

RAW MATERIALS WEEK
BRUSSELS, 17-21 DECEMBER 2025



Pre-commercial pilot for the efficient recovery of Precious Metals from European end- of-life resources with novel low-cost technologies

EU funded projects Clustering Workshop
Recycling and Production of highly efficient catalysts for different applications



The project has received funding from the European Union's Horizon 2020 research and innovation program under Grant Agreement N° 958302

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The PEACOC project



PEACOC Objectives



To demonstrate a first-of-a-kind economically and environmentally-viable pre-commercial metallurgical system for recovering precious metals from a wide variety of abundant *EoL* products in Europe

- i) **2 kg PGMs/week** from spent **autocatalysts**
- ii) **0.5-1 kg Au/week** from Printed Circuit Board Assembly (PCBA) with a focus on **low and medium grade PCBA**
- iii) **10 kg Ag/week** from **EoL Photovoltaic (PV) panels**



Design and operate a **mobile refining pilot** at pre-commercial scale for producing precious metals from EoL products



Improve the **precious metals concentration** stage by up to 100 times



Valorise PMs recovered into new marketable applications



Prove the **PEACOC sustainability** from economic, technical and environmental perspectives



Expand the impact by **exploring untapped EoL products** containing PMs in **Europe** and **neighbouring countries**



Aim at near **zero-waste strategy** by valorizing the residues into new products

PEACOC project overview

1. Pre-treatment and concentration



EoL Autocatalysts



Low/medium-grade
EoL PCBA



NOVA



Roller sorting



MDS



EoL PV panels



Magnetic sorting



GOLD REC



2. Refining – PEACOC pilot plant

Microwave-Assisted
Leaching



Gas-diffusion
Electrocrystallization



Precious
metals

Residues

3. Valorization

Mechanical
Alloying



Powder
composites

3D printing



Filaments for
3D printing

Nanoparticles



Electrochemical
energy
technologies

Manufacture of
autocatalysts
and fuel cells



Autocatalysts
and Hydrogen
fuel cells

Electroleaching



Single
Precious
Metals

1. PRETREATMENT AND CONCENTRATION

Upscaled processes under concentration routes

NOVA process 



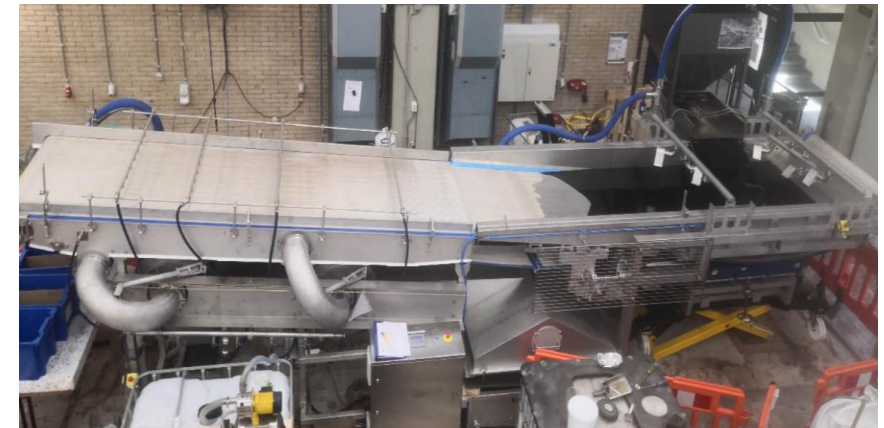
150 kg of PCBAs per batch

Roller sorting



25 kg/h of electronic components

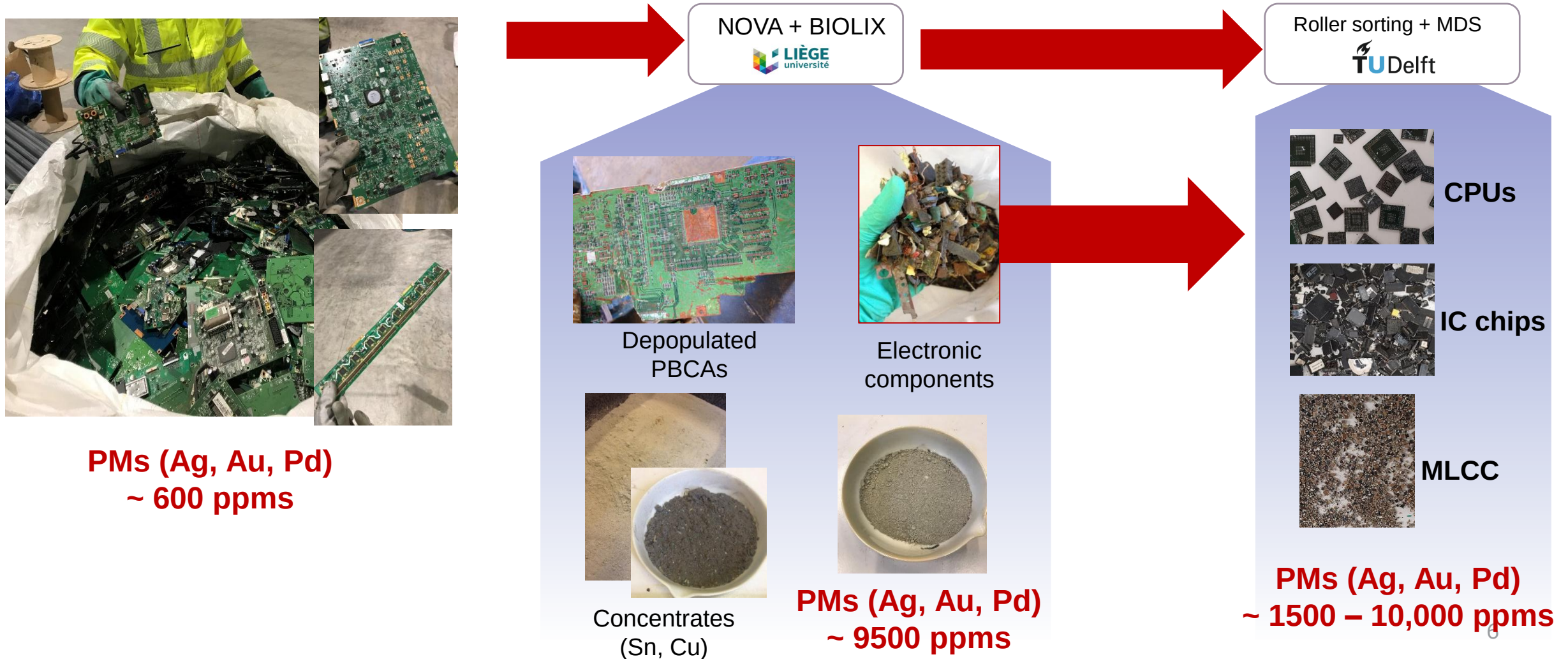
MDS process



1,000 kg/h

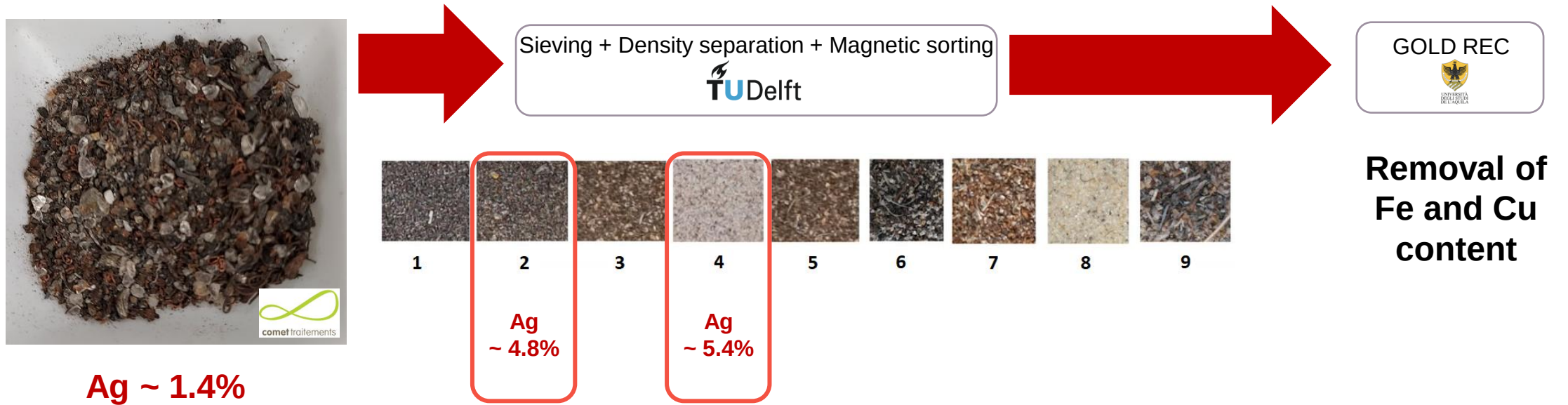
1. PRETREATMENT AND CONCENTRATION

Precious Metals concentration from mid-grade PCBAs at large scale



1. PRETREATMENT AND CONCENTRATION

Precious Metals concentration from PV scrap at large scale



2. REFINING – THE PEACOC PILOT

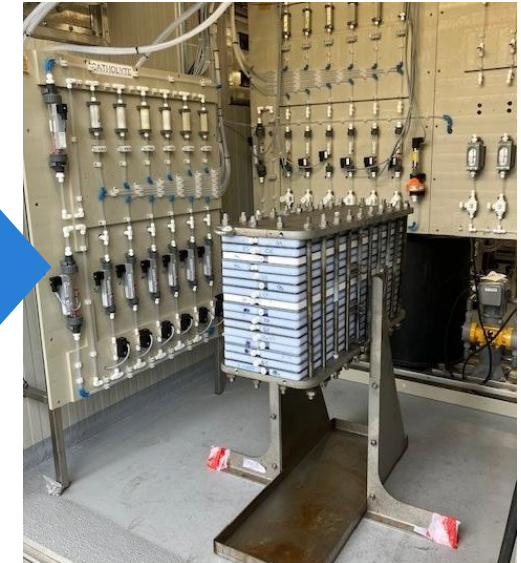
MWAL unit



Filtration unit



GDEx unit



- ✓ Installation of **peripherals** (tanks, leaking trays, feeding systems, etc)
- ✓ Installation and successful testing of the **automation system**
- ✓ **Ventilation** installed
- ✓ **Controller platform** operative
- ✓ **First testing** carried out in blank conditions, and preliminary testing with real stream

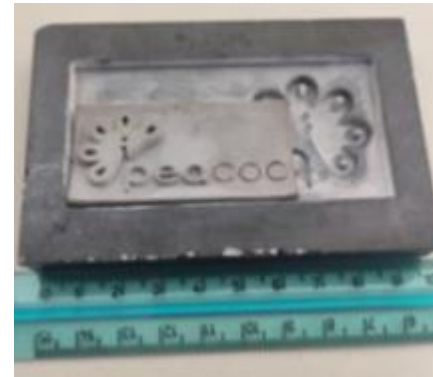
3. VALORIZATION

→ New automotive catalyst from recycled PGMs



MONOLITHOS has successfully produced it and demonstrated the same conversion performance than commercial ones.

→ Alternative process to make feedstock power for additive manufacturing



MBN has demonstrated this new process using residual matrices from the PEACOC process.

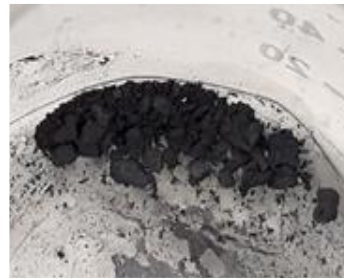
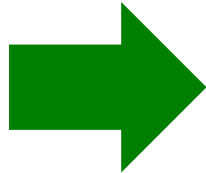
3. VALORIZATION

→ Concentration and separation of PGMs from spent autocatalysts

 **MONOLITHOS**
CATALYSTS - RECYCLING - INNOVATION

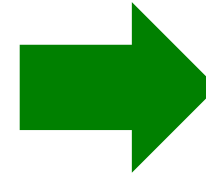


Rh ~ 0.03%
Pd ~ 0.2%
Pt ~ 0.1%



Solid sample (mixture of PGMs)

Rh ~ 1%
Pd ~ 73%
Pt ~ 26%



Rh ~ 0.64%
Pd ~ 91%
Pt ~ 8.3%



Rh ~ 0.52%
Pd ~ 12.7%
Pt ~ 86.3%

PEACOC: Objectives & Impact

Recovering Europe's precious metals from waste – sustainably and locally

The PEACOC project demonstrates innovative, energy-efficient metallurgical processes for recovering precious metals (PGMs, gold, silver) from EoL products.

This unit represents the **largest MWAL pilot in Europe**, marking a major step toward industrial-scale recovery of precious and critical metals within the EU

The pilot will be operated and validated as a pre-commercial pilot in the facilities of **Monolithos Catalysts & Recycling Ltd.**, an industrial recycler in Athens, Greece.



EoL products available in Europe that are not recovered

EoL stream	Material	Estimated at
Spent autocatalysts	Pt, Pd, Rh	13 t/year
PCBs	Au, Ag, Pd	10 t Au, 2 t Pd, 41 t Ag/year
PV panels waste	Ag	360 t until 2030

Demonstrating new technologies - Building Europe's circular metal future

Pilot Process Overview / Flow Diagram

From waste to valuable metals – the PEACOC pilot integrates innovative modules for efficient metal recovery

2 kg of PGMs per week
recovered from spent
autocatalysts

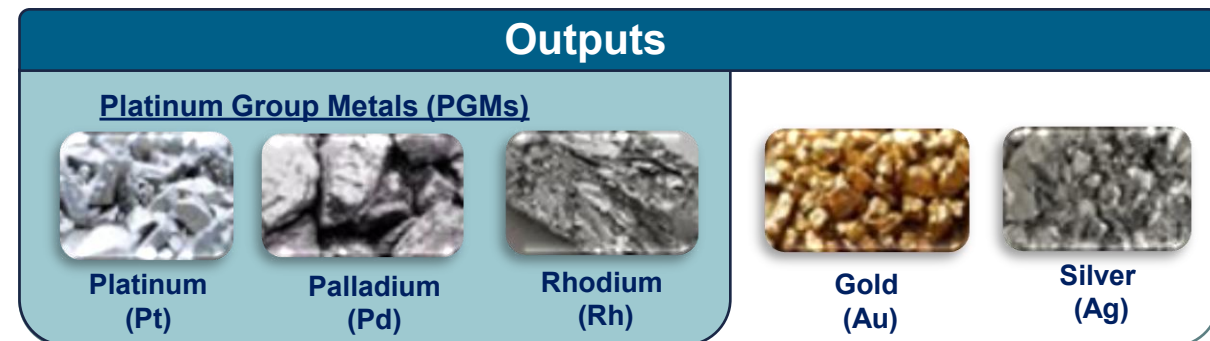
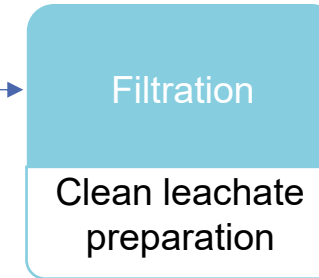
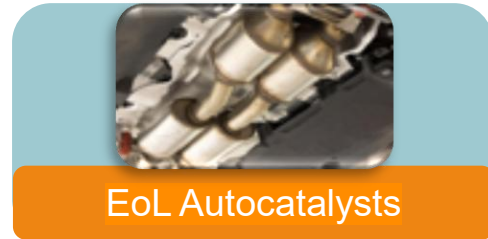
0.1–0.2 kg of gold per
day recovered from
printed circuit board
assemblies (PCBAs)

10 kg of silver per
week recovered from
End-of-Life (EoL)
photovoltaic (PV) panels



Pre-treatment and concentration

Refining – PEACOC pilot



The PEACOC pilot unit - Autocatalyst stream

Preprocessing and characterization

Collection



Dismantling



Milling/sieving



Thermal treatment



Metal determination



Pilot scale autocatalysts preprocessing unit

Process capability of **100 full scale catalysts per hour** (equivalent to 75kg of spent cordierites per hour, ie 3tns per week).

Enables efficient comminution as it can **crush the spent autocatalysts and grind them** into powder (<2mm) to increase the surface for subsequent processing steps

High-specification **dust extraction unit** that minimises losses of dust ensuring the maximum possible recovery of PGMs



Microwave-Assisted Leaching Unit



- ❑ **Higher recovery:** >90% PGMS (Pd, Pt, Rh) recovery from spent autocatalysts in a single leaching step
- ❑ **Energy-efficient:** Low-temperature operation reduces energy consumption
- ❑ **Safer chemistry:** No oxidizing agents, 50% less concentrated acids.

MWAL



Filtration



GDEx

Filtration Unit – Solid/liquid separation

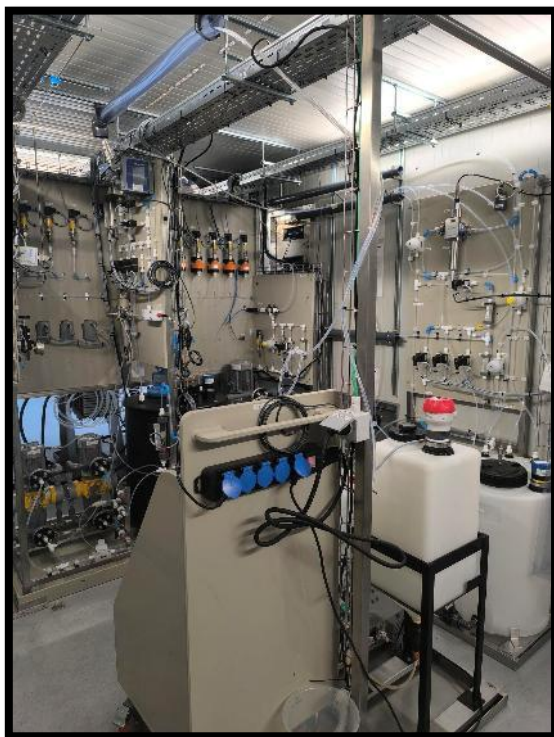


- ❑ **Efficient solid-liquid separation**
Removes solid particles after MWAL in order to obtain a clean leachate
- ❑ **Vacuum filtration**
600L settler with dual 10L filters ensure stable operation
- ❑ **Feed to GDEx**
Provides clear solution for selective metal electrocrystallization



Delivering clean solutions for efficient metal recovery at GDEx

GDEx unit



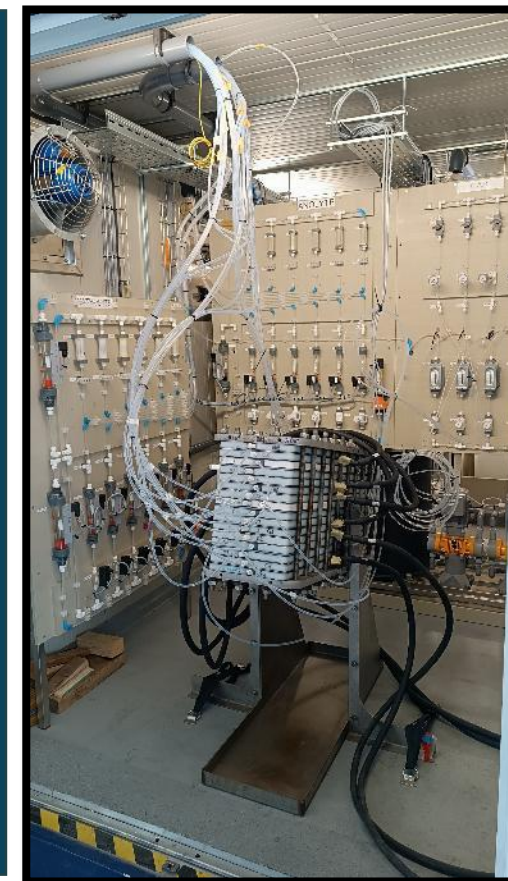
Low energy
Only 1-5 kWh/kg
of recovered PGMs



No chemicals
Generates reagents in
situ, no additional wastes
are generated during the
process



High control
Produces mono &
multimetallic
nanoparticles



6-cell stack
325 cm²/cell
100 L/h



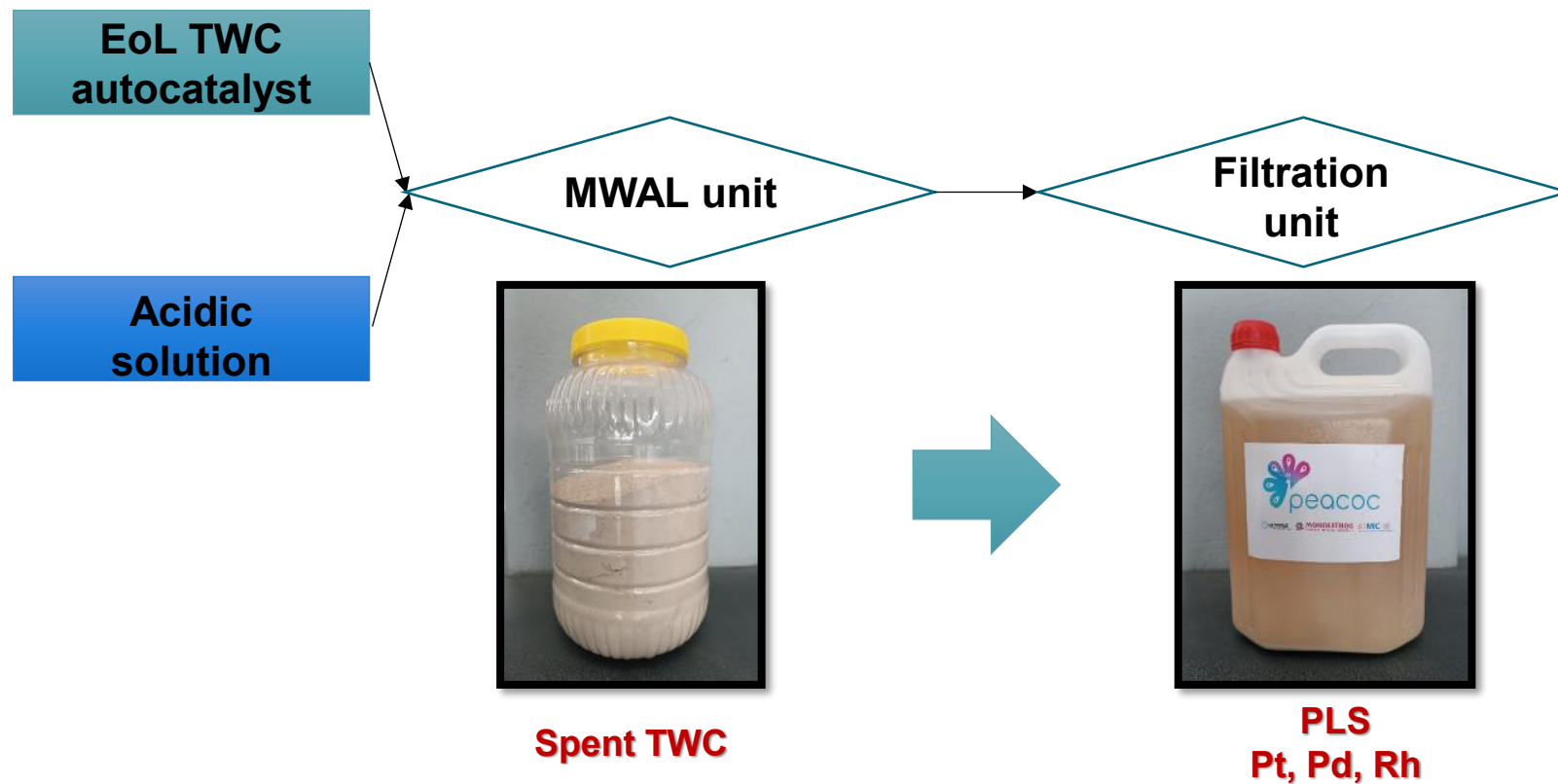
MWAL output →

Filtration →

GDEx

Turning CO₂ into value with a cutting-edge electrochemically process

Successful operation of PEACOC pilot unit



3

3 successful trials



Temperature
180-200 °C



Processing time
11 min



1.5 M HCl/
1.5 M NaCl

Scaling up sustainable precious metal recovery in Europe

Efficient operation of the MWAL–Filtration system marks a major step toward industrial-scale recycling of end-of-life catalysts.

The PEACOC pilot successfully operates the MWAL and Filtration units using real autocatalyst feedstock.

The upcoming GDEx stage will complete the recovery cycle, enabling the production of pure precious metals.

End-of-Life Streams Processed by MONOLITHOS

MONOLITHOS processes various end-of-life (EoL) materials containing precious and critical metals, which are used as input for the **PEACOC** pilot to demonstrate efficient and sustainable recovery routes for metals and alloys.

Li-ion Batteries



Li-ion batteries containing metals and graphite.

Main metals

Ni, Co, Li, Mn, Cu

Printed Circuit Boards



Electronic waste with high metal content

Main metals

Au, Ag, Pd

Fuel cells



Fuel cell stacks containing platinum-group metals

Main metals

Pt, Ir

Permanent magnets



Magnets and electric motor components containing

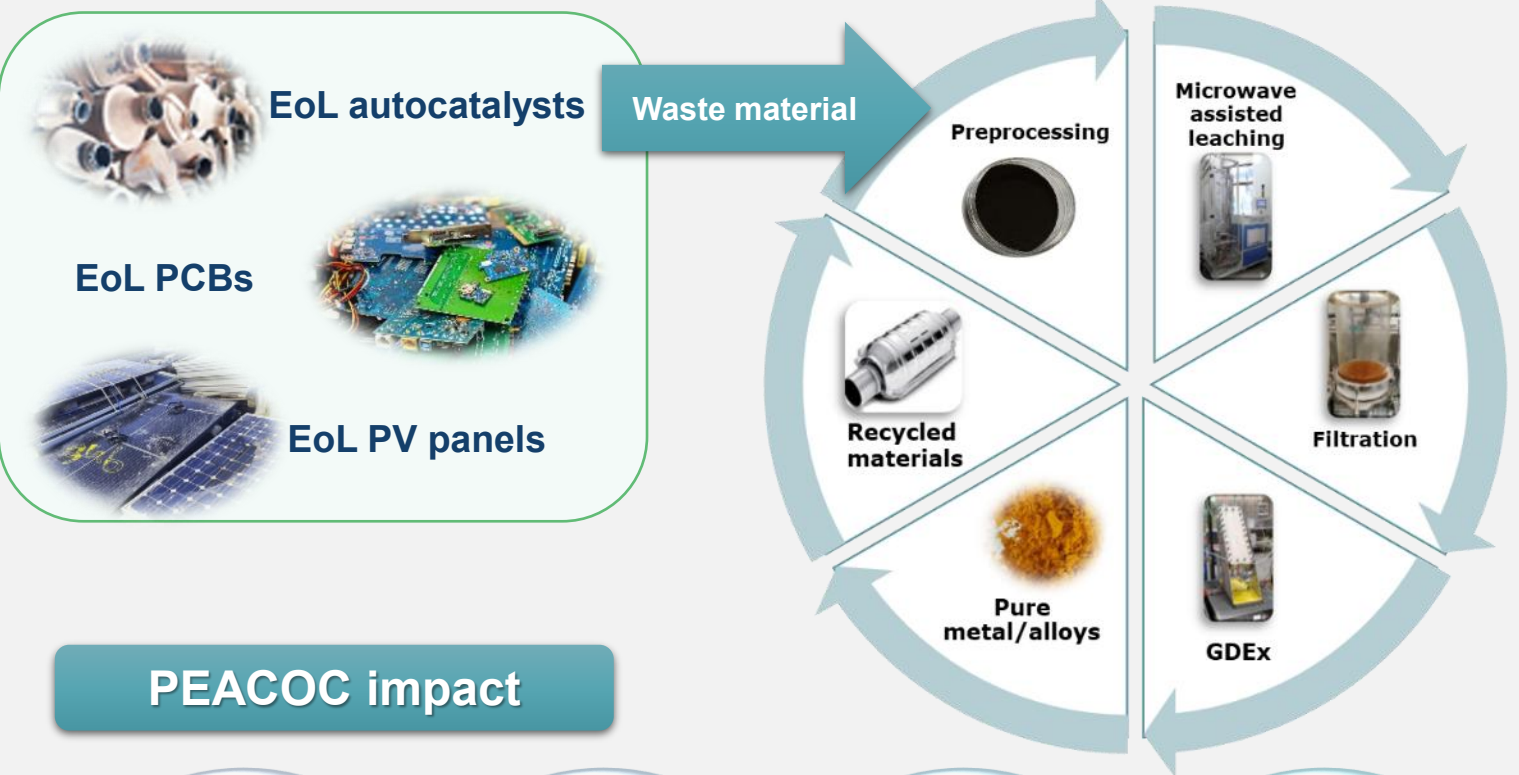
REEs

Main metals

Nd, Dy, Sm

Turning Europe's end-of-life materials into valuable resources

Closing the Loop: From Waste to Valuable Materials



PEACOC impact

The project aims to boost the economic viability of precious-metal recycling, enabling the pilot process to support expansion across Europe

Improve the health, safety, and environmental performance of precious-metal recycling to ensure secure and sustainable recovery from end-of-life products

Unlock large amounts of secondary raw materials that are currently unused across Europe

Produce precious metals with profit margins of up to 80% compared to current market prices

Next Testing Phase



Testing of GDEx with real end-of-life feedstocks



Integration of the complete MWAL–Filtration–GDEx chain



Demonstration of stable pilot-scale operation

Material Valorization



Pilot validation: Pt, Pd, Rh, Au, Ag for high-value applications



Circular economy: Contributing to EU CRM resilience & sustainable supply chains

MONOLITHOS: From Research to Industrial Application



Strong industrial partner: 25 years of experience in catalyst production and recycling

EU collaboration: Active partner in projects on circular economy and raw materials

Automotive catalysts



H₂ devices



Permanent magnets



Li-ion batteries



E-wastes



Industrial wastes/byproducts



PV panels



Fully equipped pilot infrastructure: State-of-the-art pilot facilities for leaching, filtration, recovery and characterization of precious metals

Patented technologies: MONOLITHOS holds multiple international patents in catalyst manufacturing, as well as in precious-metal leaching and recovery technologies.

Upscaling excellence: Proven ability to bridge research innovations to industrial-scale systems

PEACOC project



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Thank you



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