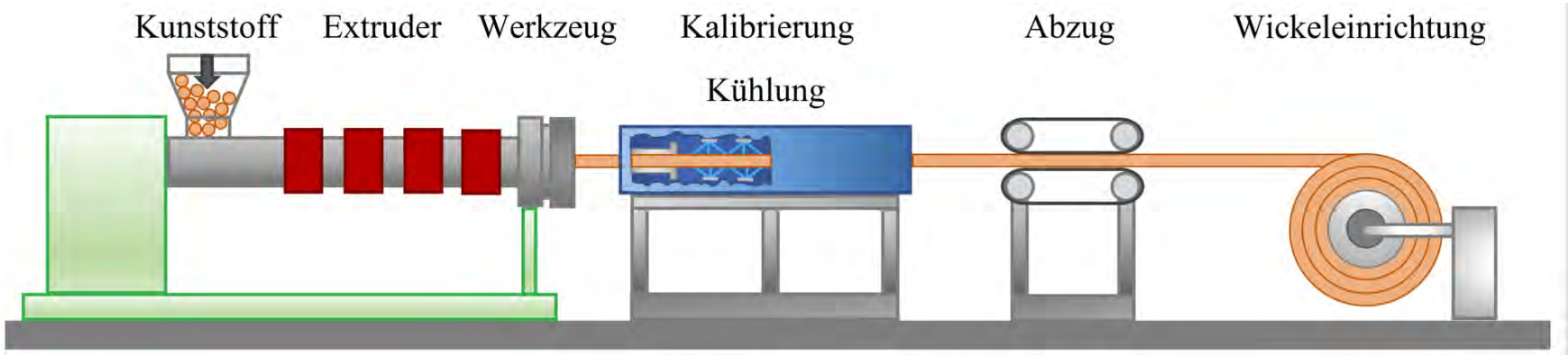
Flakes

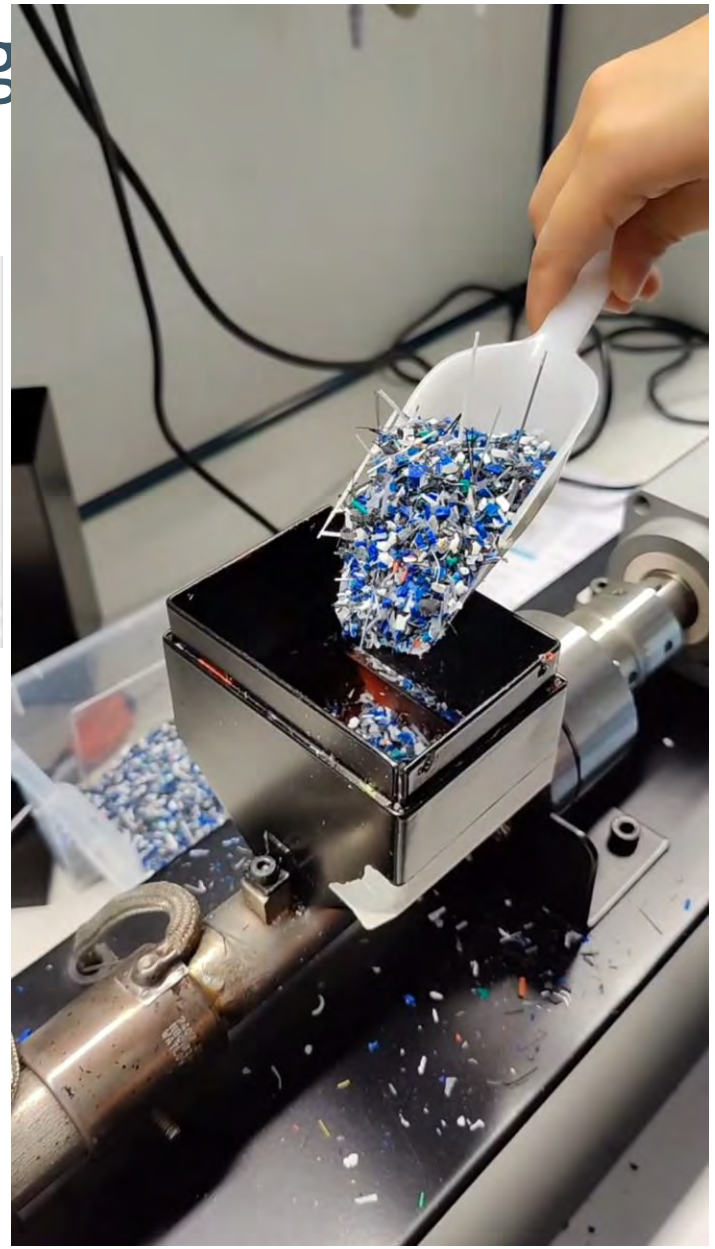
Filament

New material

Extrusion

Plastics recycling for additive manufacturing

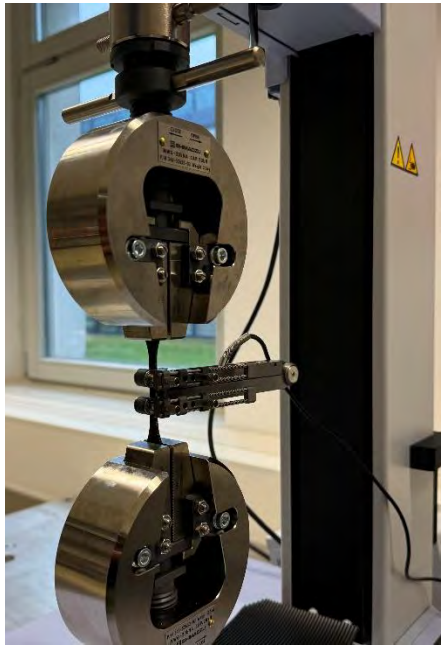


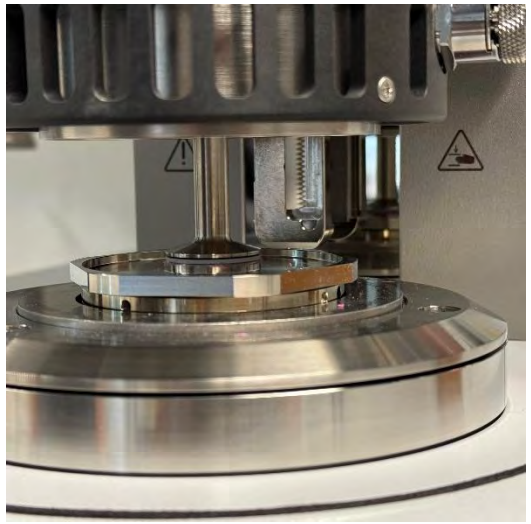


Plastics recycling for additive manufacturing

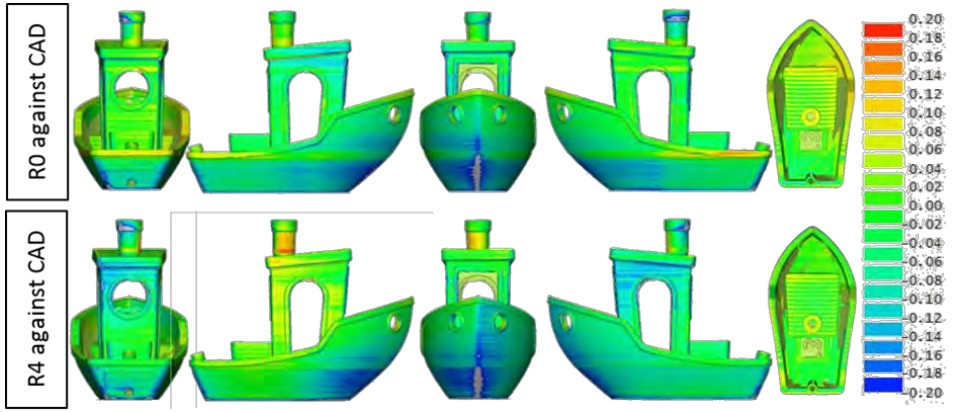
Material properties

Tensile test (ISO 527)
Notch bar impact test (ISO 179)
Rheology

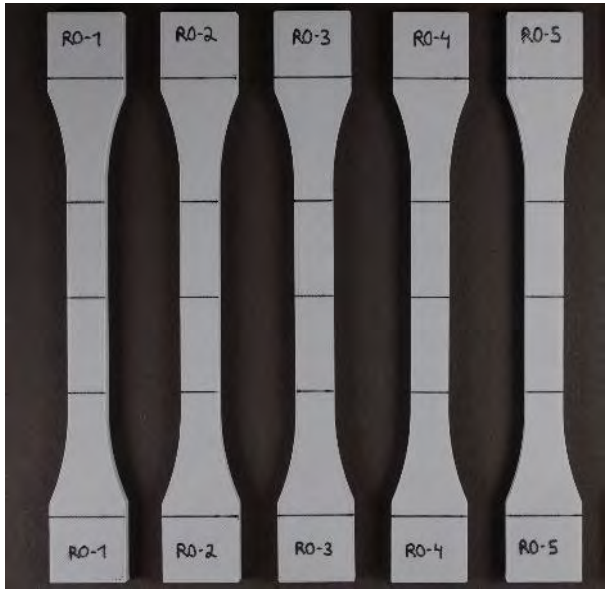


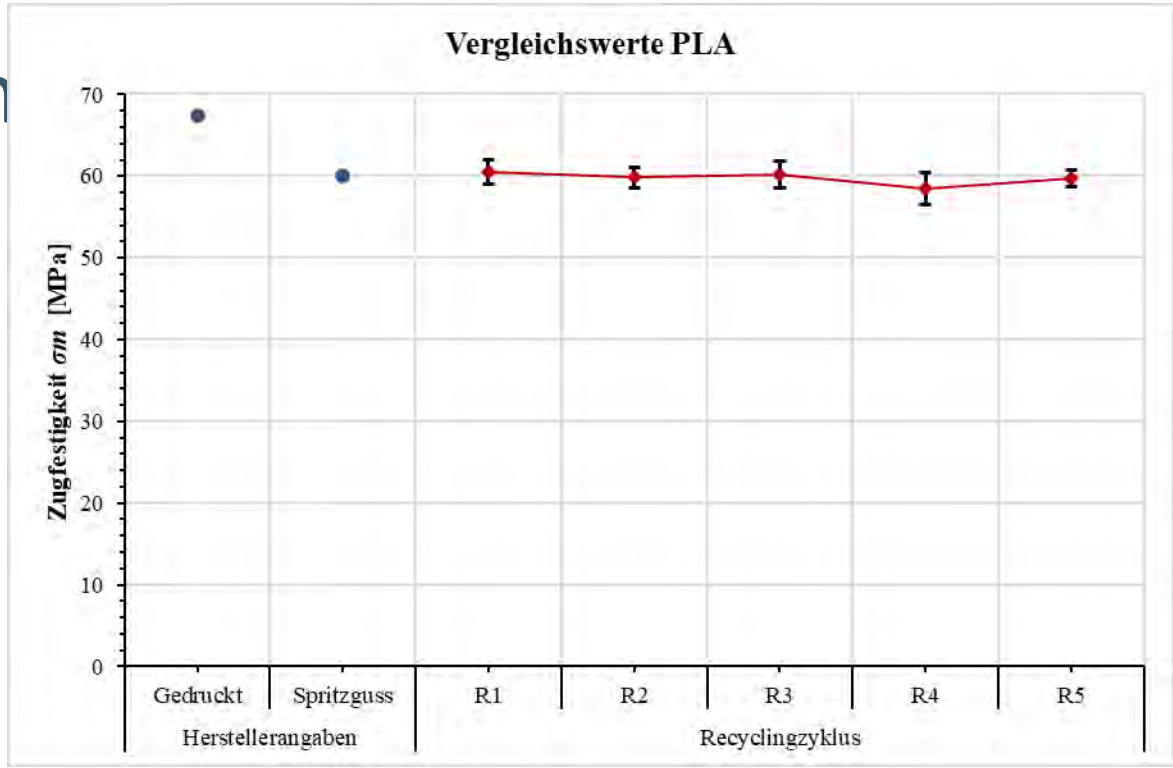


Accuracy and workability



Plastics recycling for additive man





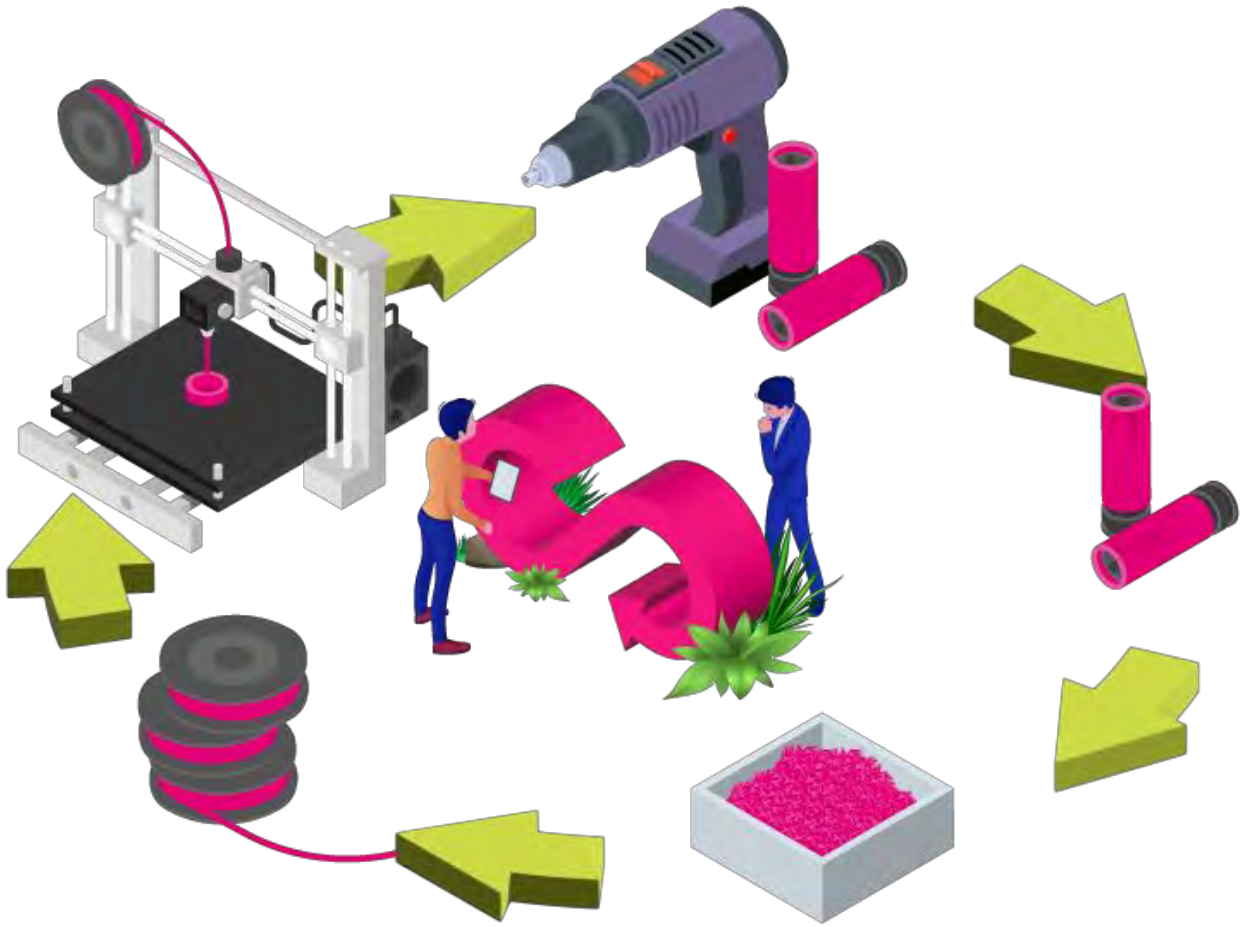
Material properties

Tensile test (ISO 527)

M. Bremer, L. Janoschek, D. Kaschta, N. Schneider, M. Wahl, „Influence of plastic recycling—a feasibility study for additive manufacturing using glycol modified polyethylene terephthalate (PETG)“, SN Applied Sciences, 2022, DOI 10.1007/s42452-022-05039-3

Examples of materials |cooperations

PE



ASA

TPU

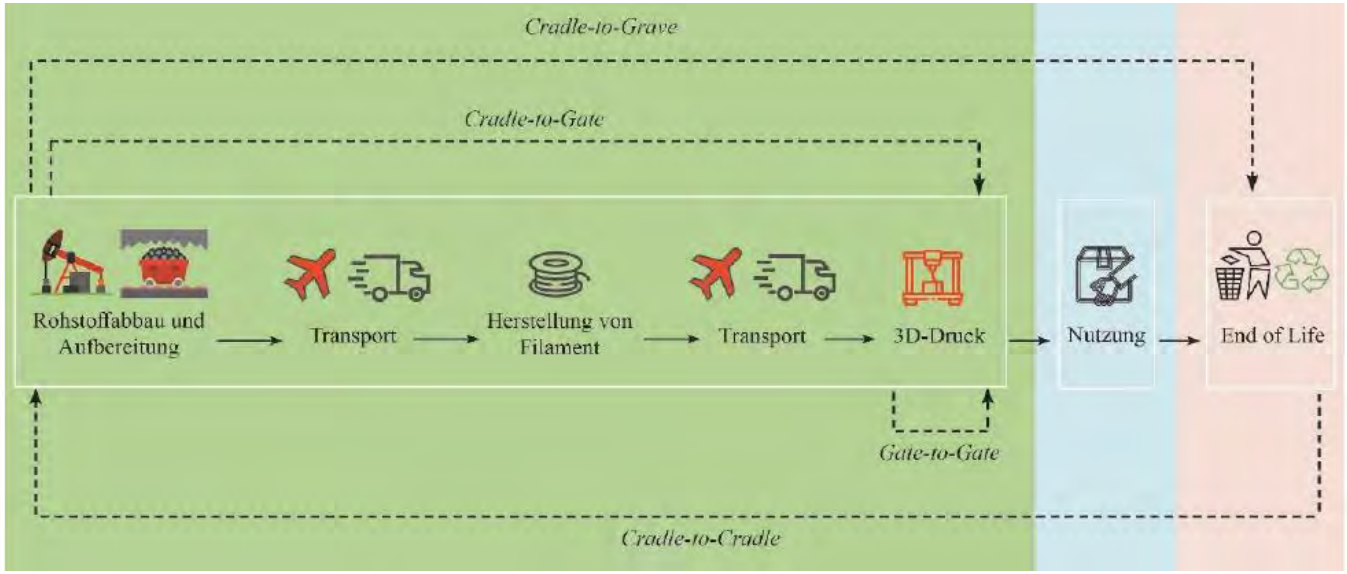
PA

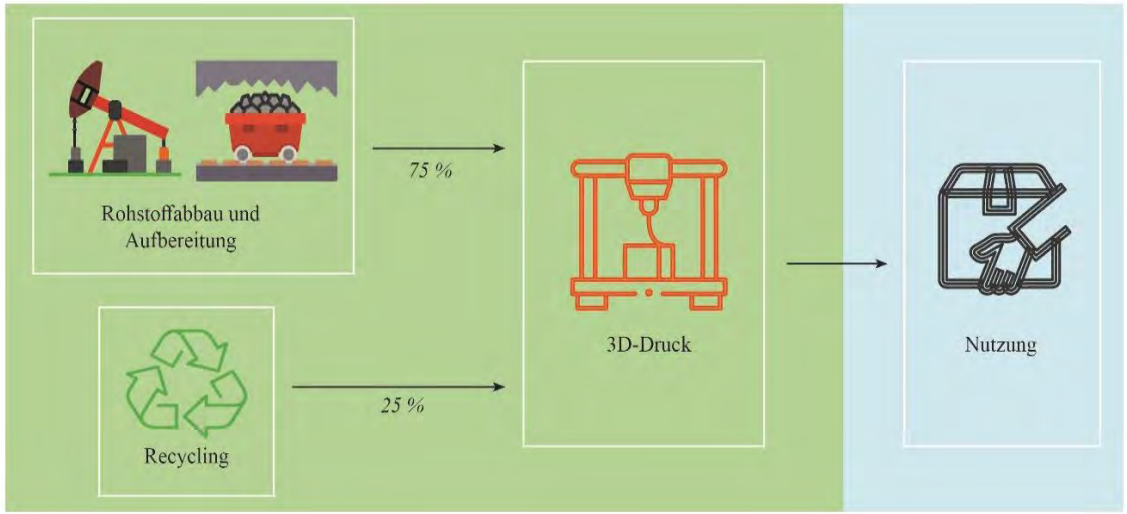
ABS

PP

Plastic recycling: CO_2 footprint

- Ressource efficieny in lab scale?
- CO_2 footprint : Alina Davlumbaeva



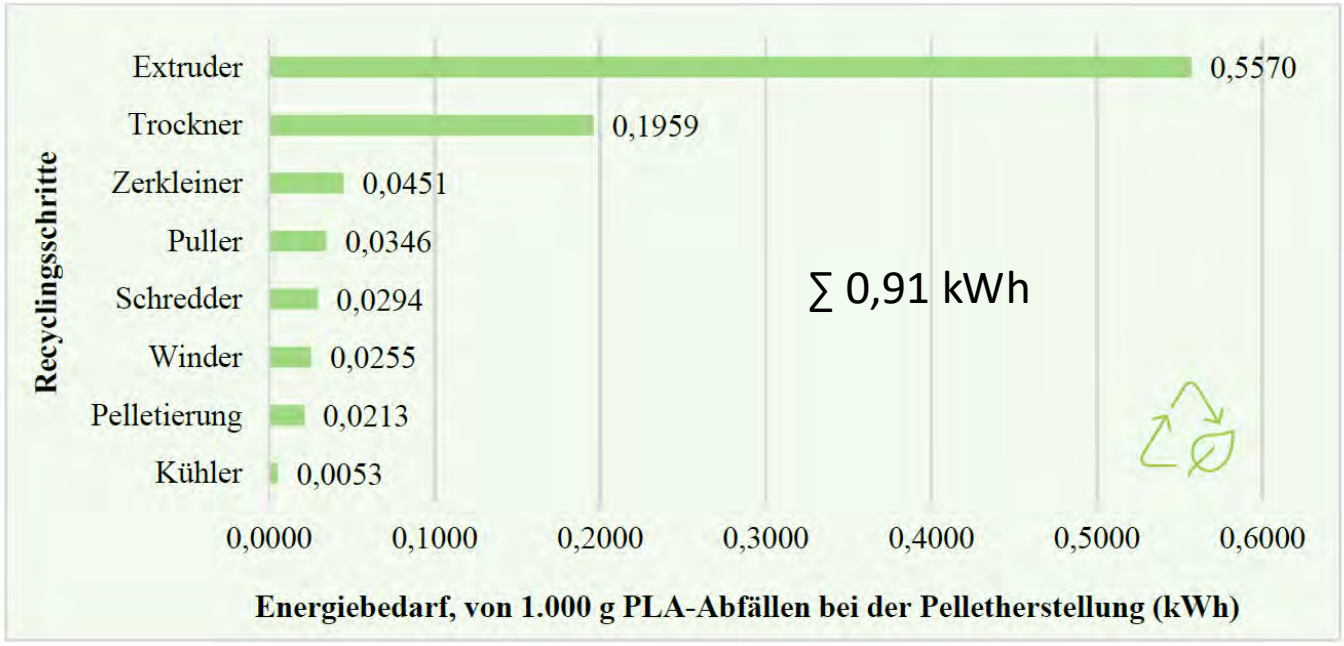


Plastic recycling: CO_2 footprint

Result:
Measured values dependent on process parameter

Plastic recycling in lab scale with **25% recycling material** leads to a reduction of the carbon footprint of around **15 % CO_2**.

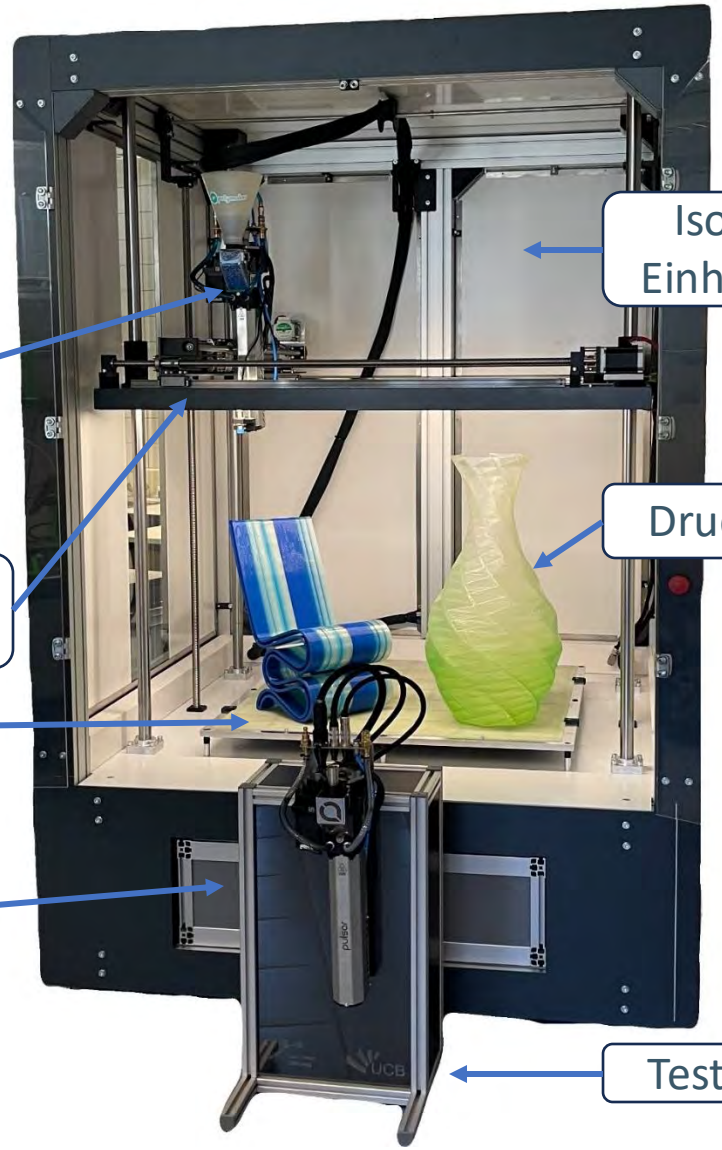
Energiebedarf bei der Filamenterzeugung



Next step:
Avoid filament production
Direct use of recycling material

AM with recycling flakes

Carl Zeiss Stiftung

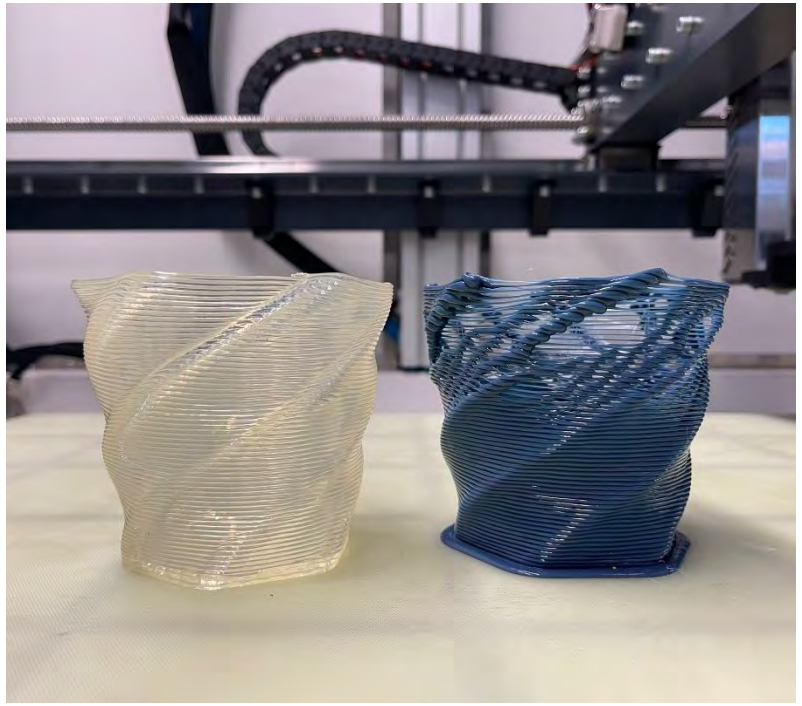


time: 7 h weigth: 2909 g

Optimization

Carl Zeiss Stiftung

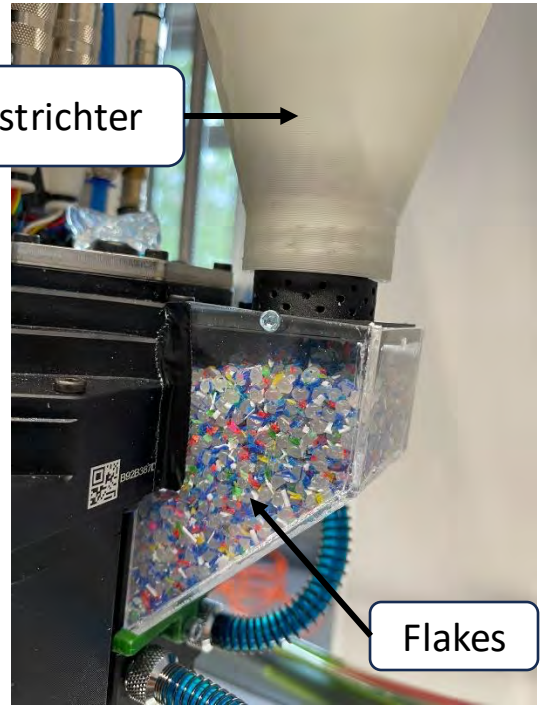
Test print recycling material



Neumaterial

50%-50% Recycling

Optimized particle handling



Up to 100% recycling material

Outlook

- Centers für RessourcenEffizienz
- Implementation of metal recycling for AM
- Projects with industrial cooperation in G.G.+
- Contract research | Project partner in a research proje
- Follow us:

Team Prof. Wahl

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Thanks!

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Homepage linkedin instagram

Industrie
Eau et environnement

Kathrin Gantner
Zahnen Technik GmbH

Alice Feller
Kurita Europe

Interreg
Cofinancé par l'Union Européenne
Kofinanziert von der Europäischen Union
GREATER GREEN
Grande Région | Großregion

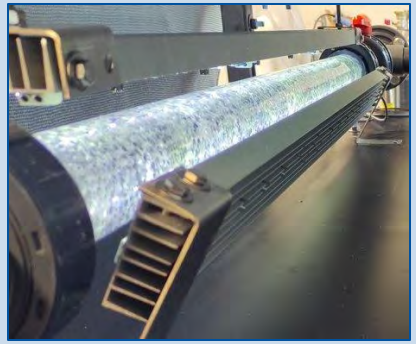
Flexbed Filter
A space and resource saving technology for various industrial and wastewater applications

zahnen TECHNIK

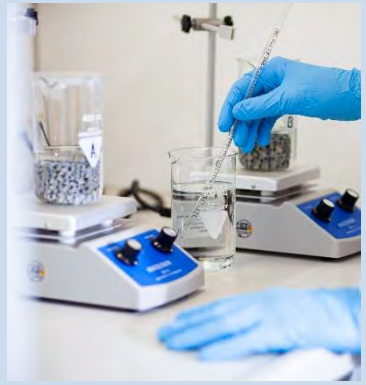
Plant Manufacturer and Solution Provider in Water Engineering

1958
Founded

+160
Employees

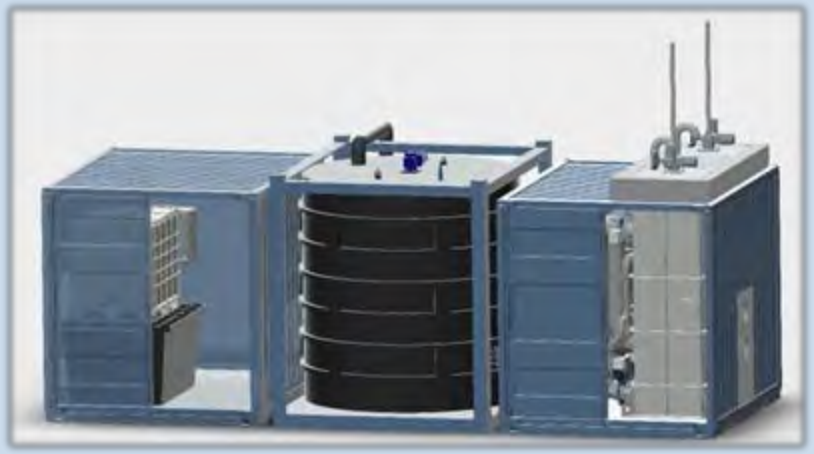




High Performance in Mechanical, Electrical and Process Engineering

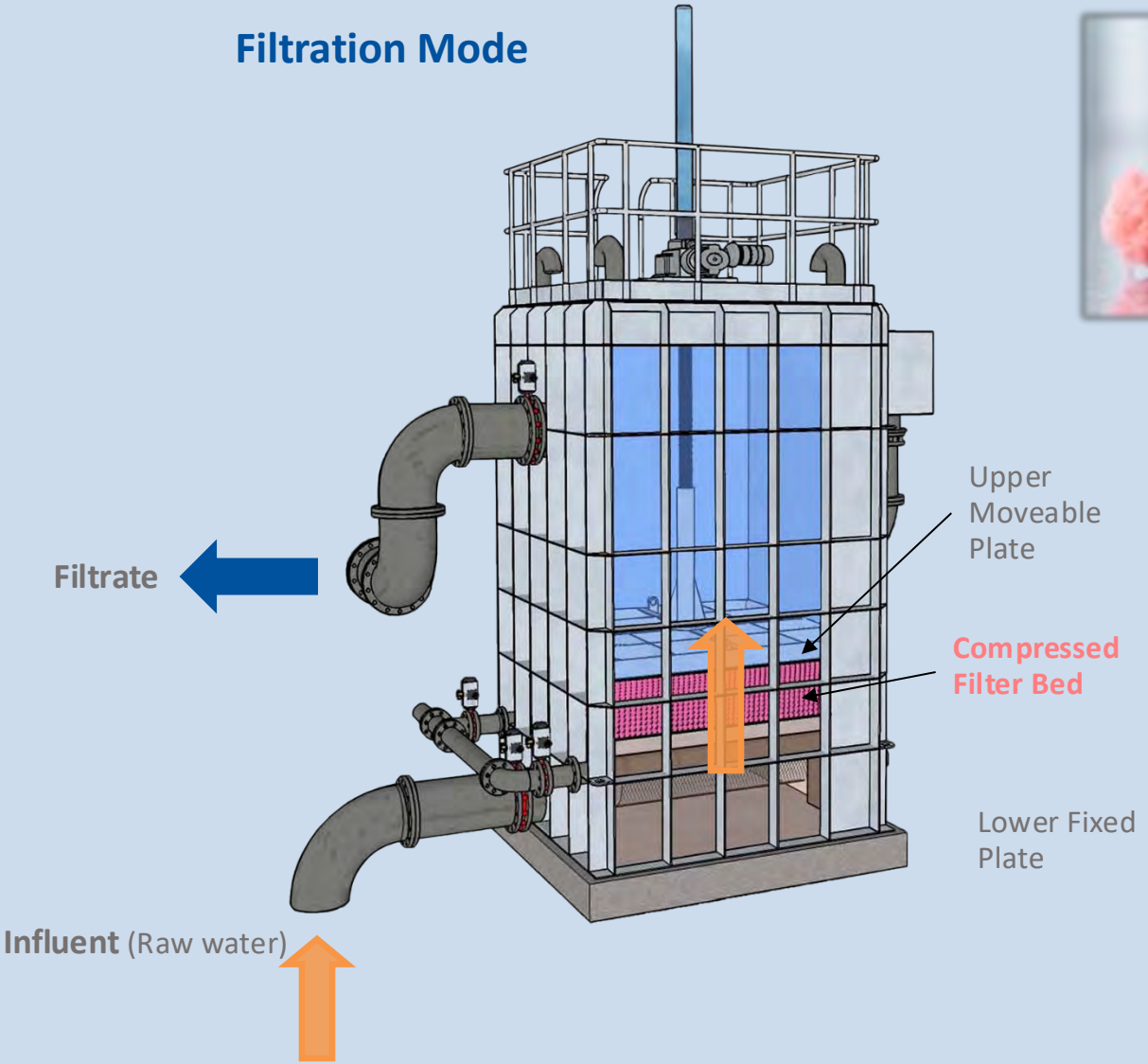
Photos: © Kathrin Kläsges Fotografie & Zahnen Technik

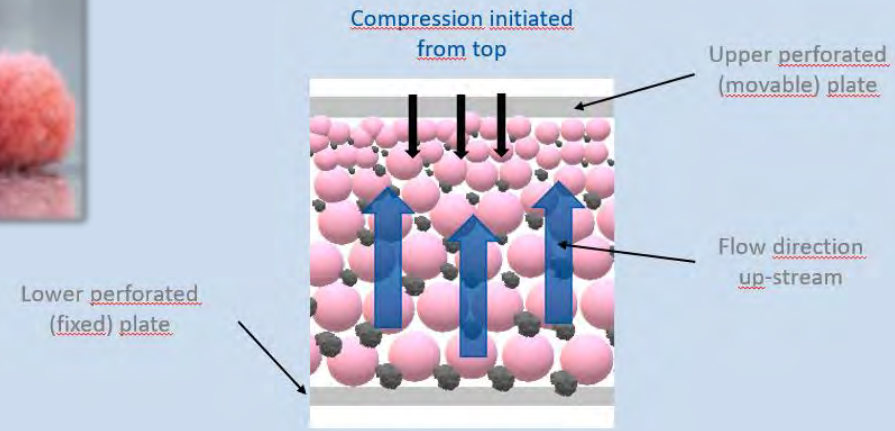
Flexbed Filter: High Rate Depth Filtration with Small Footprint



- Extremely space-saving depth filtration in modular design
- For high flow rates (avarage 75 $m^3/(m^2 \cdot h)$
- For high influent TSS, insensitive to high TSS peaks
- Universally applicable for TSS and turbidity removal
- Separation of particle sizes 5 µm … 900 µm
- Easily backwashable
- Low energy, water and air consumption during backwashing
- No clean water needed for back washing => no fresh water storage necessary
- No rotating/fast moving components => low wear and tear
- No loss of filter media
- Modulare design: quick and easy to install, to retrofit or to extent
- Several standard modul sizes available
- Available also as „Plug & Play“ container based solution

Up – Flow Filtration Process





- Highly porous and flexible filter media made of technical fibres (porousity > 80%)
- High storage capacity (> 15 kg/m³ filter bed)
- Variable adjustable pore sizes
- Performes like a multi-layer filter
- No clogging, no building-up of a barrier layer
- Long life cycle (> 10a)

Flexbed Filter: Universal Applications Possible

- Reduction of particles and turbidity
- Industrial and municipal waste water treatment plants: removal of TSS incl. $COD_{particulate}$
- Treatment of (industrial and waste) water for operational use
- Pre-filtration of surface water (rivers, lakes) for further treatment as process water
- Removal of micro-plastics
- Phosphor – elimination (after precipitation)
- Pre-filtration upstream granulated activated carbon adsorbers or ozonisation or UV – disinfection
- Removal of organic compounds and trace substances in combination with dosing of powdered activated carbon
- Post treatment of WWTP discharge before agricultural irrigation or re-use
- Police filter before discharge into sensitive or bathing water bodies bodies

Benefits Flexbed Filter:

- Space-saving and inexpansive (investment + operation)
- Long life cycle of filter medium due to it‘s high resistance towards most of the usual chemicals in industrial waste water

You have a problem with suspended solids, phosphorous or trace substances in your (waste) water?

We do have the solution!

COMPETENT. EFFICIENT. SUSTAINABLE.

Dr.-Ing. Kathrin Gantner
k.gantner@zahnen-technik.de
+49 1516 7045 060

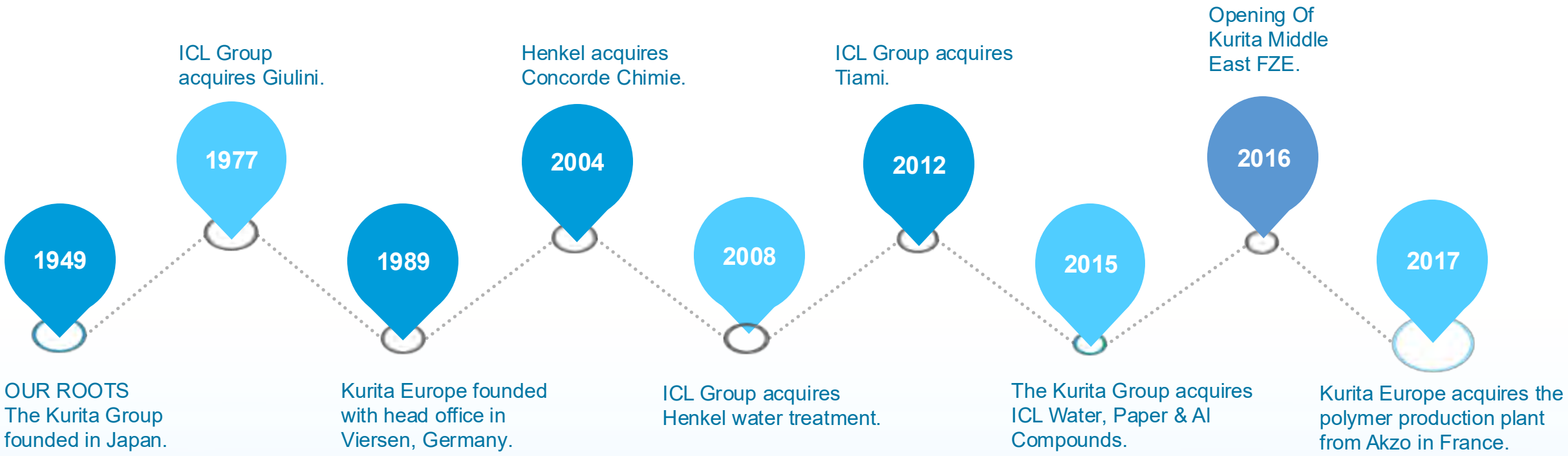
zahnen TECHNIK

Energy and water saving with steam boiler treatment

Alice Feller

GreenTech Solutions summit 2024

Milestones of history – Kurita Europe GmbH



Our capabilities

2,4B$
Sales
2022

2,0%
R&D
expenses

>100
Countries

Our people

7500

>50%
Support
on field

340

R&D Staff

>2597

Patents

Locations

Subsidiaries
Production sites
R&D Centers

4 Regions Organization and Responsible Areas

- Japan and East Asia
- Southeast Asia, South Asia, Oceania
- Europe, Middle East, Africa, Central Asia
- North America, Central and South America

Our Portfolio

Water solutions

- Boiler water
- Cooling water
- Membrane treatment
- Wastewater
- Cleaning
- Drinking water
- Swimming pool water

- Emulsion breakers
- Corrosion inhibitors
- ACF technology
- Defoamers
- Fouling inhibitors
- Cleaning & degassing

Petrochemical & Refinery process

- Dust control agents
- Cokemaking process additives
- Fuel additives
- Fouling inhibitor
- Cleaning agents
- Combustion improver

Industrial process

- Wet strength agents
- Biocides
- Surface sizing agents
- Pitch & sticky control
- Flocculants
- Defoamers
- Retention agents

Paper process

Cetamine® Technology

KURITA

Introduction Cetamine® Technology

General Presentation

SOLUTION PATENTED SOLUTION

CETAMINE® TECHNOLOGY

Water & Energy Savings

System Protection

Easy Handling & Control

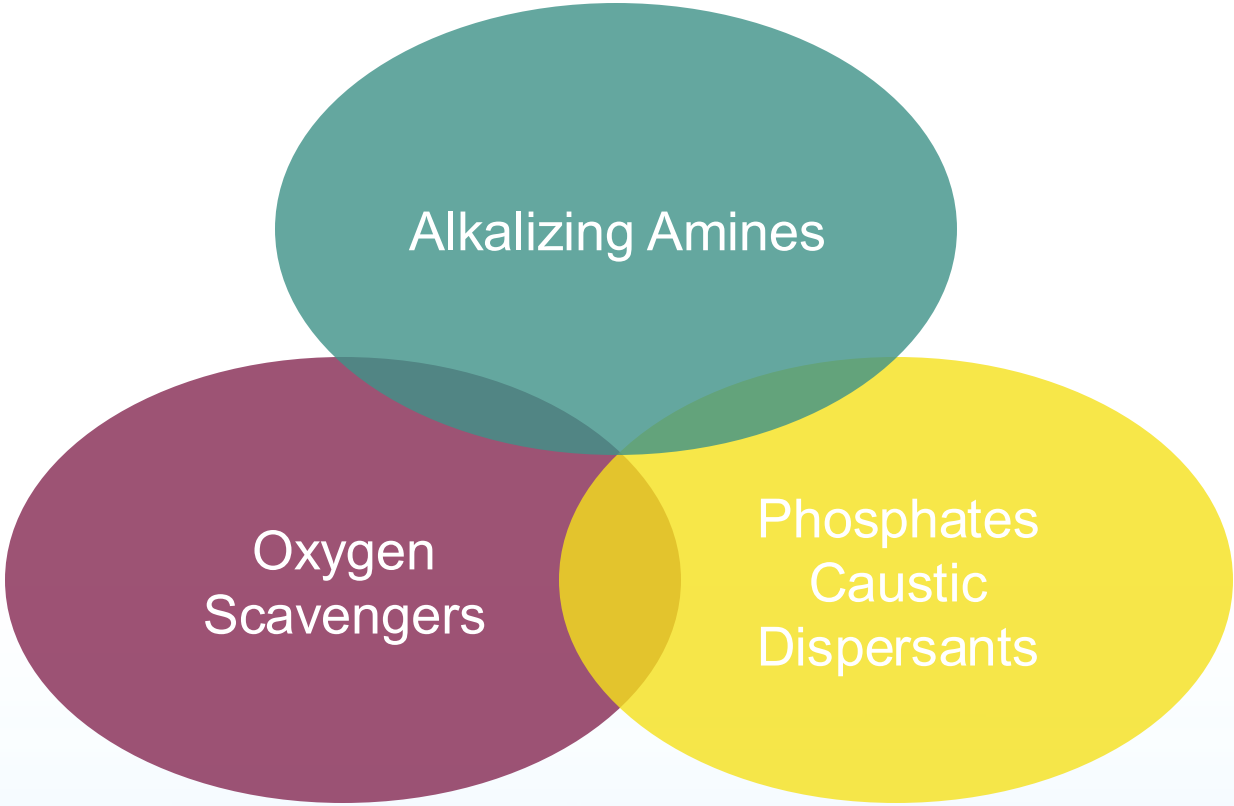
BOILER WATER

FEATURES & BENEFITS

Boiler Water Additives

Traditional treatment concepts usually require 3 main approaches:

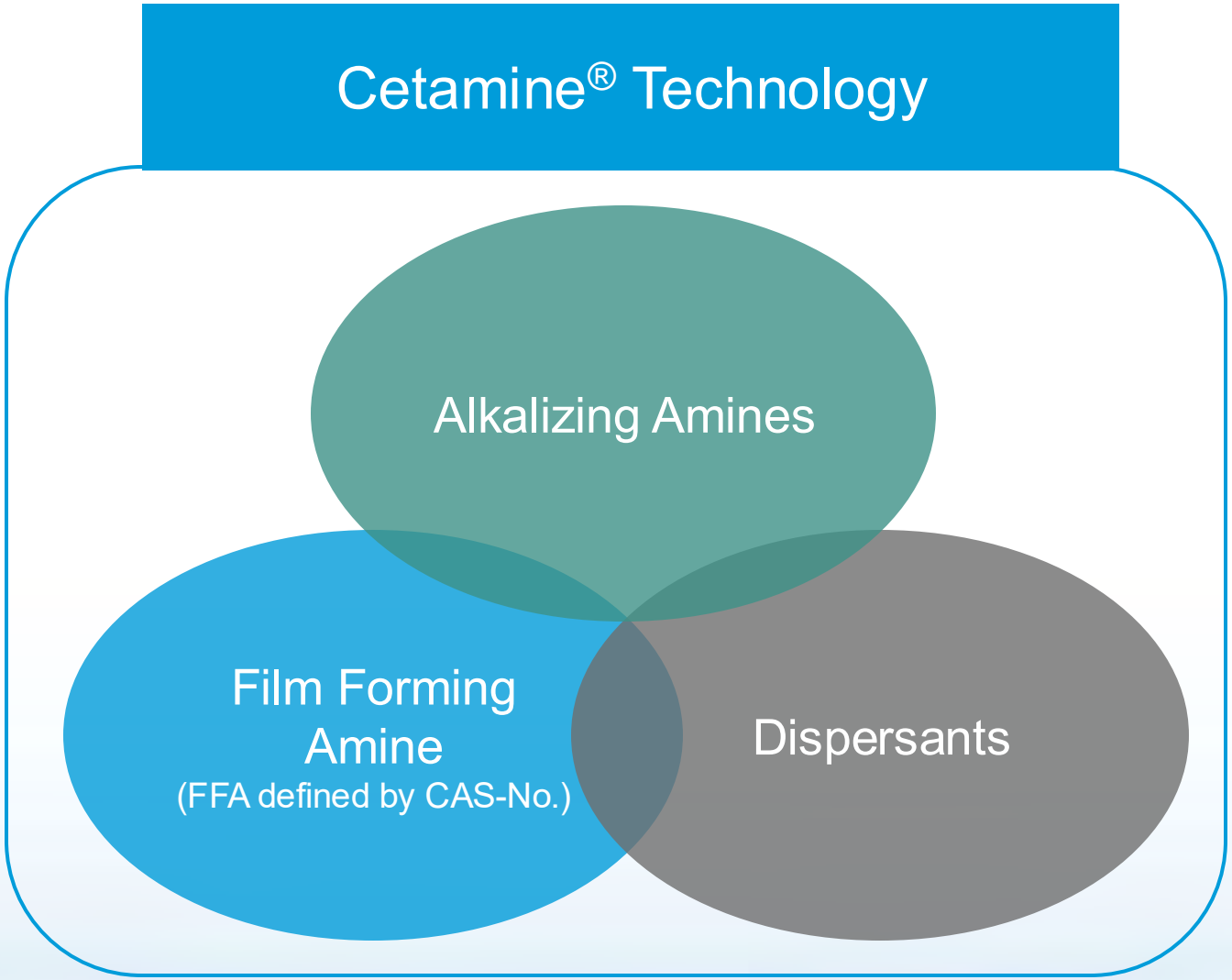
- Scavenging of Oxygen
- Internal treatment
- Steam treatment



Boiler Water Additives

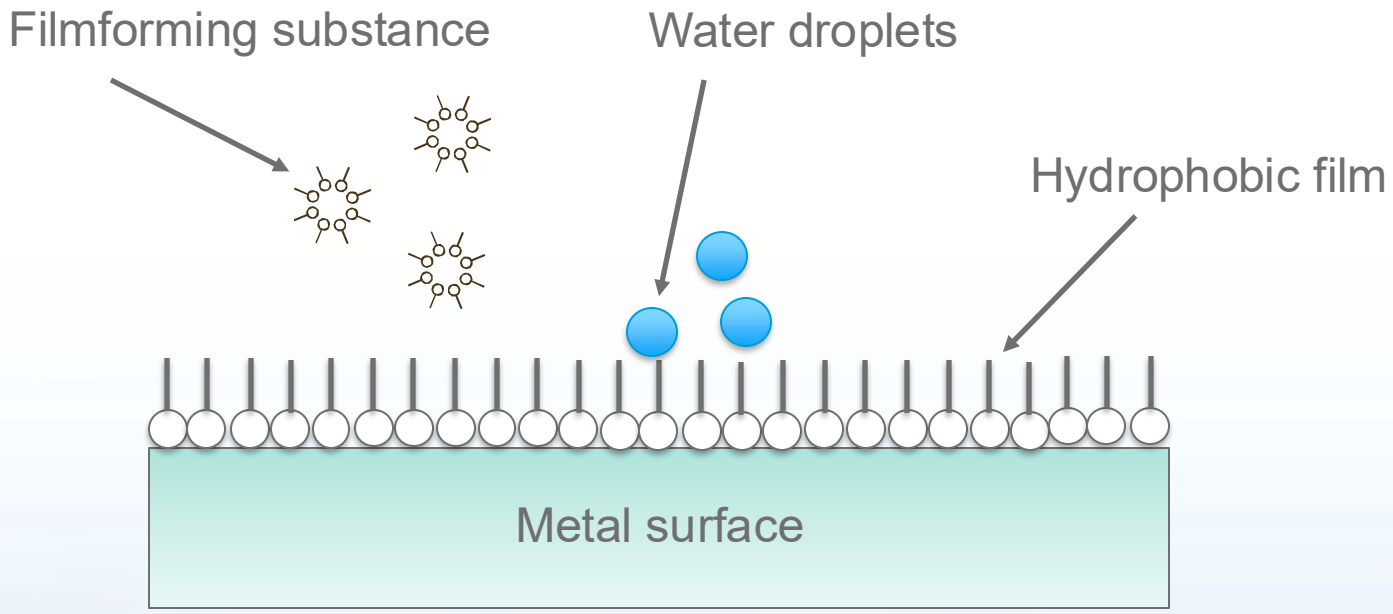
Our Cetamine® Technology portfolio offers a full range of products based on Cetamine® Filmforming Amines (CFA) to treat:

- Boiler systems with ALL-IN-ONE product concepts
- High pressure water/steam cycles with one component CFA solutions



Cetamine® system protection

Adsorption and formation of a protective Cetamine® film on metal surfaces
Hydrophobic barrier between water and metal
Excellent protection against corrosion & scaling



Cetamine® system protection

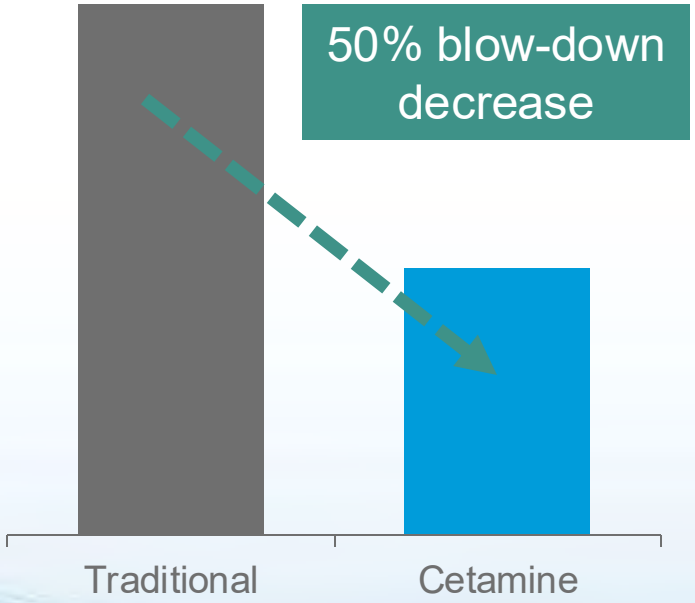
Before application	KURITA
	
No water repellency	Water repellent surface

Cetamine® cost reduction

COST REDUCTON

Cetamine® Technology
Savings of water & energy

DECREASE BLOWDOWN



All Organic Technology

Almost no impact on conductivity

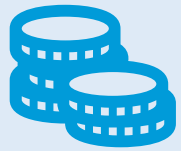
Decrease of blow-down

Savings of water & energy

Cetamine® Technology for your Boiler System

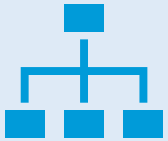
Efficiency

- Clean system surfaces
- Better heat transfer & boiler efficiency
- Higher cycles of concentration



Savings

- Reduced water & energy consumption
- Economical savings



Easy Handling & Control

- 1 product instead of 3
- Flow-meter controlled dosing proportional to make-up water
- Online monitoring & dose rate control

Protection

- Exceptional protection against corrosion & scaling throughout whole water/steam system
- Long term protection during discontinuous operation and system shut-down

Environmental Impact

- Reduced blow-down and water discharge
- Reduced CO_2 emission

Food safety

- Complies with international food regulations

Literature and Reference Letters

To whom it may concern

Geleen, August 29

The high-pressure steam system of one of SABIC's naphtha cr
in Geleen, Netherlands, has been successfully treated with pr
based on film forming amines since 2005. In 2009, the c
changed from competitor's products to a BKG Water Sol
Cetamine® treatment.

The overall performance of the Cetamine® treatment is very goo
product pricing is competitive. BKG Water Solutions partic
stands out above other market players when it comes to know
service level and partnership engagement.

We recommend Cetamine® technology for industrial s
generators, especially when traditional treatment programs do
give satisfactory results.

Roy J.M. van Lier, M.Sc., M.A.Sc.
Chief Consultant Corrosion & Water Treatment

سابك
sabic

To Whom It May Concern

Geleen, September 12, 2014

The high-pressure steam system of one of SABIC's naphtha crackers in Geleen, Netherlands, has been successfully treated with products based on film forming amines since 2005. In 2009, the cracker changed from competitor products to a Cetamine® treatment.

A substantial amount of information on this application is in the public domain[1].

During a planned shutdown in October 2013 one of the cracker's condensation backpressure turbines was opened for inspection and maintenance. It had been in continuous operation for 12 years.

The turbine was found to be exceptionally clean and in excellent mechanical state. The pictures above show partial views of the high-pressure/medium-pressure section (left) and low-pressure section of the rotor, all in "dirty" state.

Roy van Lier, M.Sc., M.A.Sc.
Chief Scientist, Technology & Innovation

Gerard Janssen, B.Sc.
Senior Utilities & Rotating Equipment Engineer, Technical Department

[1] van Lier et al., VGB PowerTech 2012 (9), 84
[2] van Lier et al., EPCHem 2008 10-1121-690

Ten Years of Experience with Polyamines in the High-Pressure Steam System of a Naphtha Cracker

ABSTRACT

INTRODUCTION

UPDATE ON NAPHTHA CRACKER POLYAMINE APPLICATION

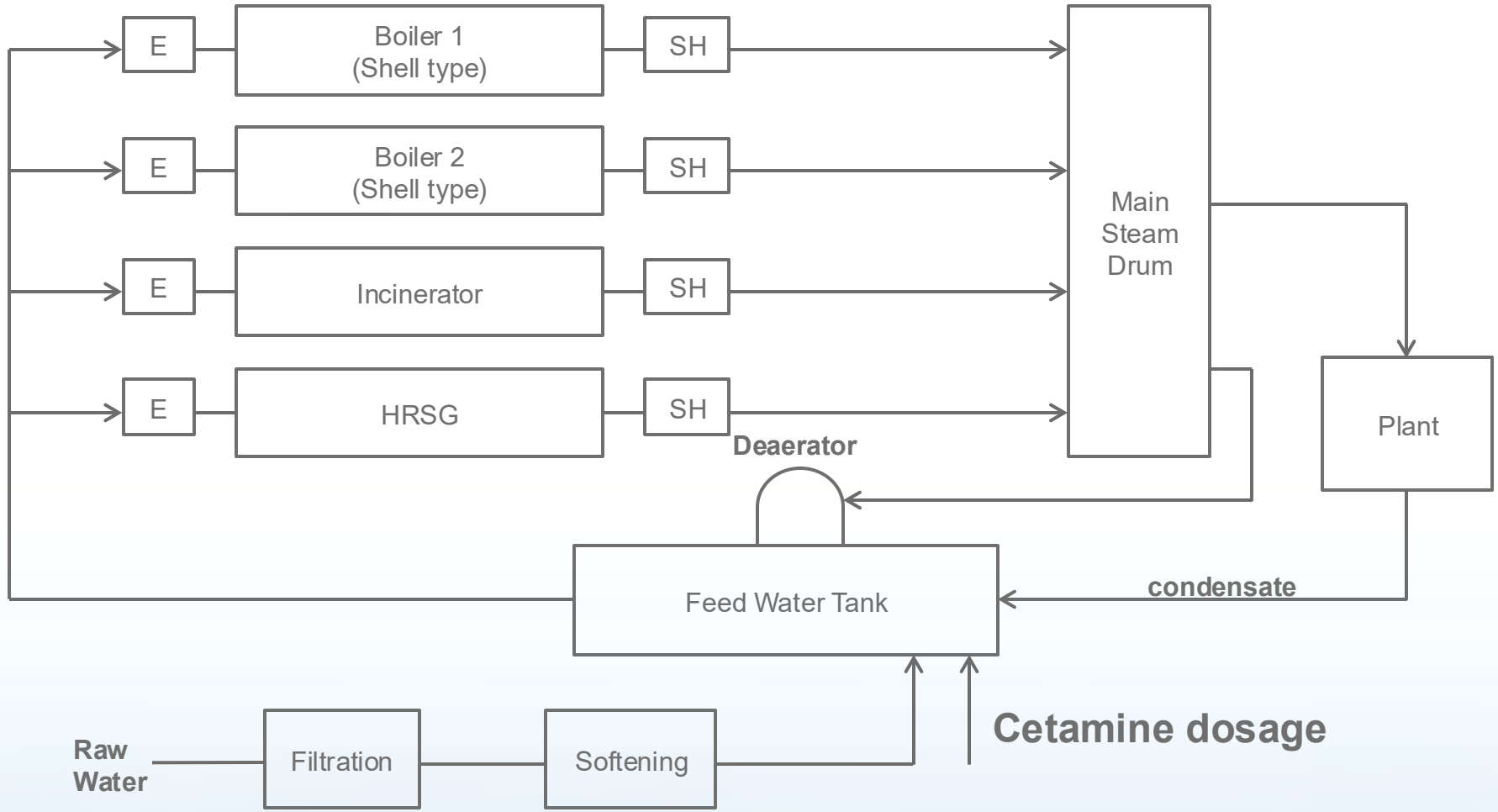
Summary

Air-Cooled Condenser

ce with polyamines
h-pressure steam system
htha cracker
ew to proven treatment

Case Study – Chemical Industry, France
Savings with Cetamine®

Plant Scheme



System Data

• Steam production:	105 000	t/year
• Pressure:	21 to 23	bar
• Superheater temperature:	260 °C	
• Condensate return:	70 %	
• Steam Generators:	2 x 16.5	t/h smoke tube boiler
	1 x 33	t/h water tube boiler (HRSG)
	1 x 8	t/h incinerator

Former Conventional Treatment Approach

- Major challenge is the discontinuous operation of the plant
- Shut-down periods 6 to 7 months per year

- One of the shell boilers under „hot stand-by“

- Sulphite, Phosphate and Alkalizing Amines applied as conventional treatment concept

- Poor treatment results
- Low and fluctuant pH values in condensate system
- High Fe content (> 0.2 ppm) in condensate system
- Low condensate return of temporarely 50 % only

Treatment with Cetamine® Technology

Treatment concept

- Cetamine® V211 (75 ppm on make-up) into feed water tank
- Additionally Ferrolix® 8340 (DEHA) into boilers during long stand-by periods

Significant increase of condensate return due to

- Keeping pH > 8.3 (more than 90 % above 9.1)
- Reduction of conductivity and iron (from above 0.2 to below 0.05 ppm)
- Better passivation of the steam condensers

Treatment with Cetamine® Technology

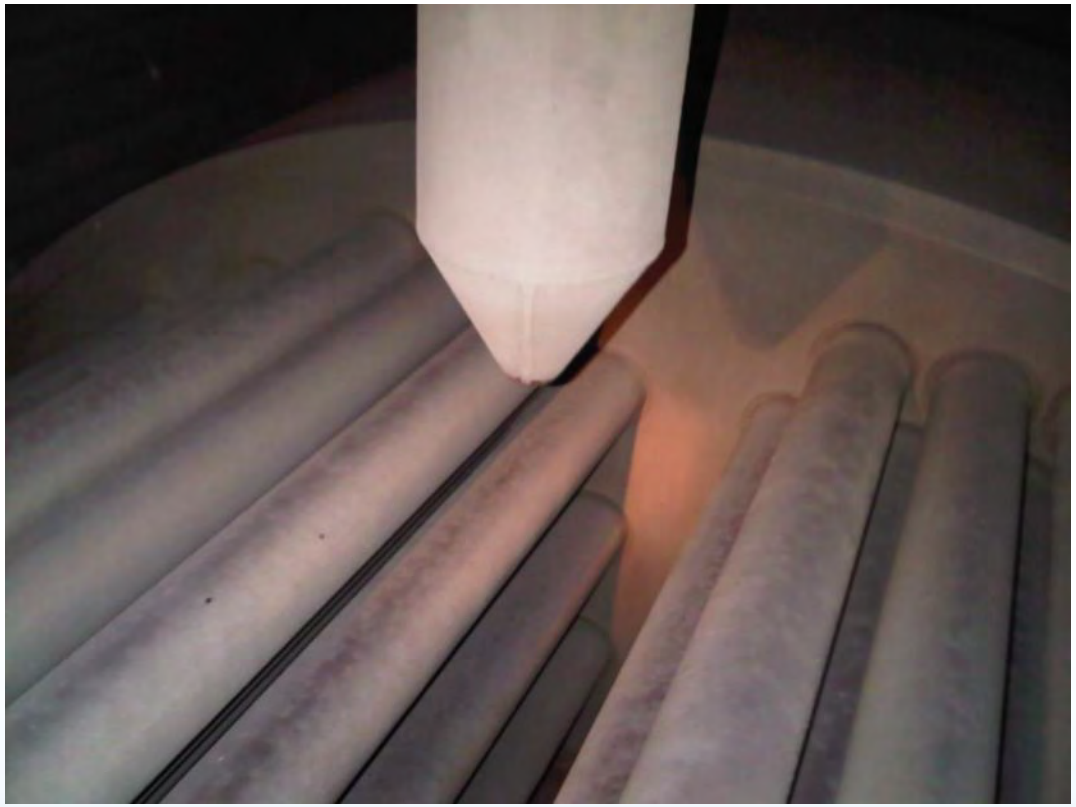
Reduction of blow-down and make-up water due to

- Increased condensate return
- Increased cycles of concentration

Reduction of gas consumption due to:

- Reduction of the steam consumption for reheating of feed water
- Decreased blow-down
- Improvement of heat transfer in boiler

Treatment with Cetamine® Technology



Appearance of Shell-type boiler Treatment with Cetamine® Technology

Comparison of Key Performance Indicators (KPIs)

KPI	Unit	2009 Conventional	2010 Cetamine®	Relative difference
Steam generation	[t/y]	105 317	107 106	+ 1.7 %
Make-up water	[m³/y]	41 157	25 455	- 38.2 %
Condensate return	[m³/y]	72 391	84 418	+ 16.6 %
Stop of steam production	[h/y]	45	29	- 35.6 %
Blow-down	[%]	7.8	2.6	- 66.0 %
Boiler efficiency *)	[t/m³ (N)]	12.1	12.3	+ 1.7 %
- Gas savings on blow-down				*+ 0.88 %*
- Improved heat transfer				*+ 0.43 %*
- Better boiler regime				*+ 0.34 %*

*) Steam production per m³(N) of gas (shell type boilers)

Cetamine® leading to significant savings

Parameters	Savings [€]
Reduction of make-up water	**45 000**
Energy	**62 000**
Reduction of blow-down	41 000
Heat transfer improvement	10 000
Reduction of steam consumption for deaerator	11 000
Reduction of steam production stops	**56 000**
Total	**163 000**

Contact information

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Grande Région | Großregion

Industrie
Énergie

Pascal Jehanno
Arcelormittal Long Products Luxembourg

Brigitte Roeser-Herlin
Metron

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Pioneering the path towards zero-emission steel by 2050

ArcelorMittal Long products Luxembourg

GreenTech Solutions Summit

September 26th, 2024

ArcelorMittal Decarbonization Targets

Scope I and II emissions

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ArcelorMittal

ArcelorMittal Long Products Luxembourg (AM LPL)

1.9 million

is the number of metric tons of crude steel produced in our Luxembourg factories in 2022.

Sheet piling

Produced at the ArcelorMittal Belval and Differdange sites, they are used to retain earth or water to create quay walls, dikes, underground car parks, tunnels, bridges or roads.

Beams

They are produced by ArcelorMittal Belval and Differdange to be integrated in the foundations, structures and/or floors of buildings.

Rails

They are made by ArcelorMittal Rodange to be integrated in public transport systems such as tramways.

Wire and fibers

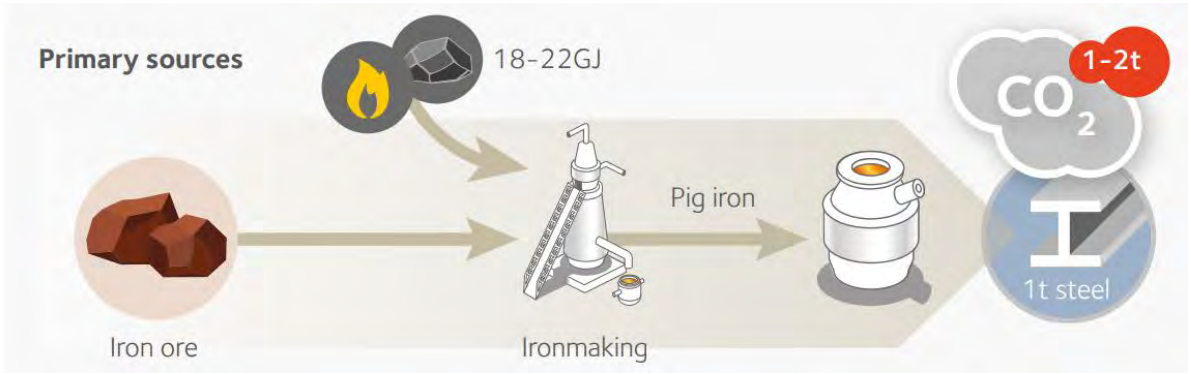
ArcelorMittal Bissen develops a wide range of solutions for fencing in agriculture and the reinforcement of structures in construction.

ArcelorMittal

Strategy for steel Industry decarbonization

Blast Oxygen Furnace (BOF) route

Scope I



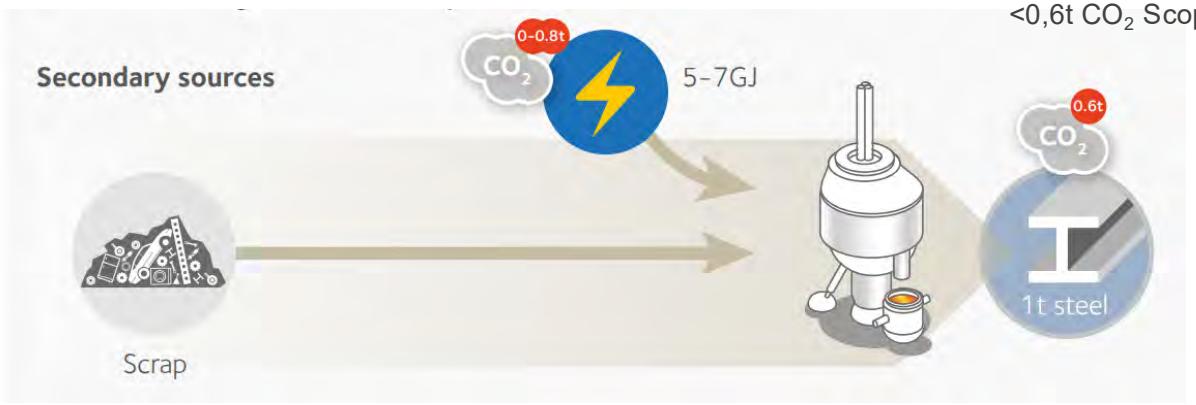
Scope I and II for finished products :

Approx $2t_{CO2}$ / t_{Steel}

Electric Arc Furnace (EAF) route

<0,8t CO_2 Scope II

<0,6t CO_2 Scope I



Less than $0,6t_{CO2}$ / t_{Steel}

AM LPL

- BOF to EAF technology -> Reduction of CO_2 emissions by ~$1,5t_{CO2}/_{tSteel}$
- Main focus for 2030 goals

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AM LPL CO_2 emissions

Over the period 2020 to 2023 emissions of
~0,4t_{CO2}/t_{Steel}

Grey Mill reheating furnace, soaking zone

Scope I : 70% Natural gas
15% Foaming Coal
15% Other emissions

Scope II : Electricity production mix from suppliers

- AM LPL already low carbon steel production
- Further efforts to reach carbon neutrality by 2050
  - A. Improvement of energy efficiency
  - B. Waste heat recovery
  - C. Development of renewable energies
  - D. Replacement of fossil fuels

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Selected ongoing decarbonization projects AM LPL

A. Energy efficiency : Belval's Steelplant Upgrade : SteelUp!

ArcelorMittal Long Products Luxembourg
SteelUp!
Steelplant Upgrade

B. Waste heat recovery : Heat4Steel Cooperation with LIST

C. Renewable energies : Photovoltaic Solar plant for self consumption

D. Replacement of fossil fuels : the hydrogen option

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Project Belval's Steelplant Upgrade

SteelUp! project (youtube.com)

ArcelorMittal Long Products Luxembourg
SteelUp!
Steelplant Upgrade

- Supply of Rodange Rolling Mill
- Convert BOF to EAF route semis

  -150kt CO_2 emissions over Europe
- 15% less energy than previous EAF
- 10kt CO_2 emissions less in Luxembourg
- 67Mio€ CAPEX

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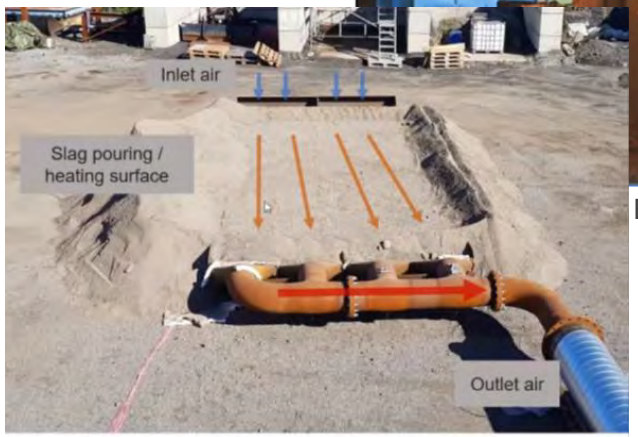
Project Heat4Steel

Waste Heat Recovery : Cooperation with Luxembourg Institute for Science and Technology (LIST)



Examples of heat recovery from slag concepts studies

- Recover energy from waste heat sources, like EAF or Ladle Furnace (LF) slag
- Use the Energy to
  1. Produce Electricity
  2. Reduce own Energy consumption
  3. Serve as heat source for buildings
- LIST support to Optimize Steam and electricity generation from lost heat (Heat2Power®)

Innovative tool to help industries optimize steam and electricity generation from lost heat - ArcelorMittal Luxembourg

Heat2Power® tool (youtube.com)

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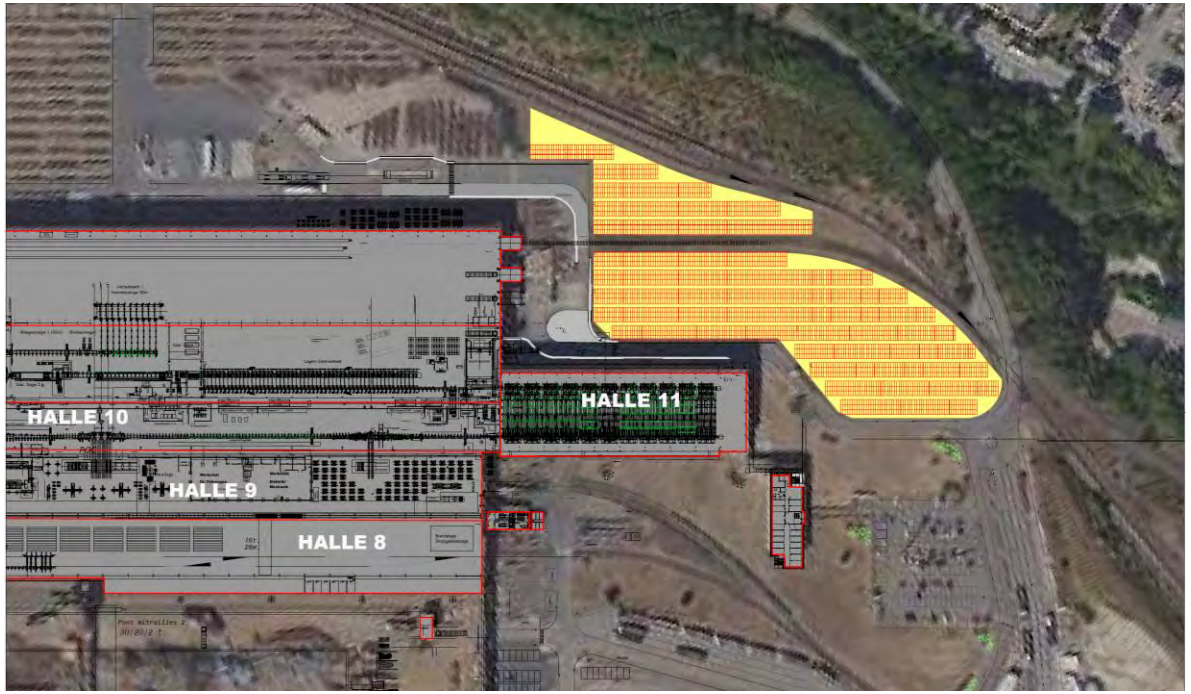
Project Solar Photovoltaic plant for TMB rolling mill



- Setup on unused industrial land
- Respect environmental criteria for RS certification
- 2.3MWp PV solar panels
- Annual production of 2.3GWh
- Reduction CO_2 emissions by ~1kt/year
- Supplies up to 15% of TMB rolling mill Electricity during summer months
- Supplies ~5% of TMB rolling mill Electricity over the year
- Commissioning in Summer 2025

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ArcelorMittal

Replacement of natural gas : the hydrogen option

Current status for AM LPL : be hydrogen ready

- Replacement of current Reheating furnace (RHF) burners with hydrogen compatible burners
- Rolling Mill TMB already partially H_2 ready compatible
- Replacement of ladle preheating burners ongoing
- Replacement of EAF burners ongoing

Ladle preheating burner

Delivery by truck

Challenges of switch from natural gas to hydrogen

- On-site storage for tests / safety regulations
- Supply of large quantities to production sites / Pipeline
- H_2 molecule costs are not competitive in the current environment

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GreenTech Solutions Summit

ArcelorMittal

THANK YOU!

METRON

Digitalize energy management to decarbonize the industrial sector

- Greentech Solutions Summit -
Luxembourg, Sept. 26th 2024

LA FRENCH TECH GREEN20 2022

SOLAR IMPULSE EFFICIENT SOLUTION

GLOBAL CLEANTECH 100 2022

Bloomberg NEW ENERGY FINANCE

THE FIRST FUEL

Reaching your decarbonization goals with one simple trick

RENEWABLE ENERGY

Diversifying your **energy mix** with renewables is a crucial decarbonization level.

36% of the net-zero scenario relies on renewables.

ENERGY EFFICIENCY

Energy efficiency is called the “**first fuel”** in clean energy transitions.

It is the **quickest** and most **cost-effective CO2 mitigation option.**

It represents more than 44% of the emissions abatement needed by 2040

CARBON OFFSET

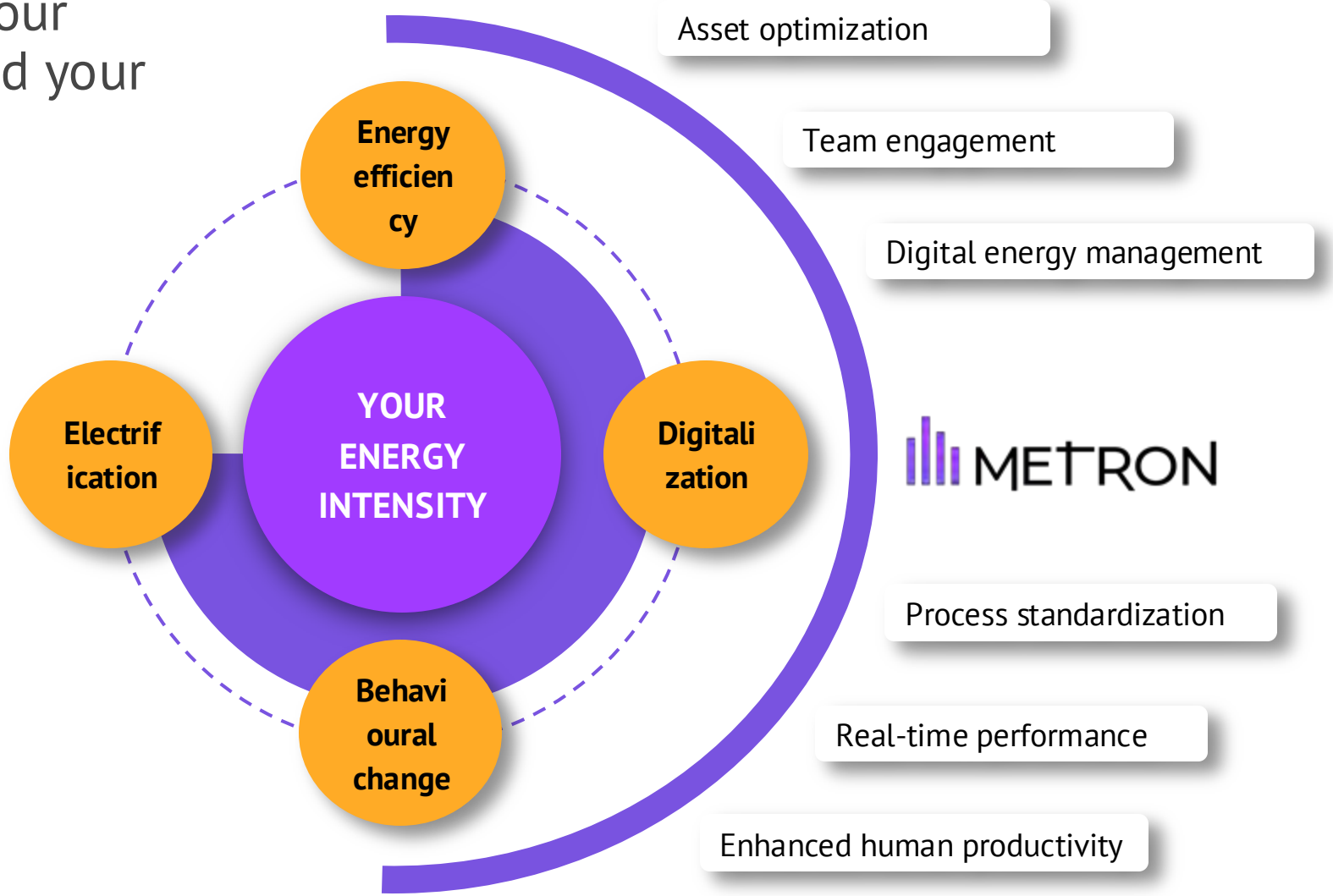
Carbon-mitigating projects are **useful** for industries that are hard to decarbonize.

It represents 9% of the net-zero scenario.

Source : IEA, Energy Efficiency

SHAPING GLOBAL ENERGY INTENSITY

The 4 pillars that make your energy consumption… and your production!



Source : IEA, Energy Efficiency

METRON EMOS

Energy Management & Optimization System

Managing all energetic risks
and make daily better decision.

Hardware Agnostic
Data Acquisition
Management

Energy Performance
Monitoring

Energy Insights
& Analytics

Advanced Energy
Optimization

Carbon
Impact Tracking

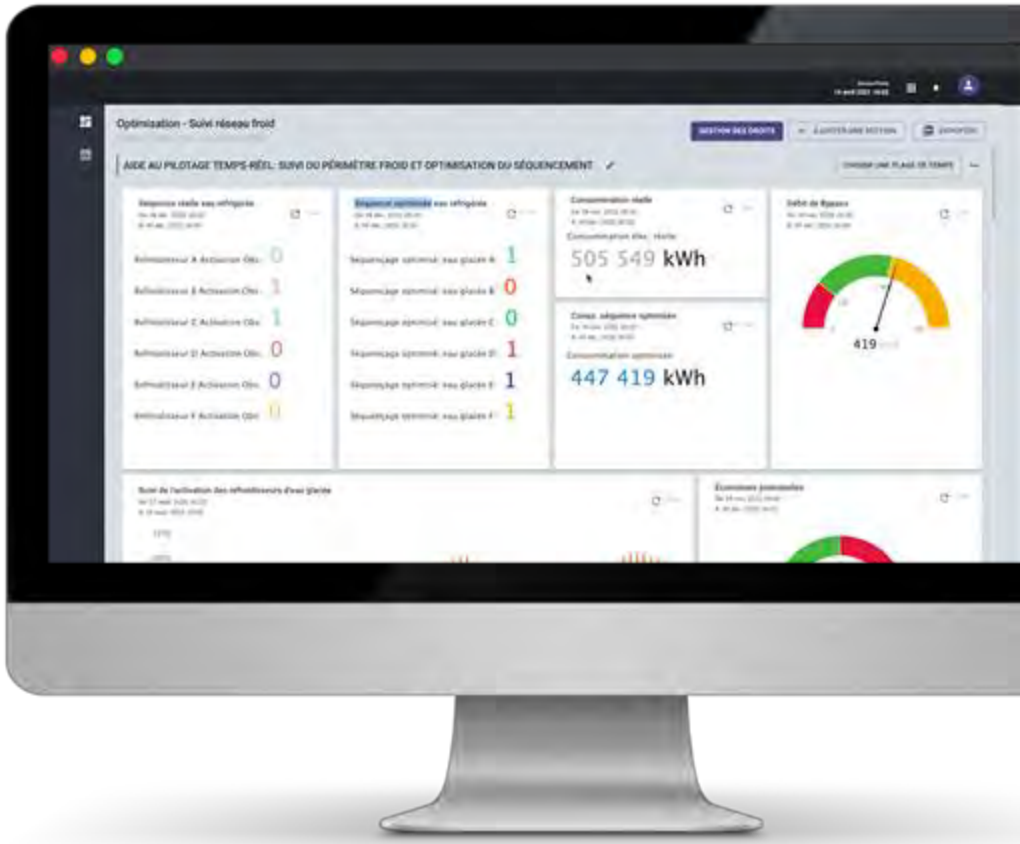
Energy Cost
Management

ENERGY OPTIMIZATION MODULE

Accelerate your path towards energy performance

SINGLE-SITE

- **ENERGY EFFICIENCY** IMPROVEMENT
- **CARBON FOOTPRINT** MONITORING
- **COMPLETE ENERGY** TRANSPARENCY
- **ENERGY BUDGET** OPTIMIZATION
- **ISO 50001** COMPLIANCE
- **TEAM** ENGAGEMENT



ENERGY MANAGEMENT MODULE

Global energy and carbon impact under control

MULTI-SITES

TRUSTWORTHY, CONSOLIDATED
ENERGY & CO2 REPORTING

MULTI-SITE
BENCHMARKING

STANDARDIZATION
OF PRACTICES & TOOLS

ENERGY COST
MANAGEMENT

ENERGYLAB, TO UNDERSTAND ENERGY CONSUMPTION AND OPTIMIZE PERFORMANCE

YOUR POCKET DATA SCIENTIST FOR EVERYDAY ANALYSIS

GET REAL ACTIONABLE INSIGHTS, ANTICIPATE AND ACT FAST

UNDERSTAND

Gain in-depth knowledge of your energy consumption

ANTICIPATE

Uncover actions to optimize your energy consumption

REACT

Detect drifts, continuously **improve** processes

QUANTIFY

Demonstrate savings thanks to reliable models (IPMVP compliance)

WE MAKE 25.000 SITES ENERGY EFFICIENT

Food & Beverage

DANONE ONE PLANET. ONE HEALTH · Savéol · Buencafé Liofilizado de Colombia · TERRENA LA NOUVELLE AGRICULTURE · GRUPPO CAMPARI · GROUPE SAVENCIA Saveurs & Spécialités · Avril · MAYORA · Cofigeo LA CONSERVERIE DU GOÛT

Glass

GROUPE POCHET · SAINT-GOBAIN · ZIGNAGO VETRO

Chemical

KEM ONE · CABOT · bcf Life Sciences · Brinsa Química

Automotive & Aeronautics

SAFRAN · Autoliv · faurecia inspiring mobility · JTEKT · OP PLASTIC OMNIUM

Cement & Mining

MANAGEM · etex · CARMEUSE

Plastics/ Packaging

Berry · ITW · dauniaplast · WP innovative packaging

Paper

Carvajal · WIZPAPER

And many more...

PUIG · IMERYS · Aptar · Industeel ArcelorMittal · ARMOR · AFV BELTRAME GROUP · COGENIO

Tertiary & Public

Cofinimmo · LYON AÉROPORT · LIEGE AIRPORT · Goodman

Glass & Luxury Annealing furnaces

SUCCESS STORY

CONSUMPTION
Gas: 255 GWh/year
Electricity: 55 GWh/year

PRODUCTION
Glass bottles (1M/day)

MAIN ASSETS
Annealing furnace

CARBON FOOTPRINT
100 tCO_2eq (Scope 1-2-3)

CONTEXT

- With the support of one of its client — a iconic luxury brand —, the site wants to reduce its carbon footprint (scope 3)
- The site has a sustainability plan to reduce its carbon footprint by 50% before 2030

RESULTS

For a period of **1 year,** we achieved:

-27% gas consumption in the annealing furnace

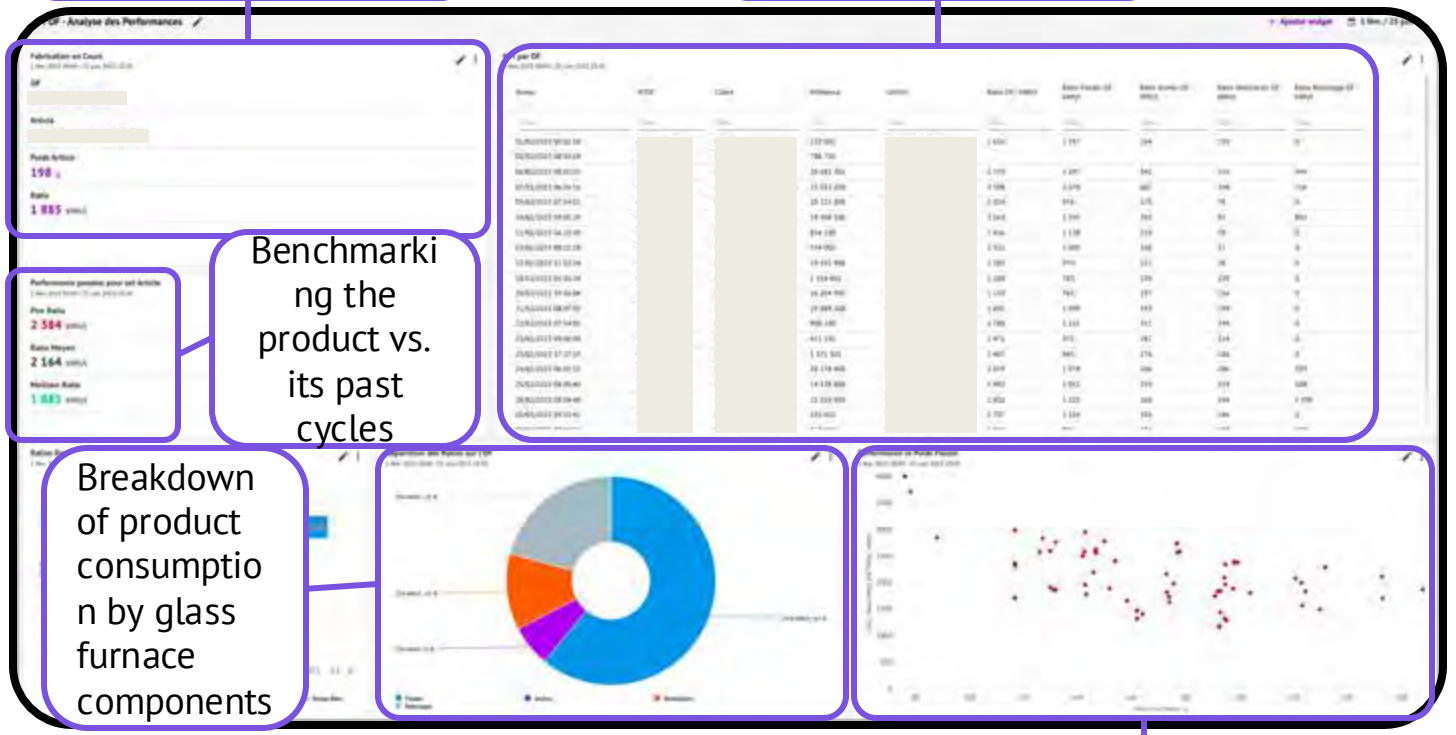
The energy consumption of the plant is **under control**

An empowered and proactive team

REDUCING ENERGY CONSUMPTION AND CALCULATING CARBON IMPACT, PRODUCT BY PRODUCT

Energy performance of the current product

All products or batches with kWh/t calculations



Benchmarking the product vs. its past cycles

Breakdown of product consumption by glass furnace components

Analysis of the kWh/t as a function of the weight of the glass bottle

VISUALIZE

Glass & Luxury Annealing furnaces

SUCCESS STORY

CONSUMPTION
Gas: 255 GWh/year
Electricity: 55 GWh/year

PRODUCTION
Glass bottles (1M/day)

MAIN ASSETS
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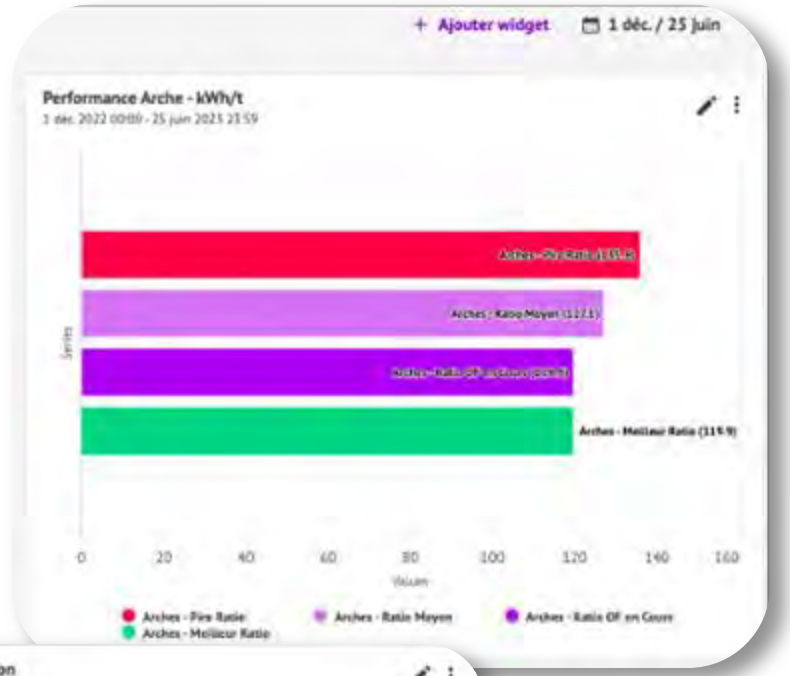
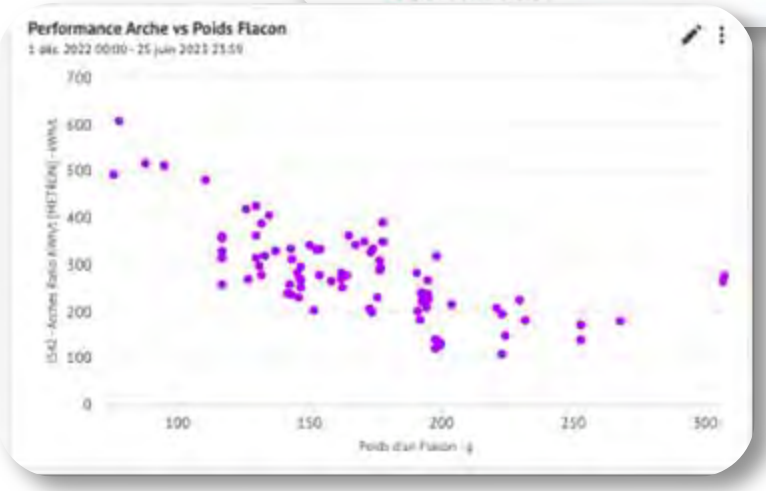
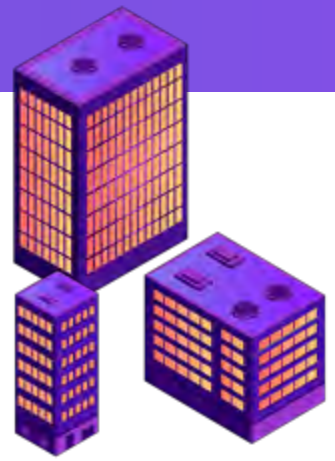
REDUCING ENERGY CONSUMPTION AND CALCULATING CARBON IMPACT, PRODUCT BY PRODUCT

OPTIMIZE





DIGITALIZE YOUR ENERGY & DECARBONIZATION STRATEGY



FROM CORPORATE ROADMAP

Standardize your **worldwide energy management…**

TO ACTIONS ON THE FIELD

…and implement **local monitoring and actions!**

200+ groups

25,000+ sites monitored

From **all sectors**: Food & Beverage, Iron & Steel, Paper & Pulp, Glass, Chemicals, Pharmaceuticals, Automotive, Utilities….

METRON

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Bioéconomie

Philipp Hauser
Soler group

Laetitia Urbanczyk
CERM - University of Liège

Interreg
Cofinancé par l'Union Européenne
Kofinanziert von der Europäischen Union
GREATER GREEN
Grande Région | Großregion

Innovative technologies for climate neutrality

Climate-Smart Forestry and Carbon Management: Key to Industrial Climate Neutrality and Regional Development

Responsible charcoal | Biocarbon | Biochar | Renewable energy | Molecules

Soler

www.soler-group.com

SOLER GROUP

Leader in renewable carbon production, offering sustainable solutions for climate neutrality

1993

The Soler-My family founded the **historic production site** in Gyé-sur-Seine (France)

8 patents

12% of staff dedicated to **R&D**

1 Mt of CO_2e avoided

since 2012

3 biorefineries

Operating in **France** (2 in Gyé-sur-Seine + 1 in Lacanau)

50,000 tonnes

of **renewable carbon** produced per year

RED II certified

+200 employees

In **France** and **abroad**

52,000 MWh

of **green electricity** production a year, eq. to the consumption of 20,000 households

10,000 tonnes

biocarbon delivered to metallurgical industries

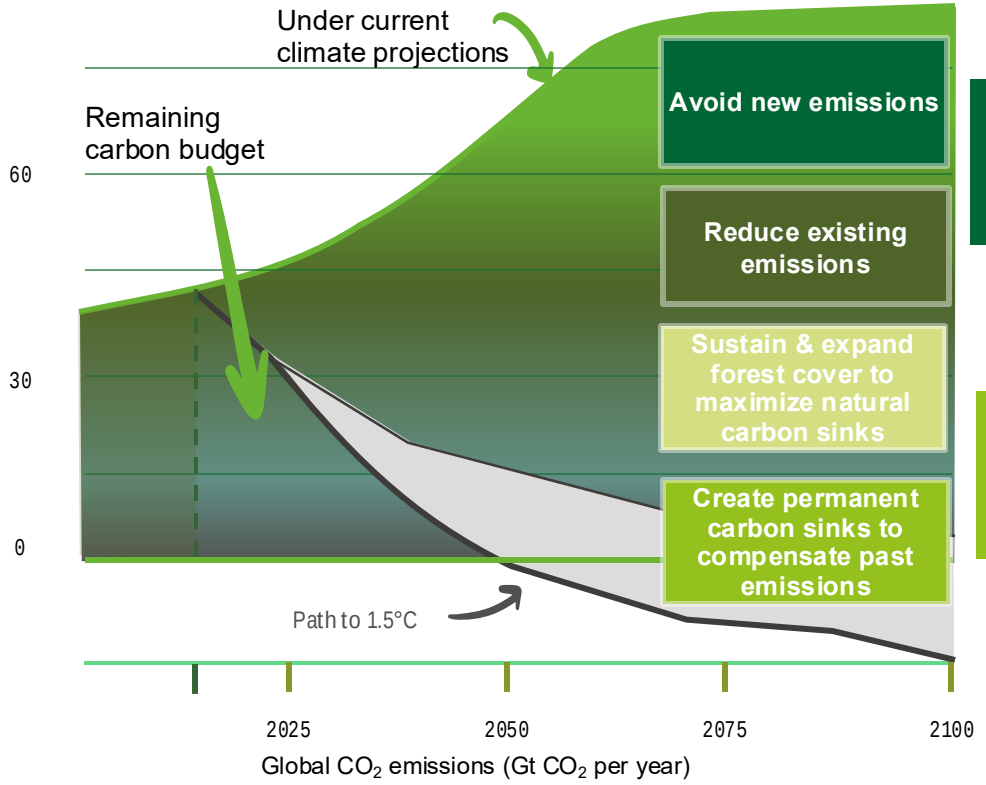
Innovative technologies for climate neutrality

The fight against climate change requires strong strategies for carbon management to reduce GHG emissions and amplify carbon sinks

URGENT NEED TO MITIGATE CLIMATE CHANGE

The avoidance of new, and the reduction of existing emissions is a priority to limit climate change. At the same time, **sustainable carbon removal strategies must be developed and scaled to achieve climate neutrality**

Limiting climate change requires emission reductions & removals



GHG EMISSIONS REDUCTION
to limit climate change

CARBON REMOVAL
to compensate for unavoidable and remove past emissions

CARBON MANAGEMENT SOLUTIONS

The SOLER Group's sustainable production of biocarbon and its use as a **strategic feedstock to produce climate neutral and climate positive materials** is a holistic, safe and immediate solution for global implementation at scale

3 technology-based strategies to reduce GHG emissions

Clean production technology | **Biocarbon & Molecules** | **Increasing material efficiency**

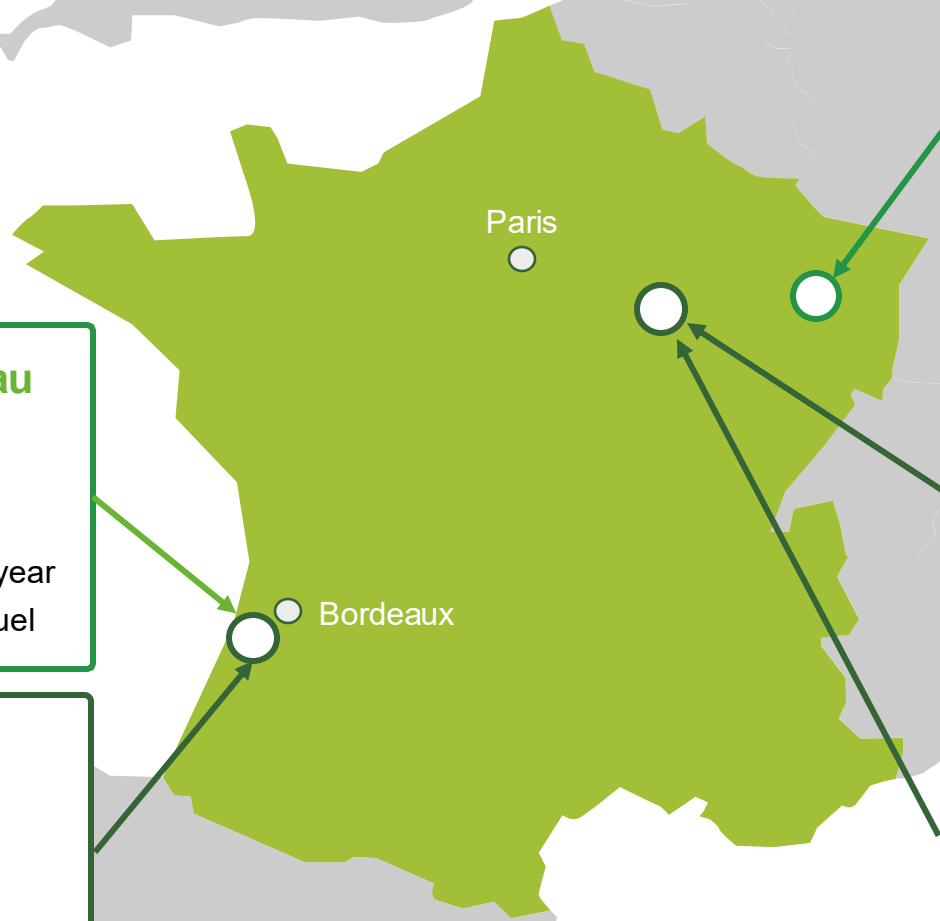
3 nature- & technology-based strategies to generate carbon sinks

Climate Smart Forestry | **Biochar** | **Technical carbon sinks**

Sources: IPCC, Mercator Research Institute, European Biochar Industry

SOLER GROUP

An innovative technology with over a decade of industrial scale operation and 2 advanced projects under development in France



Project: Lacanau biorefinery II

Nouvelle-Aquitaine, France (→ 2026/27)

- 20,000 tonnes per year
- 13,600 t of Bio-e-Fuel

Lacanau biorefinery I

Nouvelle-Aquitaine, France (2021)

- 20,000 tonnes per year
- 12,000 MWh per year

≈ 30km supply radius in Gironde department, perpetual plantations of maritime pine

Project: Epinal

Grand Est, France (→ 2026/27)

- 40,000 tonnes per year
- 15,000 t of Bio-e-Fuel

Gyé-sur-Seine biorefinery I

Grand Est, France (2012)

- 10,000 tonnes per year
- 28,000 MWh per year

Gyé-sur-Seine biorefinery II

Grand Est, France (2019)

- 20,000 tonnes per year
- 12,000 MWh per year

≈ 62km supply radius in Aube and Yonne departments, sustainable forest management with diverse species

Confidential document. Do not share.

Soler

Forests at the heart of SOLER System

SOLER promotes climate-smart forestry as the fundament of a climate neutral economy

- Sourcing of wood residues from **sustainably managed forests** located **within a 100km radius** of production sites
- Use of wood residues promotes forest management in favor of **biodiversity, resilience and enhanced CO2 sequestration**
- **Recovery of calamity wood** supports reforestation after forest fires, disease or wind break and prevents further disasters

+ The upcycling of low-value wood residues into renewable carbon and molecules allows to **maximize climate benefits by connecting nature- and technology-based solutions**.

Verified and **certified** process

sbp · EBC · Earthworm · PEFC (Promoting Sustainable Forest Management, www.pefc.org) · bois-de-france (Forêt Française Fabrication Française) · Origine France Garantie (FCBA 1703100) · WWF Entreprendre pour la Planète

The SOLER technology & concept for nature-positive production

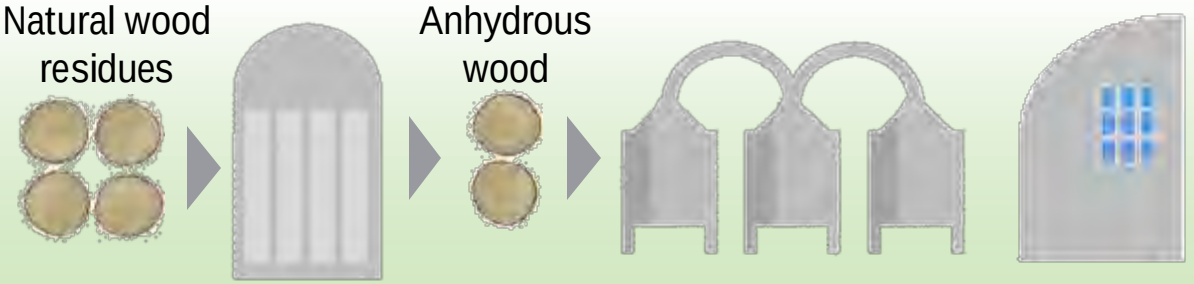
Proven bio-refinery technology with benefits for forests to produce biocarbon with tailored qualities that maximize GHG reduction and sequestration in industry and agriculture

FEEDSTOCKS

Climate Smart Forestry & Agriculture

Cooperation with Forest owners & operators

BIOREFINERY



SOLER biorefinery process is based on a unique & proprietary technology that is self-sustaining and allows to export energy without the use of fossil fuels.

PRODUCTS

Gas valorization → Electricity, Biomolecules

Biocarbon → Bio-reductant, Biochar

Cooperation with clients to develop products with tailored qualities and maximum climate benefits

Technology with superior advantages

Integrated solution with low environmental impact

Focus on **resource efficiency** and the support to **climate smart forest management**

Proven technology with 3 plants that operate with **reliable and high load** factors

Producing **biocarbon with replicable and reliable qualities to offer best value-in-use**

Available for immediate replication at scale for rapid industrial transformation.

Proven capacity to build new units within 1 year

Valorization of pyrolytic product gases eliminates GHG emissions and ensures financial and resource efficiency.

Low LCA emissions of **0,14 tCO_2 per t of Biocarbon**

Technology & sustainability open the door to new opportunities

Biocarbon & Syngas use for climate neutral and resource efficient production in diverse industries

1 | BIOCARBON

Biocarbon with optimized properties to substitute fossil feedstocks in industries where biocarbon is the only path to climate neutrality

PRIMARY & SECONDARY STEELMAKING

PRODUCTION OF FERROALLOYS

PRODUCTION OF SILICON

2 | BIOCHAR

Biochar is optimized as additive in agriculture and industrial materials to generate a permanent carbon sink and additional benefits

SOIL IMPROVEMENT IN ARGICULTURE

FEED ADDITIVE IN HUSBANDRY

MATERIAL ADDITIVE IN CONCRETE & PLASTIC

3 | ELECTRICITY, HEAT & SYNGAS

Syngas can be used for the cogeneration of electricity and heat or for Bioenergy with Carbon Capture & Storage in industrial processes

ELECTRICITY & HEAT GREEN PPA & SALE

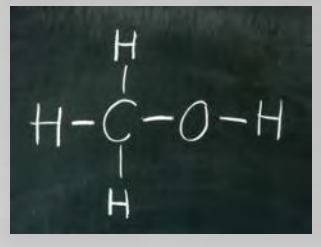
RENEWABLE SYNGAS FOR CEMENT-KILNS

RENEWABLE REACTANT FOR DRI-BASED STEEL

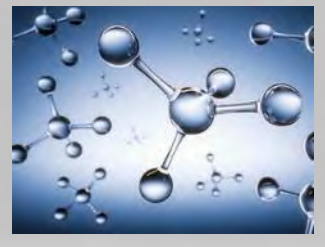
4 | BIOMOLECULES

Large scale production of syngas allow producing green chemicals and renewable transport fuels

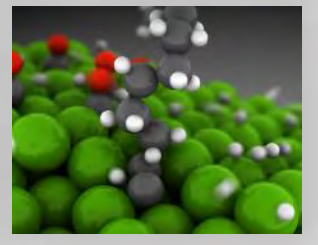
BIO-METHANOL AS CHEMICAL FEEDSTOCK



BIO-METHANE FOR GAS-GRID INJECTION



GREEN NAPHTA FOR SAF PRODUCTION



1 | Biocarbon demand for industrial uses

Biocarbon use for climate neutral and resource efficient production in metallurgical industries

PRIMARY AND SECONDARY STEELMAKING

Biocarbon allows near climate neutral & potentially climate positive steel production:

- Biocarbon **PCI** or direct use in **BF-BOF**
- Biocarbon for **slag-foaming in EAF** for DRI & Scrap based steel production.
- Negative emissions with **BECCS**

PRODUCTION OF FERROALLOYS

Biocarbon as **renewable reductant minimizes** emissions of alloy production

- Biocarbon **reduces the Product Carbon Footprint** of ferroalloys
- Local production allows **substituting import of fossil reductants.**

➢ **Reduces Scope 3 of Steel**.

PRODUCTION OF SILICON

Biocarbon is key to expand **sustainable and near climate neutral production of silicon metal** as strategic raw material:

- Biocarbon **reduces direct emissions.**
- Biocarbon with high reactivity **reduces specific energy consumption**.
- Biocarbon allows producing **high purity silicon** with low refining costs.

Minimum estimated demand for Biocarbon (Mt) in a scenario of climate neutrality (zero growth)

Global	**40**	**40**	**5**
EU	3	2	0.6

2 | SOLER Biochar & Nature positive carbon removal solutions

The use of SOLER biochar supports climate smart forest management and creates permanent carbon sinks to compensate otherwise unavoidable GHG emissions

- SOLER biochar is a high-carbon, fine-grained material used to create **permanent carbon sinks** with benefits in agriculture and construction.
- The use of our biochar in fields enhances their productivity and water retention and contributes to the **sustainability and climate adaptation of our agriculture.**
- The use of our biochar to produce innovative construction materials allows to design **buildings as permanent carbon sinks.**
- SOLER biochar is produced from wood residues generated by the **sustainable management of local forests** and contributes to the **adaptation and climate resilience of forest landscapes.**
- SOLER biochar is produced and used according to the Norm of the European Biochar Initiative which allows us to generate and sell **carbon removal credits of the highest quality.**
- We cooperate with companies that are committed to reduce their emissions and use carbon removal credits to **compensate residual and unavoidable emissions.**

EUROPEAN BIOCHAR q.inspecta CERTIFIED

SOLER biochar for agriculture

Certified carbon removal and agricultural benefits from biochar produced at Soler facilities in Gye Sur Seine & Lacanau

Soler biochar is certified for use in organic agriculture according to regulation CE 8 89/2008

Agricultural benefits are:

- **Enhanced water & nutrient retention of soils**
- **Boost nitrogen fixation & the availability of nutrients**
- **Increase the biologic activity of soils & humus accumulation**
- **Permanent Carbon Storage in soils**

Carbon Removal Benefit

O

1 ton of biochar → **2,9 tons** of CO_2 stored

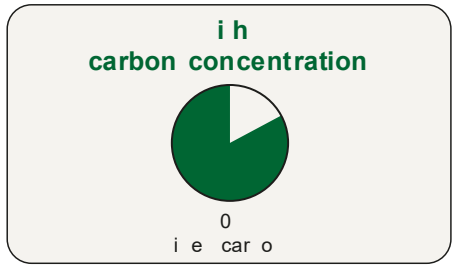
EUROPEAN BIOCHAR q inspecta CERTIFIED

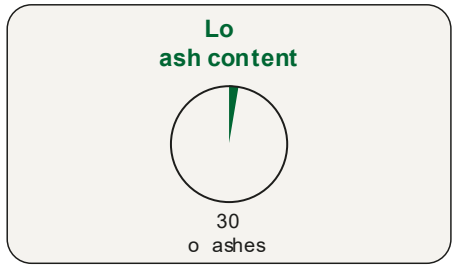
Certi ie iochar

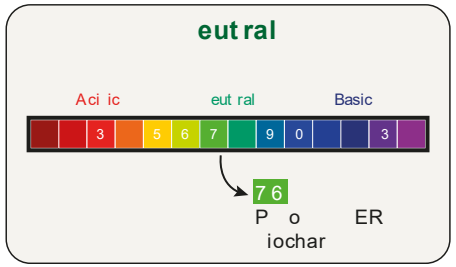
Find out more

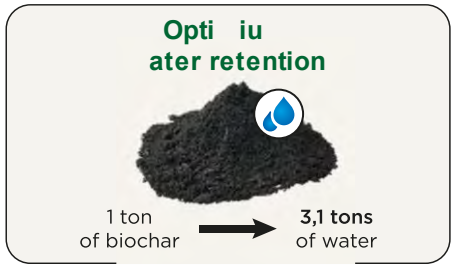
Biochar produced in Gyé sur Seine

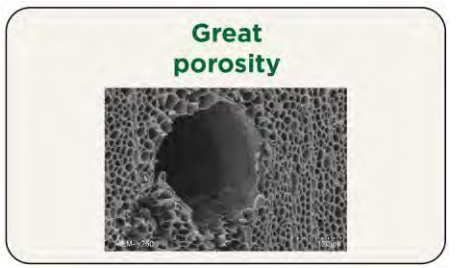
Biochar produced in Lacanau











SOLER biochar for construction

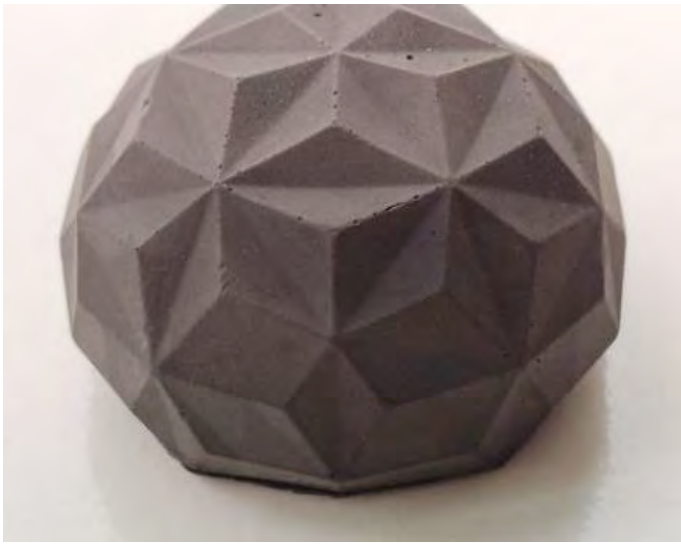
Certified carbon removal from biochar produced at Soler facilities in Gye Sur Seine & Lacanau

Construction material benefits include:

- Permanent Carbon storage
- Improves the heat and sound insulation of buildings[1]
- Reduces the proportion of clinker in cement
- Improves humidity regulation characteristics
- Imparts a unique finish on concrete in application

Carbon Removal Benefit

1 ton of biochar → **2,9 tons** of CO_2 stored



Test mould made with Biochar-cement, now sold for construction projects under the CARAT brand. Photo credit: VICAT

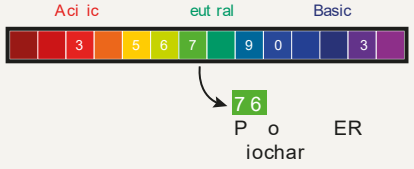
i h carbon concentration

0
i e car o

Low volatile concentration

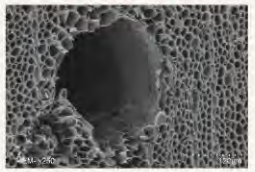
<18% volatiles

eut ral



Optimised granulometry

Great porosity

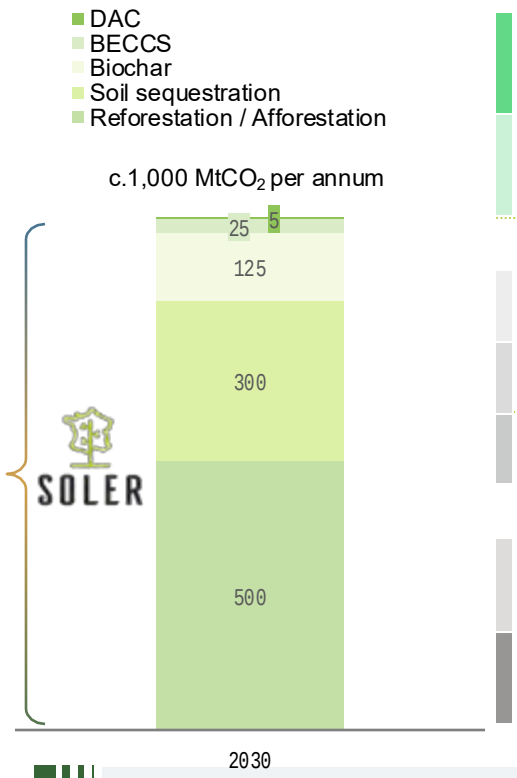


1. Cuthbertson, D., Berardi, U., Briens, C. & Berruti, F. Biochar from residual biomass as a concrete filler for improved thermal and acoustic properties. *Biomass and Bioenergy* **120**, 77–83 (2019).

The role of carbon removals on the way to climate neutrality

Carbon removal credits are the most appropriate strategy to compensate otherwise unavoidable GHG emissions. SOLER offers a package with optimized cost, permanence as well as social and economic benefits

Total additional carbon removal demand (in MtCO2)[1]



Three classes of negative emissions	Selected examples of negative emissions technologies	Cost €/tC$_2$	Availability	Duration	ESG-benefits
Technology-based solutions	Direct air carbon capture & storage (DACCS) — Artificial capturing & geological sequestration is **energy intensive and expensive** but can remove CO_2 from atmosphere. Available volumes are still small.	400 - 1000			
	Bioenergy carbon capture and storage (BECCS) — oler evelops this solutio at o a die ts' sites. **Syngas & biocarbon are used and renewable CO_2 is captured and stored**. Available volumes are still small	200 - 400			
Enhanced natural processes	Mineralization of biogenic CO_2 — Renewable **CO_2 is combined with minerals to permanently remove carbon from the atmosphere.** Soler is discussing with partners to develop this solution.	150 - 250			
	Biochar to enhance soil sequestration[3] — Biochar[4] with enhanced agriculture techniques increases the amount of CO_2 stored in soils and increases the yields and climate resilience of crops	200 - 400			
Nature-based solutions	Climate smart forest management — The use of forest management residues by the bio-refinery finances forest management to increase biodiversity, resilience & ecosystem benefits of forests[6]	10 - 40	?		
	Reforestation & afforestation — The recovery of destroyed or the planting of new forests can be financed by using the resulting biomass as feedstock for the bio-refinery	10 - 40			

SOLER

Holistic solution

- **SOLER produces biochar from sustainable forest management residues to convert the temporary carbon stock of wood into a permanent carbon stock in agriculture**
- **By purchasing wood residues from forest owners such as the ONF, we support the sustainable management of forests with their respective socio-environmental benefits**
- **By providing biochar for agriculture, we support the productivity, sustainability and climate resilience of farmers and their crop production**
- **In summary, we provide a holistic and nature positive solution that results in permanent and independently certified carbon sinks as well as ESG benefits in forest and agriculture**

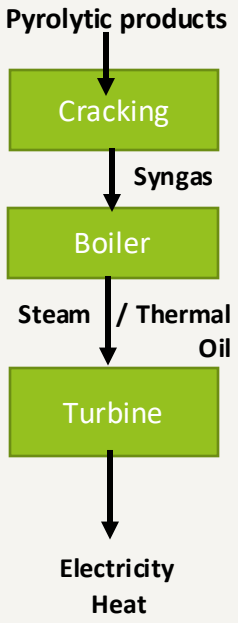
Source: *Reputable Strategic Consultant*
Notes: (1) BCG estimates that national pledges and voluntary market demand for carbon removal will total 3 Gt in 2030, of which 2 Gt will be met through natural ecosystem removal. This leaves an additional demand of 1 GtCO2e

3 & 4 | Valorising pyrolytic residues

Avoiding methane and other polluting emissions is an environmental imperative
Converting residual gases into renewable energy & products generates economic and environmental value

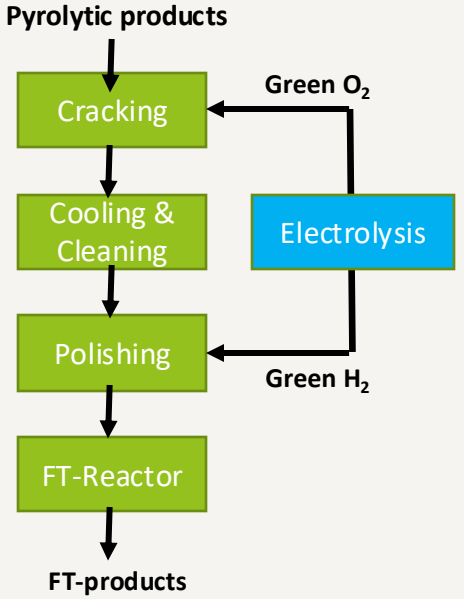
Today: Energetic valorization of pyrolytic waste gases

- Volatile pyrolytic products are converted to **syngas to avoid condensates and facilitate valorization**
- **Combustion of syngas** to power a steam turbine (3.3 MWe) or an ORC (1.4 MWe)



Tomorrow: Chemical valorization of pyrolytic waste gas

- **Syngas is combined with green hydrogen** to obtain **the optimal ratio of CO to H_2**
- **FT-Reactor transforms syngas into Bio-e-Fuels & to maximize environmental & economic value**



Opportunities and need for biocarbon in the Greater Region BeDeFraLux

The production and processing of iron & steel, ferrous and non-ferrous metals as well as lime, clinker and cement are fundamental to the economy of the Greater Region and their transformation is key for its climate neutrality

Biocarbon is key for the climate neutrality of pig iron & steel production and processing:

- as charge & injection coal for climate-friendly steel production from scrap or H_2-DRI
- as substitute to fossil PCI in Bf-BOF
- As complement to anthracite and foundry coke in cupula furnaces

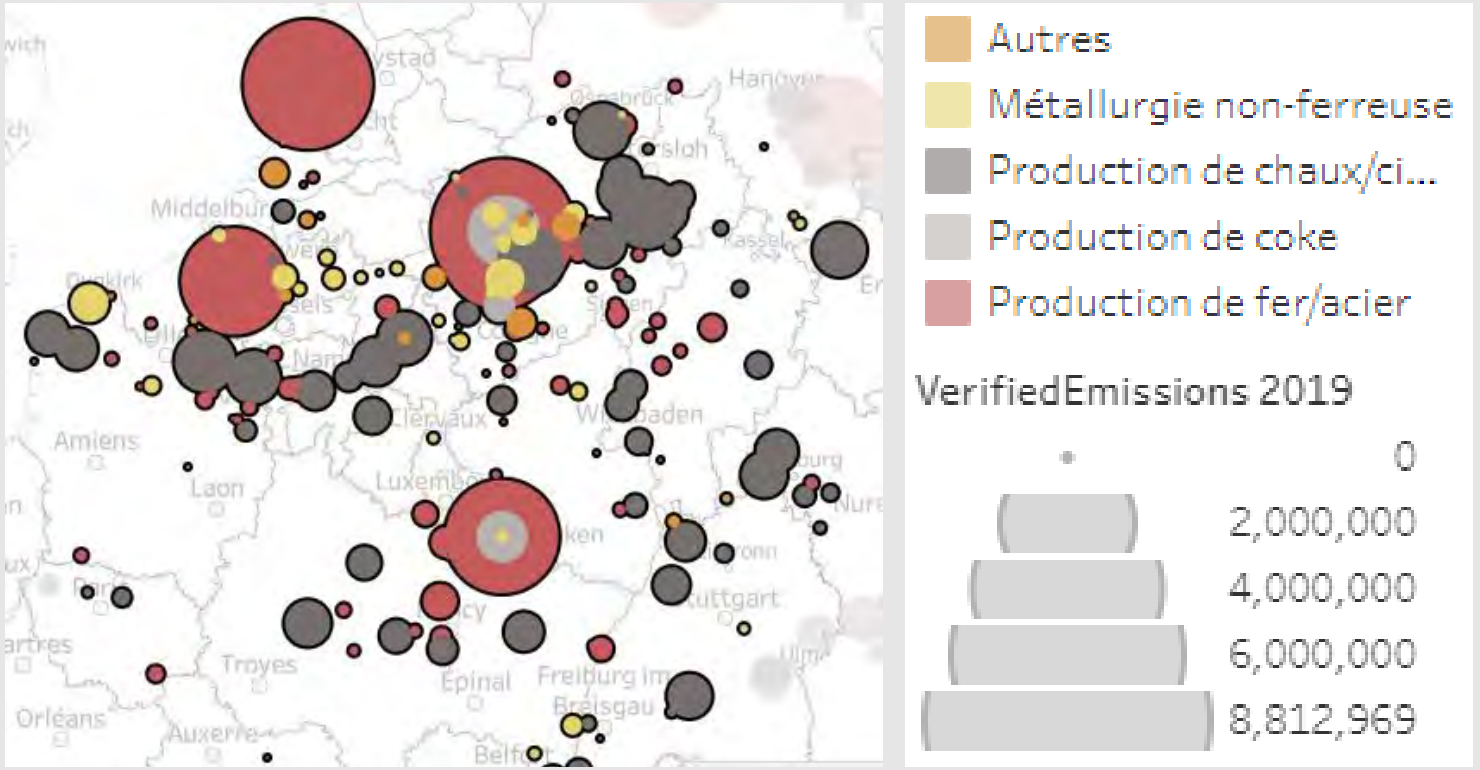
Biocarbon is only alternative for the climate friendly production of silicon and ferroalloys:

- Green Silicon is key to the production of climate friendly PV panels microchips and high-performance materials
- Ferroalloys are key to producing green steel

Biocarbon supports the climate positive production of lime and concrete

- Biocarbon helps using other alternative fuels
- In combination with CCS, climate positive production of lime and cement is possible

The production of metals, clinker and lime is in the greater region of Belgium, Germany, France and Luxemburg is responsible for more than 60 Mt of CO_2



Source: EU ETS | Tableau Public

The Synblaze My-Vosges Project in Epinal

At the heart of a dynamic industrial hub, the project produces 40 kt biocarbon & 15 kt e-Fuels to support climate smart forestry in the Vosges & climate neutrality for industries in France, Germany & BENELUX.

The Ecoparc & Green Valley industrial platforms in Epinal offer an ideal ecosystem for a biorefinery

- Public & private forests require **improved forest management with environmentally and economically attractive uses of low-value wood** (calamity wood, saw-mill off-cuts and thinning residues).
- A **strategic position allows** supplying heavy industries in the east and north of France, Switzerland, Germany and Benelux.
- **Logistic infrastructure reduces cost** (rail, canal, road).
- **High voltage grid connection** and other facilities offered by the industrial park facilitate development
- **An ecosystem of green energy & forest -based companies** allow synergies and enhance circularity
- **Strong support and guidance from the local authorities**

→ SUBSIDIES : PROJECT WINNER OF PUBLIC SUBSIDY

APPEL À PROJETS
FRANCE 2030
PREMIÈRE USINE

13,3 M€

A virtual visit to our production sites in Gyé sur Seine – Grand Est

Click on the image

Soler

www.soler-group.com

Thank you for your interest!

Philipp D. Hauser

Business Development Director

philipp.hauser@soler-group.com

Biosourced polyurethane foams:
a sustainable and industrially-adaptable solution developed at ULiege

Laetitia URBANCZYK – CERM

Greentech, Luxemburg 26-09-2024

About myself

CENTER FOR EDUCATION AND RESEARCH ON MACROMOLECULES

Ph. D. thesis Polymer chemistry 2010

Polystyrene foams / CO_2

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CENTER FOR EDUCATION AND RESEARCH ON MACROMOLECULES

Ph. D. thesis Polymer chemistry 2010

Polystyrene foams / CO_2

Expandable polystyrene foams (EPS)

TotalEnergies

R&D plastics

Lab

Industrial production

Back to CERM 13 years later…

CENTER FOR EDUCATION AND RESEARCH ON MACROMOLECULES

Post-doc – foams development since 2023

Back to CERM 13 years later…

CENTER FOR EDUCATION AND RESEARCH ON MACROMOLECULES

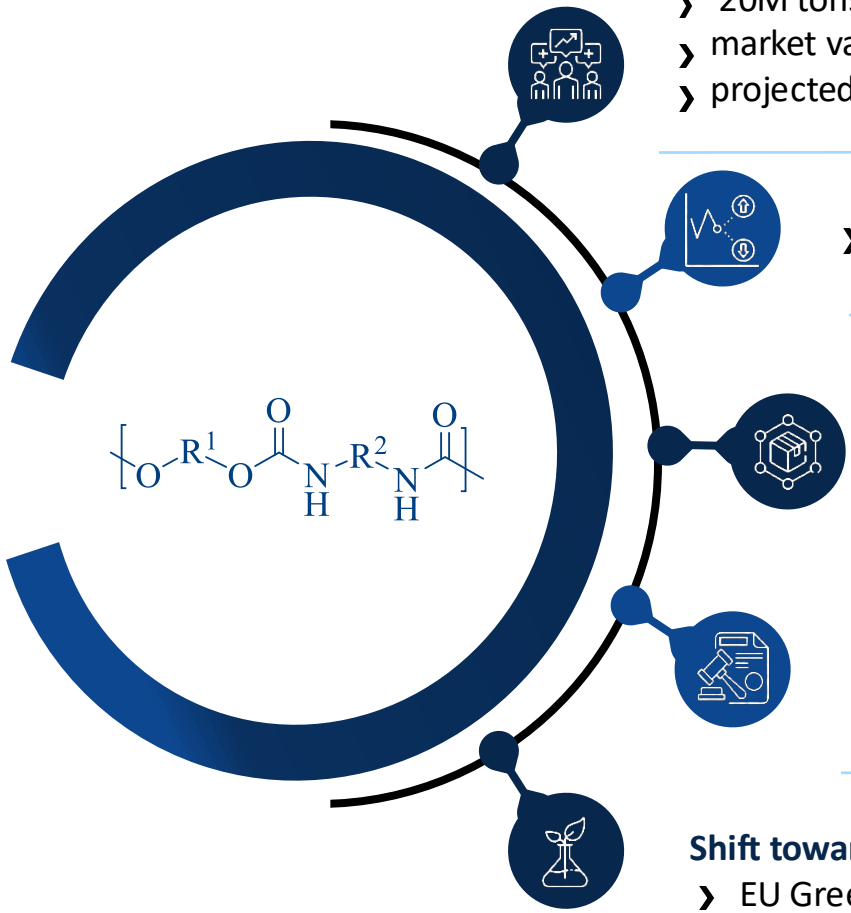
Post-doc – foams development since 2023

NIPU foams

Non-isocyanate polyurethane

16 researchers, 2 technicians – 10 years of know how

Why NIPU? → PU context



Increasing demand

- 20M tons/year
- market valued at USD 80B in 2022
- projected to grow to USD 119B by 2032

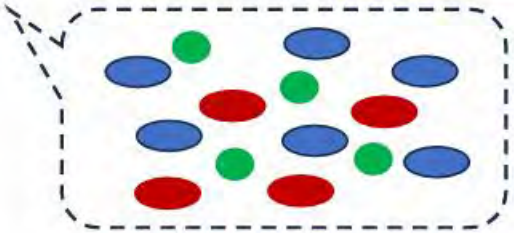
- **Volatile Feedstock Prices of isocyanates**
- **Supply Chain Disruptions of isocyanates**
- **Regulatory Pressure on isocyanates and end-of-life PUs**

REACH restrictions

Shift towards green chemistry

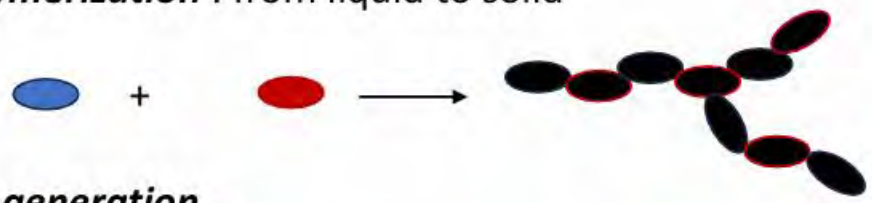
- EU Green Deal

Self-blowing polyurethane



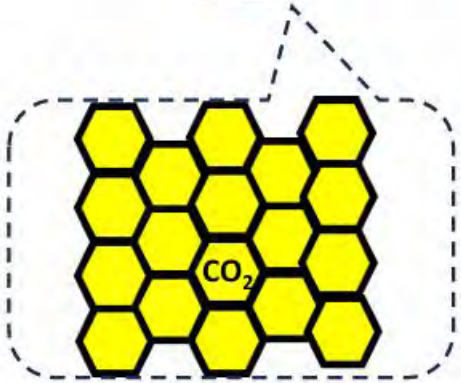
Chemical reaction

Polymerization : from liquid to solid



Gas generation

expansion



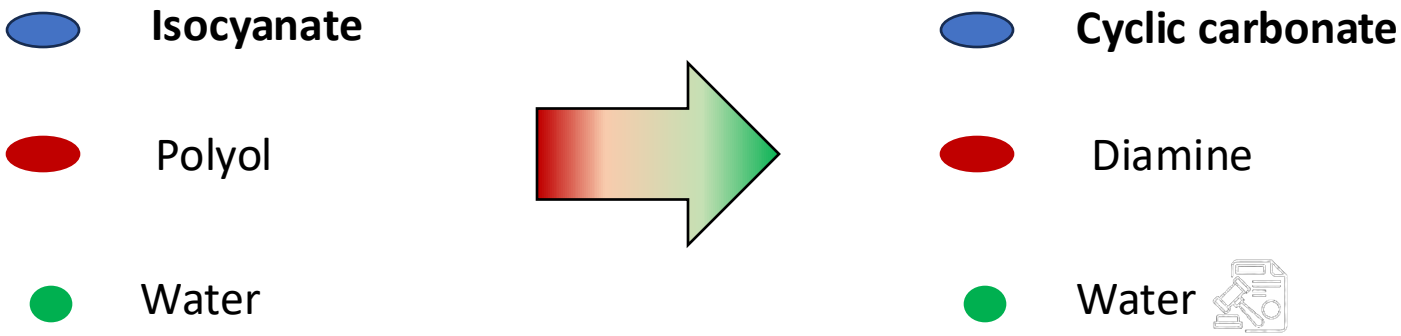
- ✓ Complex shape
- ✓ Light but robust materials
- ✓ Porous, so special properties
- ✓ …

Self-blowing non-isocyanate polyurethane

CENTER FOR EDUCATION AND RESEARCH ON MACROMOLECULES

NIPU foams with process compatible with industrial PU foams production

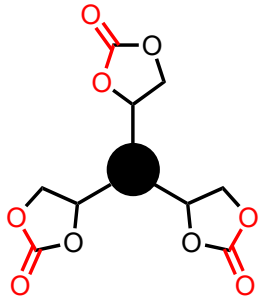
Chemistry :



Process : Raw materials availability – foam reaction speed – similar process – competitive properties + price

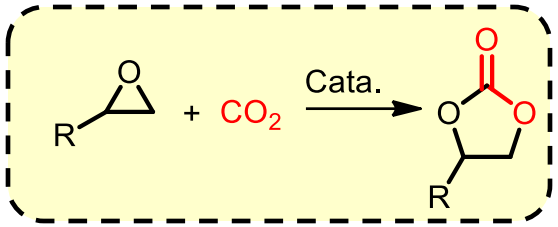
Cyclic carbonate: a way to capture CO_2

Cyclic carbonate

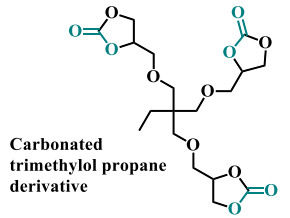


+

amine



- ✓ Up to 30wt% of CO_2 in cyclic carbonate
- ✓ Up to 10wt% of CO_2 in final foam

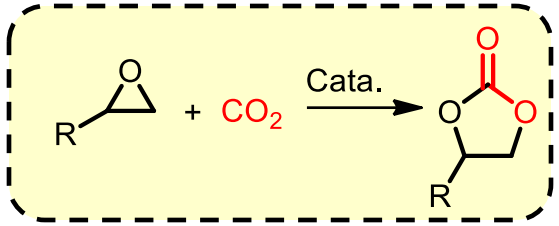


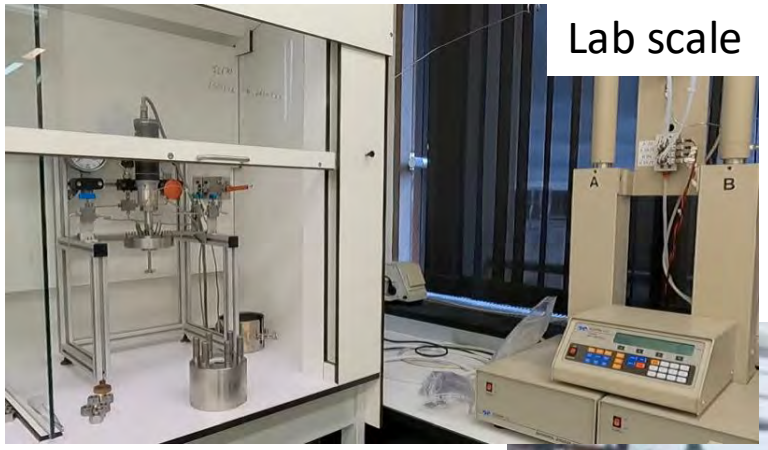
Biosourced feedstocks:

- o Glycerol = by-product of oil production

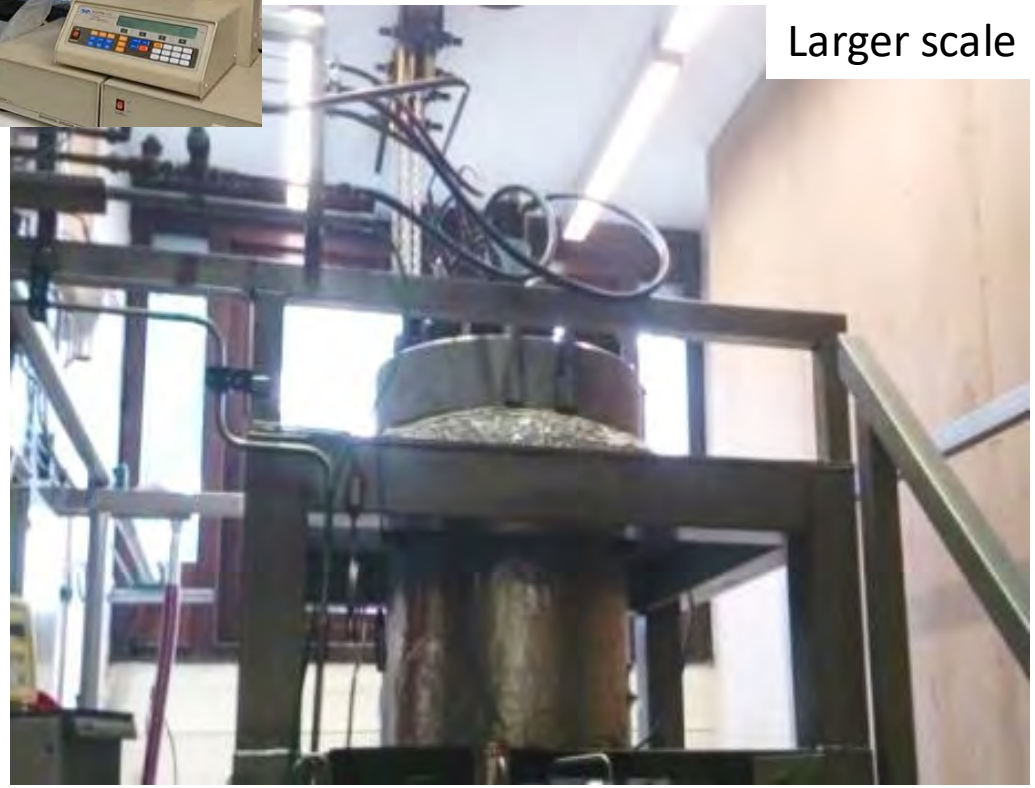
Resorcinol biscyclic carbonate, butanediol biscyclic carbonate, cyclocarbonated esters of lindseed oil, cyclocarbonated soybean oil,…

Green production of cyclic carbonate at ULiege





Lab scale



Larger scale

- ✓ solvent-free process
- ✓ No by-product, no purification
- ✓ 15-20 kg/batch

Foaming process compatible with industrial production

2019 — **Thiol induced foaming**

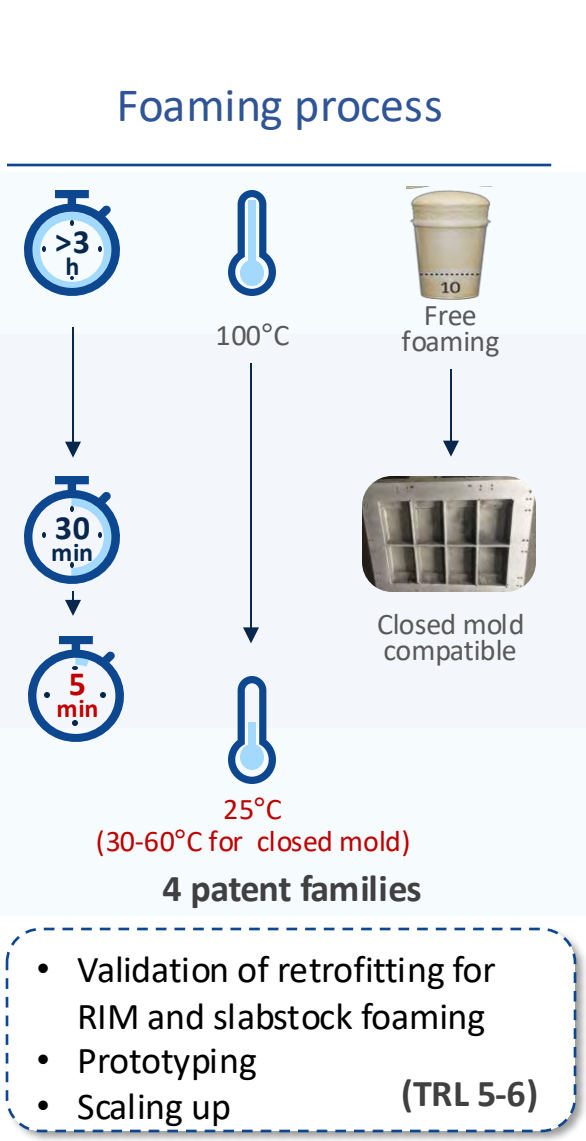
2021

2022 — **Water induced foaming**

2023

2024 — **Hybrid PHU-Epoxide Foams**

202X — **On-going work**



- Validation of retrofitting for RIM and slabstock foaming
- Prototyping
- Scaling up

(TRL 5-6)

Foaming process compatible with industrial production

2019 — **Thiol induced foaming**

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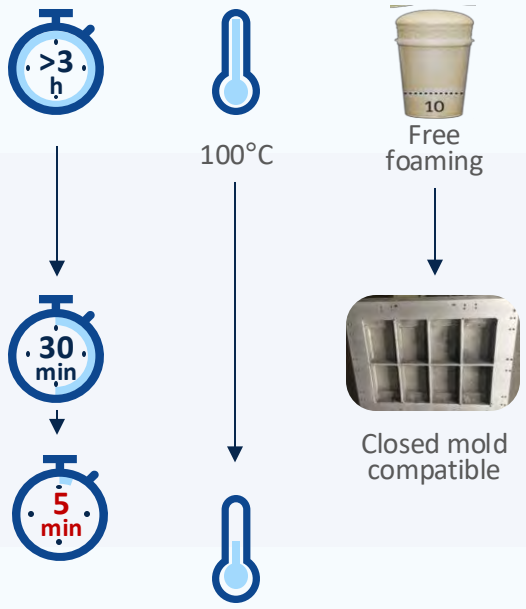
Foaming process



4 patent families

- Validation of retrofitting for RIM and slabstock foaming
- Prototyping
- Scaling up

(TRL 5-6)

+ foams properties
+ biobased content
+ recycling / end-of-life

Patents :

WO 2021/004993 A1
US 2022/0195117 A1
WO 2022/128822 A1
WO 2023/104362 A1
US2024/0043647A1

Publications:

Angew. Chem. Int. Ed. **2020**, 59, 17033;
Angew. Chem. Int. Ed. **2022**, e202213422; *ACS Macro Lett.* **2022**, 11, 236
Preprint: https://doi.org/10.26434/chemrxiv-2023-t48bf;
JACS **2024**, *146*, 988-1000

Let's play the game!

More than 300 foams in the lab, building the know how ☺

Scale-up: not a piece of cake !

Case study:
rigid NIPU foam for thermal insulation

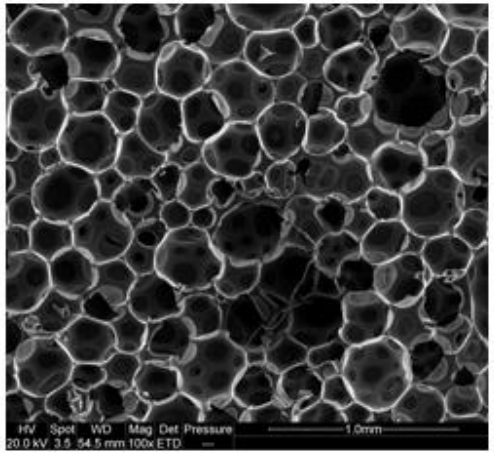
Low density foams < 50 kg/m³
Hih Closed cells content
30 x 30 cm foams

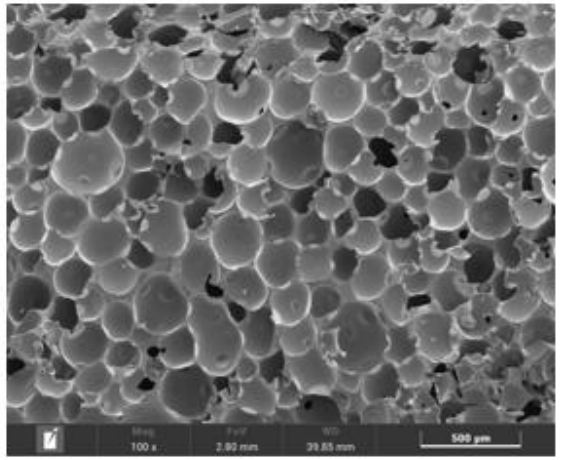
Classical materials

Glass wool

polyurethane

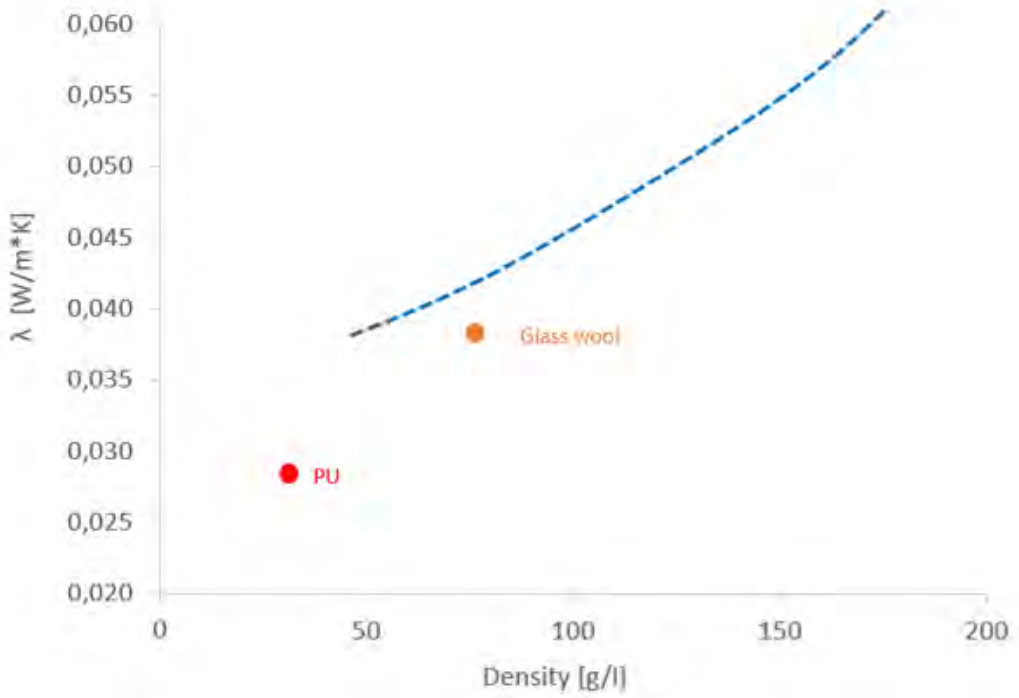
Case study:
rigid NIPU foam for thermal insulation





- Closed cells content ~50%
- 40 – 200g/l achieved
- 15 x 15 cm panels so far

Thermal insulation properties

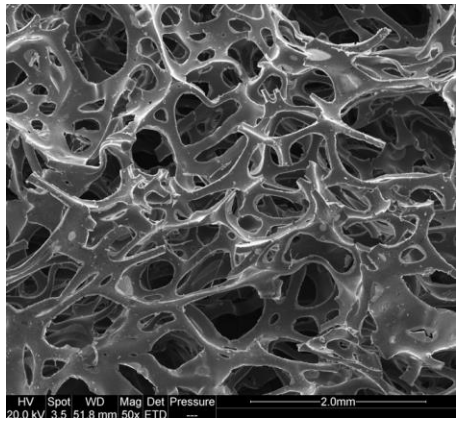


NIPU foams ~ glass wool

Need some R&D to compete with PU foams

Scale-up of flexible NIPU foams

Achievements: Medium to low density foams : 30 - 100 g/l
Majority of open or closed cells
Scale up to 20 x 30 cm panels



Partnerships for industrial developments

- ✓ Material under evaluation with industrial partners for a few applications

Many other applications to assess… we are ready for the challenges!

FRITCO$_2$T, the research platform from ULiège

CO_2 CAPTURE

- Process modeling and simulation
- Techno-economic analyses
- Prototyping and testing from lab to pilot

CHEMICAL ENGINEERING

LIÈGE université
FRITCO$_2$T

fritco2t@uliege.be

CO_2 CHEMICAL TRANSFORMATION

- CCU plastics (polyurethanes, polycarbonates, others)
- (e)-Fuels
- Commodity chemicals/monomers

ERM

CO_2 MINERALIZATION

- CO_2 concretes and aggregates fabrication
- Lightweight concretes (biofillers)
- Accelerated concretes aging

LIÈGE université
Urban & Environmental Engineering

PHARMACEUTICAL PROCESSES

- CO_2 assisted sterilization
- Drugs formulation/encapsulation
- Extraction

LPTB
Laboratoire of Pharmaceutical Technology & Biopharmacy

Acknowledgments

Funding agencies

NIPU foams team

- *55 researchers*
- *6 technicians*

Spin-off company

Flexura

Discours de clôture

Sasha Baillie
Luxinnovation GIE

Interreg
Grande Région | Großregion
Cofinancé par l'Union Européenne
Kofinanziert von der Europäischen Union
GREATER GREEN