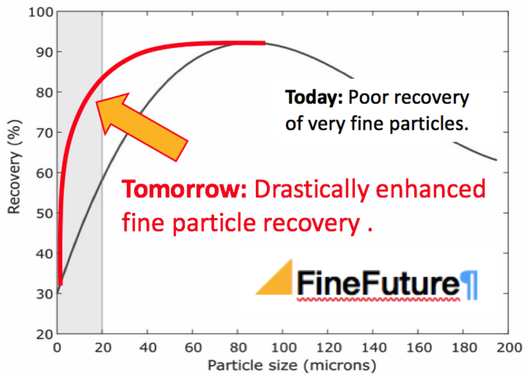
Łukasiewicz
Instytut Metali
Nieżelaznych

Research projects in pilot scale in Łukasiewicz-IMN

Tadeusz Gorewoda

The PROMETIA seminar, Lisbon, 30.12.2023



Innovative technologies and concepts for fine particle flotation: unlocking future fine-grained deposits and Critical Raw Materials resources for the EU

Horizon2020 Call: H2020-SC5-2018-2019-2020

Project duration 2019 - 2023

The aim of the FineFuture project was to improve the efficiency of recovery of fine grains (below 20 µm) through a better understanding of fine grain flotation phenomena, which will lead to the development of breakthrough technological solutions. The tested solutions may result in more effective recovery of raw materials from existing and inactive deposits, as well as improve the recycling of critical raw materials from end-of-life products.

The solution tested at Łukasiewicz - IMN was a microbubble generator operating on the principle of mechanical dispersion of air in a concentrated foaming reagent solution by generating a high shear rate of the medium in the dispersant head. The microbubble generator has been designed for industrial-scale testing in conventional flotation operations.

Project partners:

FineFuture

funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No 821265

Innovative technologies and concepts for fine particle flotation: unlocking future fine-grained deposits and Critical Raw Materials resources for the EU

Horizon2020 Call: H2020-SC5-2018-2019-2020

Project duration 2019 - 2023

Pilot Scale Flotation

IF type 140L flotation cell

Generator MBGen-0.012

The Laboratory Pilot Installation is used to study the flotation process on a semi-industrial scale with the possibility of closed-circuit flotation. ***It has a capacity of about 80 kg/h.***

Flotation is carried out ***in flotation machines with a volume of 140, 40, 15 and 10 dm^3****.*

*The installation has a modular structure, which allows to change the configuration and modeling of various flowsheets. The installation is equipped with devices for measuring and regulating selected operating parameters (*froth depth in the flotation chamber, amount of air supplied, impellers speed in flotation machines, pulp flow through the pump system*).*

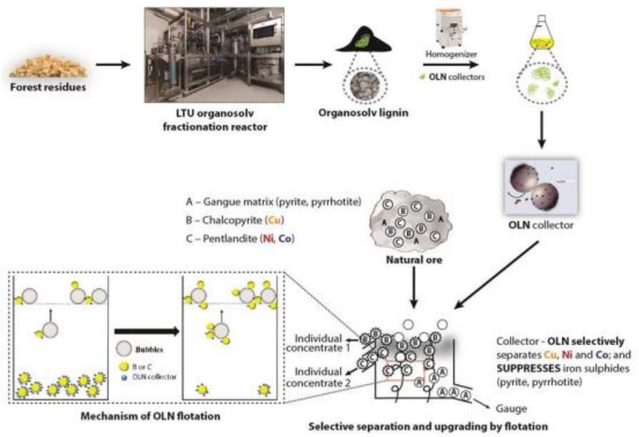
The pilot installation was used to verify the results of laboratory tests on a semi-technical scale in a closed circuit. For testing, a generator was implemented in the flotation circuit of the pilot installation. Tests on this scale are performed immediately before tests on an industrial scale.

FineFuture

funded by the European Union's Horizon 2020 research and innovation programme under grant agreement No 821265

Supply of BATTERy minerals using lignin nanoparticles as FLotAtIon collectors

Project duration 2020 - 2023



Research in the BATTERFLAI project aimed to improve the efficiency of the flotation process in terms of recovery of metals used in the production of batteries (Cu, Ni, Co, Au), focusing mainly on the production of environmentally friendly lignin-based flotation reagents in the form of micro and nano particles (OLP).

- *Improving the recovery of basic metals for battery production,*
- *Ensuring a continuous supply chain of reagents to processing plants.*

Project partners:

Supported by

Supply of BATTERy minerals using lignin nanoparticles as FLotAtIon collectors

Project duration 2020 - 2023

The Laboratory Pilot Installation

The Laboratory Pilot Installation was used to determine the effectiveness of the tested reagent in conditions like industrial ones.

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The installation has a modular structure, which allows to change the configuration and modeling of various flowsheets. The devices are equipped with equipment for measuring and regulating selected operating parameters (froth depth in the flotation chamber, amount of air supplied, impellers speed in flotation machines, pulp flow through the pump system).

The technological scheme was configured to correspond to the scheme used in an industrial copper ore enrichment plant. The installation scheme consisted of main flotation and several cleaning stages.

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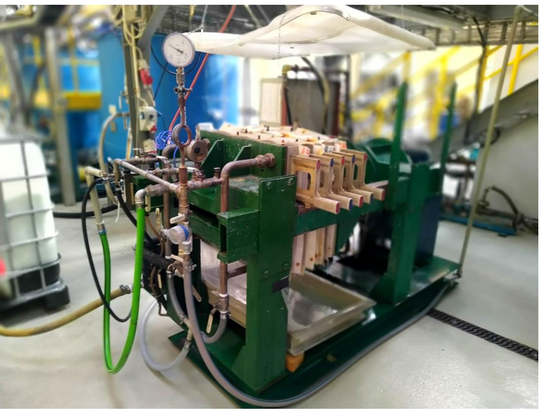
REcovery of Added-Value Raw Materials from Copper Primary Production
Project duration (2021-2024)

RECOPP will offer a proven (pilot scale at TRL 7) recovery protocol for the recovery of high-priced metals on the market (Sb and Bi) from effluents and residues while removing As impurities. The value for the customer is both increased residue management efficiency creating environmentally safer waste plus recovery of valuable secondary metals, Bi and Sb, creating a new revenue stream for the customer.

REcovery of Added-Value Raw Materials from Copper Primary Production
Project duration (2021-2024)



Plastic, ***ventilated reactor of a volume 1.2m³*** *equipped with teflon-lined mixer (to prevent from contacting eluate with any metal element and eliminate AsH_3 evolution was used to precipitate antimony oxochloride concentrate, while bismuth oxochloride was produced in a* ***consecutive reactor of a volume 2.7m³****. Arsenic was first sorbed from a chloride solution and then stabilized in form of hardly soluble scorodite* ***in 0.4m³ reactor heated with a steam****. Individual* ***automated filter presses for phase separation*** *of each product: antimony, bismuth, and arsenic concentrates, were applied to avoid cross contamination. Produced antimony concentrate was then purified to remove arsenic contaminations and converted into antimony oxide using sodium hydroxide solution in* ***a reactor equipped with a heating mantle (heating by a steam). 20m³ of elaute has been processed so far, which allowed to produce around 150kg of antimony oxide.***

Hydrometallurgical recovery of lead, silver and tin from sulphate leach residues
Project duration (2020-2023)

TETALEAD has increased the raw material efficiency in zinc production by valorising significant amounts of lead, silver and tin contained in leach residues presently landfilled. A de-sulfurization method producing high quality concentrates was developed and patented for industrial implementation and commercialisation. This highly reduces energy consumption and CO_2-emission, improves working environment and increases lead product market.

Hydrometallurgical recovery of lead, silver and tin from sulphate leach residues
Project duration (2020-2023)

Whole pilot technological line ***contained reactors for leaching (1m³), carbonation (2.8m³), acidification (1.5m³), regeneration (0.4m3) and separate filter presses*** *for each unit operation, as well as all pumps needed to transport solutions and sludges. Amine solution for leaching operation was pumped from IBC containers, while solid residue containing lead for recovery was added manually to the reactor. At the end of leaching, suspension was pumped to filter press. Amine solution with lead and sulphate ions was then purged with carbon dioxide to precipitate lead carbonate – the main product of the proposed technology. Next solution was purified and regenerated with lime to produce gypsum. This operation allowed to recycle leaching solution, minimize leachant consumption, satisfy close-loop operation and minimize environmental impact.*

Demonstration of battery metals recovery from primary and secondary resources through a sustainable processing methodology

Horizon2020 Call: HORIZON-CL4-2022-RESILIENCE-01

Project duration 2023 - 2026

The battery sector has been experiencing increasing demand for raw materials for years and is vulnerable for supply risks. Various strategies are being pursued to meet the growing demand for critical raw materials and to build up viable, sustainable and innovative value chains. Waste valorization by recovery and recycling plays a central role.

METALLICO will:

- *recover valuable materials from primary and secondary resources*
- *demonstrate sustainable production and recovery of (critical) battery metals (Li, Co, Cu, Mn, Ni)*
- *assess end-use of the recovered (critical) battery metals (Li, Co, Cu, Mn, Ni)*
- *identify and characterize (critical) battery metals (Li, Co, Cu, Mn, Ni) with innovative technologies*
- *enable social participation, stakeholder engagement and networking*

Project partners:

Fraunhofer Institute for Ceramic Technologies and Systems IKTS

METALLICO

Funded by the European Union

Demonstration of battery metals recovery from primary and secondary resources through a sustainable processing methodology

Horizon2020 Call: HORIZON-CL4-2022-RESILIENCE-01

Project duration 2023 - 2026

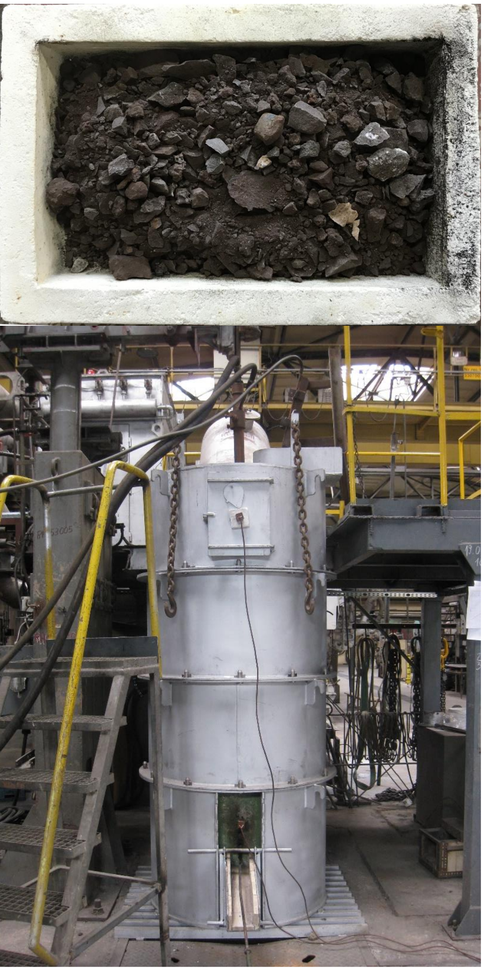
The pilot plant will be built in the Łukasiewicz-IMN's facilities, as it has the required infrastructure from previous projects. A slight modernization of the existing Łukasiewicz-IMN's installations is planned, consisting of a purchase of a new reactor with the necessary devices to monitor the parameters of the conducted processes and off-gases treatment.

The tests which will be carried out using the pilot plant and will verify the conditions of individual unit operations:

- *oxidative leaching of the Fe-As alloy to dissolve Cu, Ni, Co, Fe, As*
- *recovery of Pb in the form of leach sludge*
- *removal of Fe and As from the solution in the form of scorodite, precipitation of Cu and Co-Ni concentrates, which will be researched first in the tests performed on the laboratory scale*

***The built pilot plant will have a process capacity of 100 kg per day**.*

Funded by the European Union



Slag valorisation for multi metal recovery and mineral resource Production

The project duration 2018-2021

The aim of the project was to develop a technology for processing slag from lead and zinc metallurgy in a TSL furnace with a vertical lance and in an electric furnace, solving the following problems:

- Recovery of metals from slags in the form of metals or dust, such as: lead, zinc, copper, silver, tin, antimony,
- Transformation of slags into silicate mineral raw materials suitable for economic use in the form of road aggregates, geopolymers, concrete fillers and bituminous masses,
- Liquidation of waste landfills for slag from the lead and zinc metallurgy,
- Improving the economic efficiency of lead and zinc smelters by recovering metals from slags,

The project results are the basis for the construction of an installation for processing slags in a TSL furnace or an electric furnace to improve the economic efficiency of steelworks and protect the natural environment after the liquidation of several million tons of waste slags produced and stored in Europe.

Partners
Lukasiewicz Research Network – Institute of Non-Ferrous Metals (Project leader)
RWTH Aachen
VITO
Baterpol S.A.
Berzelius
Küttner

Co-funded by the European Union

Slag valorisation for multi metal recovery and mineral resource Production

The project duration 2018-2021

The SlagVal project used a **pilot TSL furnace with a capacity of 200 kg of slag with a vertical lance fired with fuel oil and air** for melting and fuming three waste lead slags from Baterpol S.A., KGHM Polska Miedź S.A. and from the QSL Berzelius Stolberg furnace - Germany, which allowed to obtain the following technological effects:

- Recovery of metals (Pb, Zn, Ag, Sn, Sb) from slags in the form of oxide dust with a yield of 85-95%,
- Copper recovery in matte, transformation of silicate slags into road aggregates and sodium slags into geopolymers.

Internal dimensions of the furnace:

- Round variant: diameter 440mm, height 1500mm.
- Square variant: shaft 345x345mm, height 1500 mm.

Capacity: about 200kg

Heating: oil-air lance

Process gas removal installation:

- Aftercombustion chamber.
- Dust chamber.
- Tubular cooler with an area of 34 m^2.
- Bag filters with a total area of 47 m^2.

Development of an innovative technology to separate recycled copper cable granulates into red copper (Cu) and tinned copper (CuSn) by the application of the hybrid methods of mechanical separation

The project duration 2021-2023

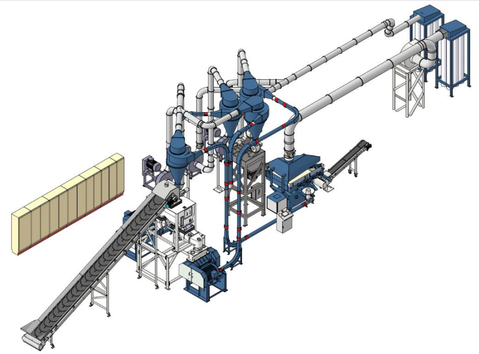
The aim of the project was to develop and implement an innovative, automated closed-circuit separation process of copper granulates from electric power wires and cables, allowing continuous operation of devices in the technological line while separating polymer (cable insulation) and copper recyclate in two quality categories:
-pure copper (so-called red copper)
-copper with additions of other metals, mainly tin (so-called whitewash)

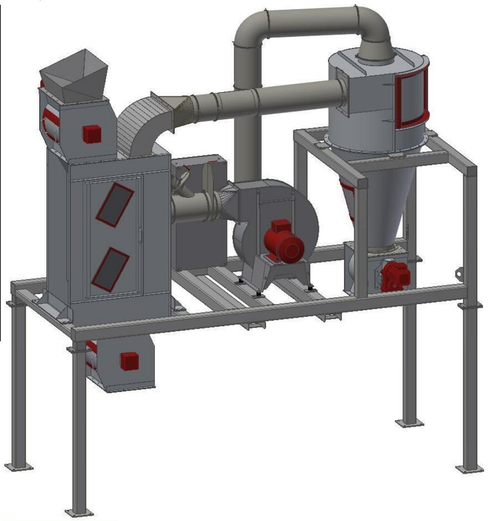
Benefits of the developed technology:
- increasing the recycling rate of electrical and power cables
- reducing the amount of human work on the operation of the line
- reduction of copper losses in polymer recyclate (cable insulation) from 2% to >1%
- reducing dust emissions into the atmosphere

Partners
Mercury HM (Project leader)
Lukasiewicz Research Network – Institute of Non-Ferrous Metals

Development of an innovative technology to separate recycled copper cable granulates into red copper (Cu) and tinned copper (CuSn) by the application of the hybrid methods of mechanical separation

The project duration 2021-2023





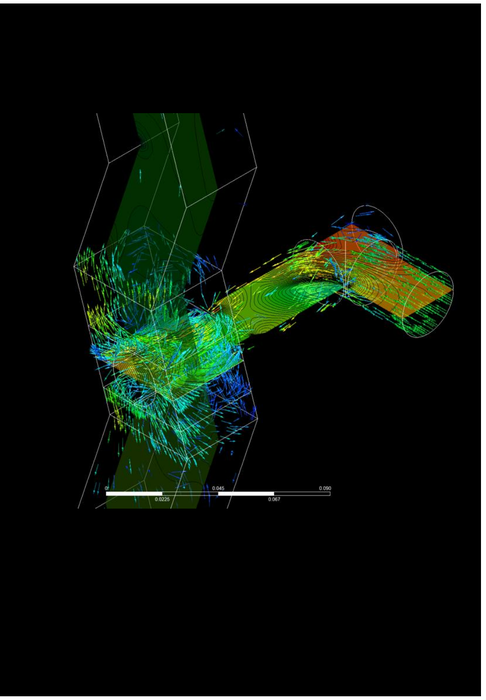
The line included the following devices:

- ***WEIMA WKS 1800/500 preliminary shredder with a magnetic separator***
- ***two ELDAN FG952 granulation mills***
- ***SMV feeding silo with a volume of 1m³***
- ***ELDAN C22 air-shaking separation table***
- ***air-beam separator of the zig-zag type by TST Trennso Technik, model ZZS180x400-4***
- ***passive dust extraction system***
- ***pneumatic transport system for copper granulates and polymer recyclate***
- ***system of belt feeders***

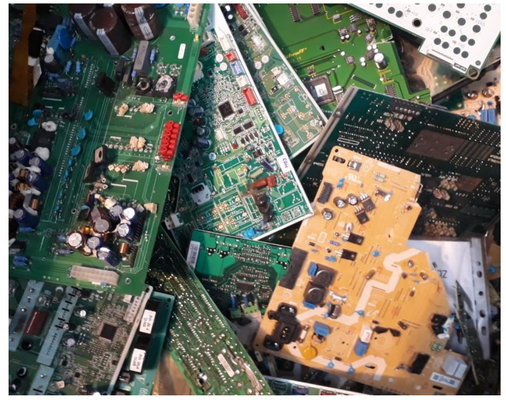
The line is used to test the electricity cable recycling technology developed as part of the Project. Thanks to it, pure copper granulate, the so-called red copper with purity > 99.5% Cu is produced.

Development of an innovative technology to separate recycled copper cable granulates into red copper (Cu) and tinned copper (CuSn) by the application of the hybrid methods of mechanical separation

The project duration 2021-2023



The line created as part of the project can be used in the future to test the separation of new types of waste of anthropogenic origin, in particular:
- enrichment of PCB scrap
- recycling and enrichment of metallic granulates from the dismantling of electric car batteries
- tests of copper removal from polymer recyclate (cable insulation)
- tests of air separation of materials with a density difference of min. 0.3 g/cm^3
- testing of the refining of metal granulates



Environmentally friendly technology for vitrification of lead-bearing slag by intensifying the work of a short rotary furnace with the dust and process gas conditioning system

The project duration 2021-2023

The aim of the project was to intensify the recovery of Pb from waste materials from the Cu metallurgy (shaft sludge) and from the demolition of car batteries, along with the processing of the resulting lead slag into a product suitable for repeated, economic use (as a flux for copper briquettes). At the same time, the operation of the post-combustion and process gas conditioning system will be optimized. The implementation of the project will allow for the reduction of pollutant emissions (VOCs and PCDD/F) and greenhouse gases.

Benefits of the developed technology:
- limiting the Pb content in waste slag below 3%
- reducing the consumption of natural gas for the process by 5÷10%
- treatment of reverse dust
- CO emission reduction < 0.3%
- treatment of lead slag

Partners
Lukasiewicz Research Network – Institute of Non-Ferrous Metals

Environmentally friendly technology for vitrification of lead-bearing slag by intensifying the work of a short rotary furnace with the dust and process gas conditioning system

The project duration 2021-2023

The line included the following devices:
*- **short rotary furnace KPO no. 2***
- afterburning chamber of AKPO furnace no. 2
- main burner with a power of 1.5 MW
- afterburner chamber burner with a power of 0.3 MW
- process gas analyzer
- control and monitoring system of equipment operation

The installation is used to test the process of smelting raw lead from waste lead-bearing materials. As part of the research, it was also used to study the after-combustion of process gases generated during the process.

Mineral Processing

Unique Laboratory Pilot Installation (LPI) for the continuous flotation process which provides the ability to map and simulate various process conditions in non-ferrous ore enrichment plants:

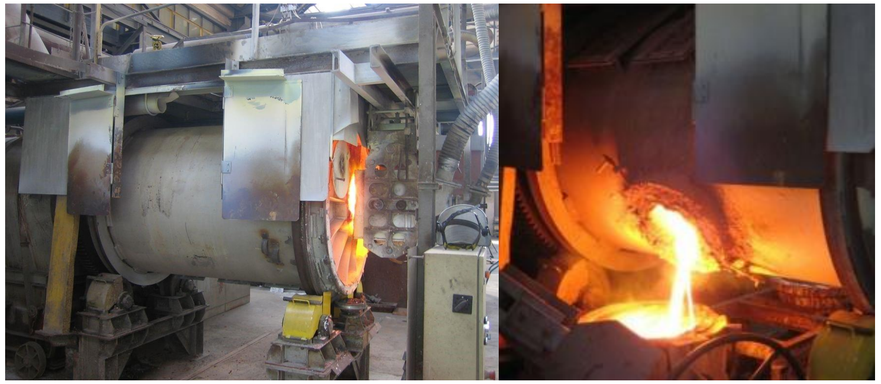
- ❑ installation capacity: 50-150 kg/min
- ❑ flotation cells capacity of 150, 40, 15, 10 and 3 dm^3,
- ❑ classification system (hydrocyclones)
- ❑ re-grinding system (ball mill)
- ❑ automatic control system

Other processing equipment: mills, crushers, concentrating tables, hydrocyclones, classifiers, separators

Pyrometallurgy

Arc-resistance furnaces

Pilot plant for metallurgical processes (vertical oil-air lance with system for dedusting of proces gases

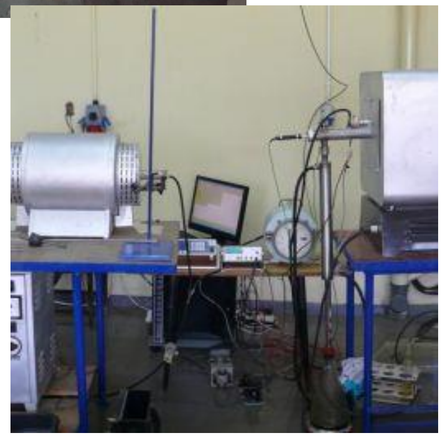


Rotary-rocking furnace for treatment of lead- and zinc-bearing waste

Plasma arc furnace SPL05

LVDV-II+ DIGITAL Brookfield Engineering Laboratories, INC. viscosity meter with chamber furnace

Mettler TA1 thermoanalyser



Thermolysis and pyrolysis test station

process gases analyser

TBRC furnace – installation in 2024

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Hydrometallurgy

Our Pilot scale Equipment

Chamber-membrane filtration press of plates of 630 x 630 mm with adjustable membrane pressure up to 12 bar, filtration chamber thickness 20 to 50 mm

Large-laboratory scale installation for continuous liquid extraction

Vacuum evaporator of capacity 2 dm3/h of evaporated liquid for concentration and crystallisation of metal salts

Laboratory equipment for continuous liquid extraction

Large-laboratory scale SIMAX equipment for conducting studies into leaching and filtration

Set of leaching reactors of volume : 1.0; 1.7 and 2.8 m^3
heated with direct steam

Installation for investigations into electrorefining and electrowinning of metals

Reactors of 120 dm3 capacity for pilot scale studies into hydrometallurgical processes

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The people

Sustainable Economy in Horizon Europe. International Matchmaking & Networking (INSE) is an event covering the broadly understood sustainable economy, including raw materials, development of raw material extraction, value chain, CRM, recycling technologies. One of the goals of the event is to enable establishing business contacts, creating consortiums and sharing experience and knowledge between participants.

Sustainable Economy in Horizon Europe
International Matchmaking & Networking

2 edition of INSE (25-26 Oct. 2023):

- 241 registered people from 21 countries,
- 149 participants were present on the event,
- 17 speakers, including European Parliament and European Commission representatives,
- Prepared in cooperation with European Partnerships: EIT Raw Materials and A.SPIRE and polish partners: Łukasiewicz-Warsaw Institute of Technology, The Polish Chamber of Commerce for High Technology (IZTECH)
- 2 networking and 2 matchmaking sessions – 74 sheduled meetings via the b2match platform,
- 2 pitching sessions – 18 presentations of projects' ideas.

3 edition: Autumn 2024

Website of the event: https://inse-2023.b2match.io/

Next edition – November 2024, details will be provided soon

We invite you to cooperate

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