The use of DES and Ionic Liquids in ION4RAW

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ION4RAW

Ionometallurgy of primary sources for an enhanced raw materials recovery

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Outline

1. **Project overview: What? Who? What is the aim? What about the timing? Which are the goals and outputs?**
2. **The use of Deep Eutectic Solvents and Ionic Liquids in ION4RAW**

What?

- ION4RAW will develop a new energy- and material-efficient mineral processing technology to recover by-products from primary sources by means of innovative ***Deep Eutectic Solvent (DES) ionic liquids*** and ***advanced electro-recovery*** as an only step.

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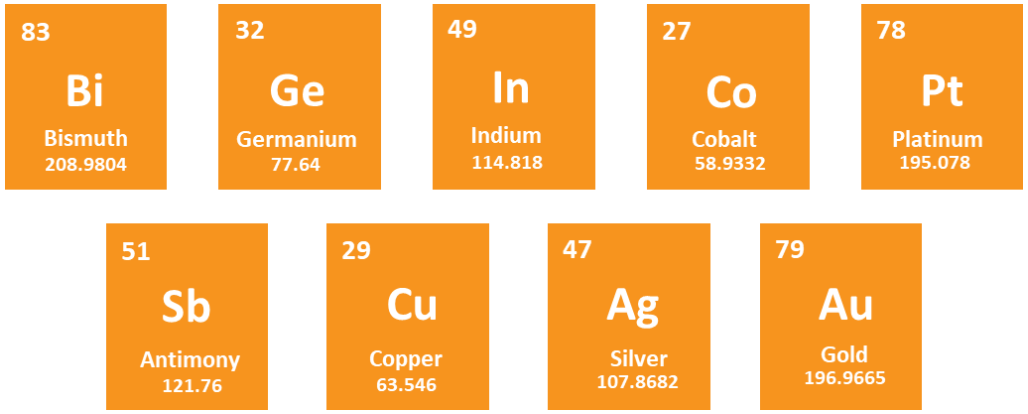
- ION4RAW will develop a new energy- and material-efficient mineral processing technology to recover by-products from primary sources by means of innovative ***Deep Eutectic Solvent (DES) ionic liquids*** and ***advanced electro-recovery*** as an only step.
- Most of the targeted by-products elements are Critical Raw Materials such as bismuth (Bi), germanium (Ge), indium (In), cobalt (Co), platinum (Pt) and antimony (Sb). Accompanying major product metals, e.g. copper (Cu), silver (Ag) and gold (Au), may also be recovered by this process.



Who?

- ✓ ***13*** Partners
- ✓ ***8*** Countries (7 from EU + Peru)
- ✓ ***5.648.450 €*** Budget
- ✓ From ***01.06.2019*** to ***30.11.2023***
- ✓ H2020, Research & Innovation Action

What is the aim?

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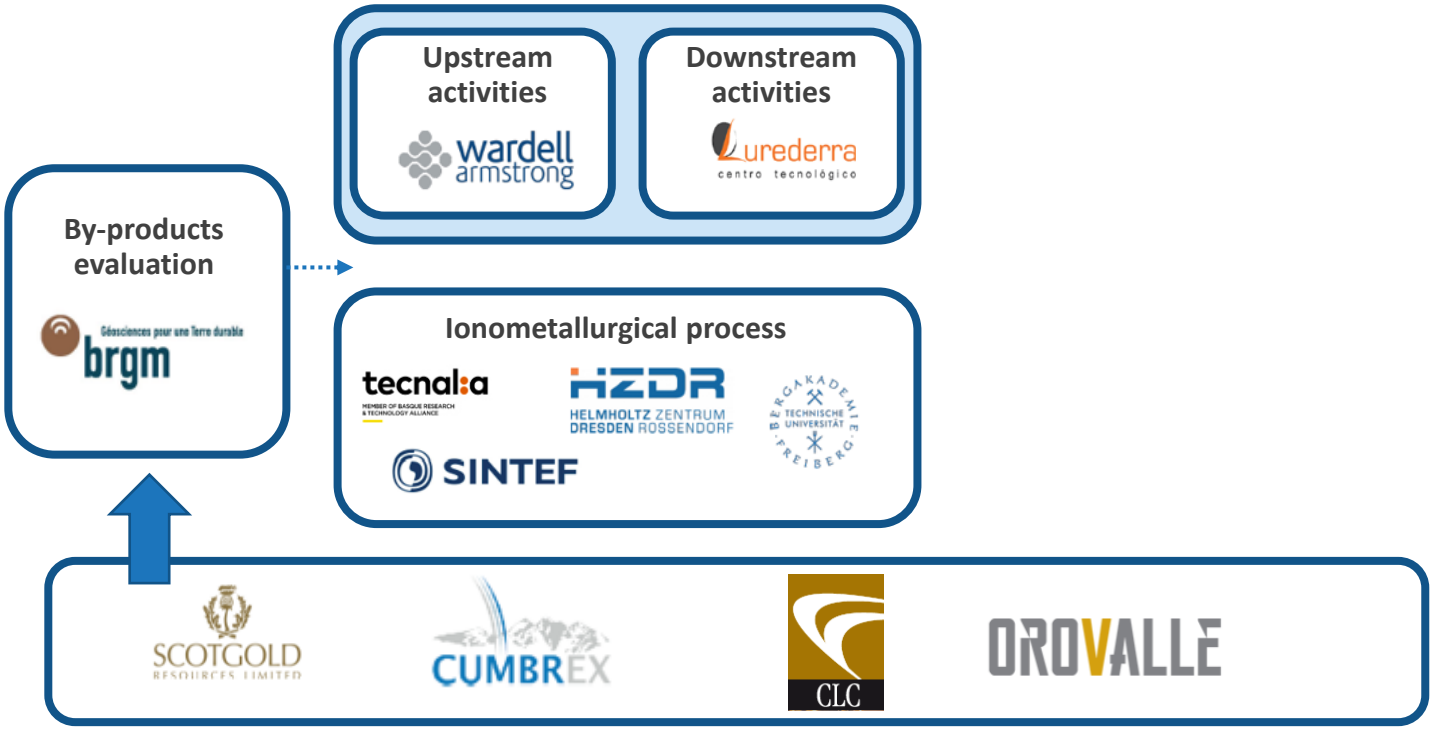

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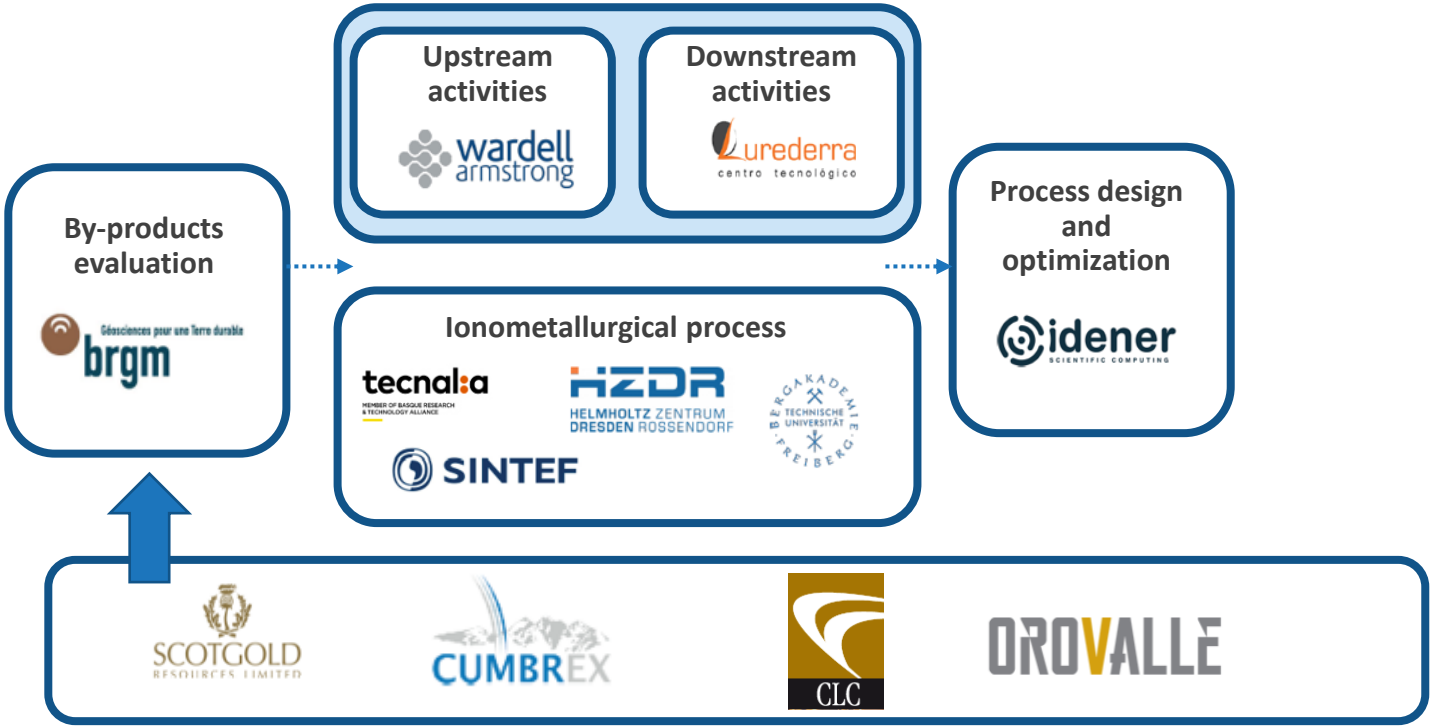

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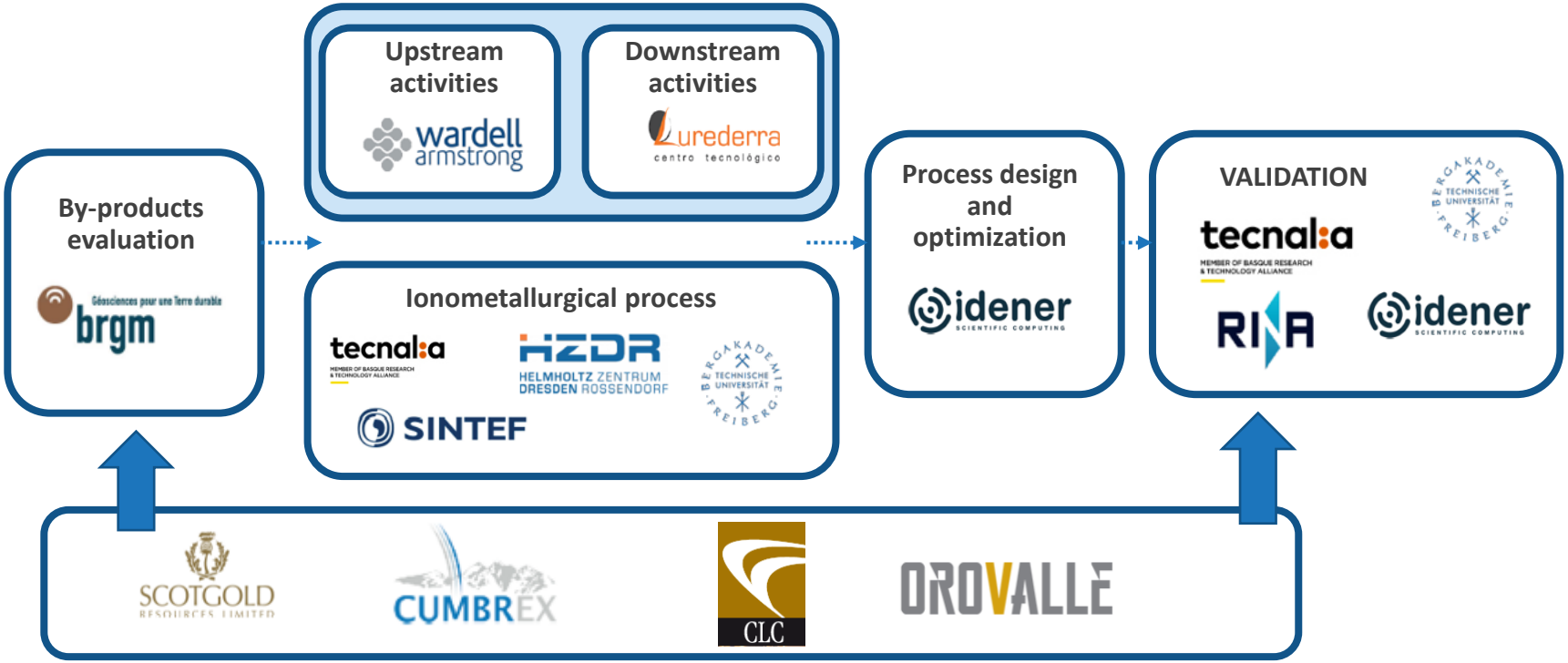

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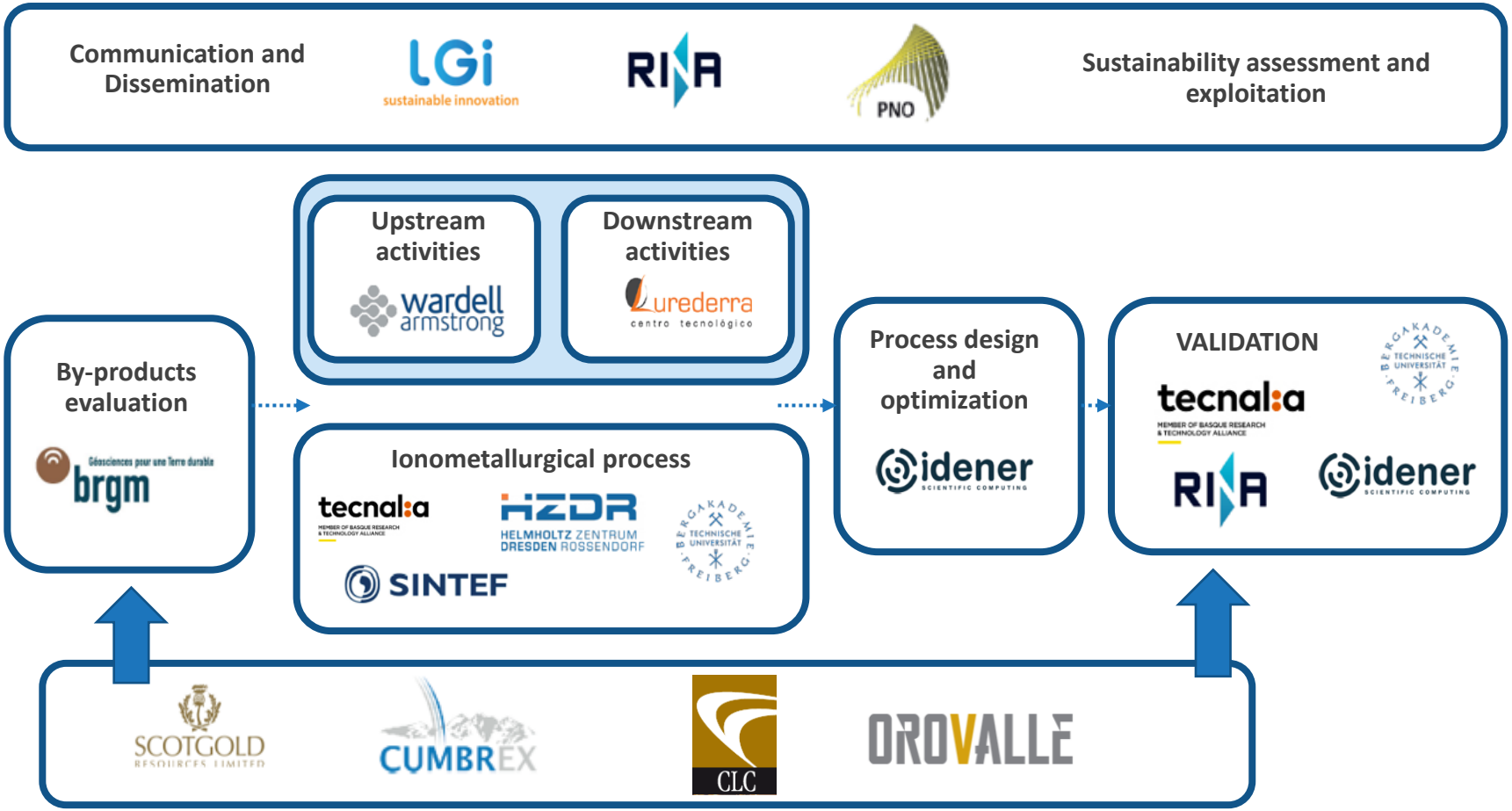

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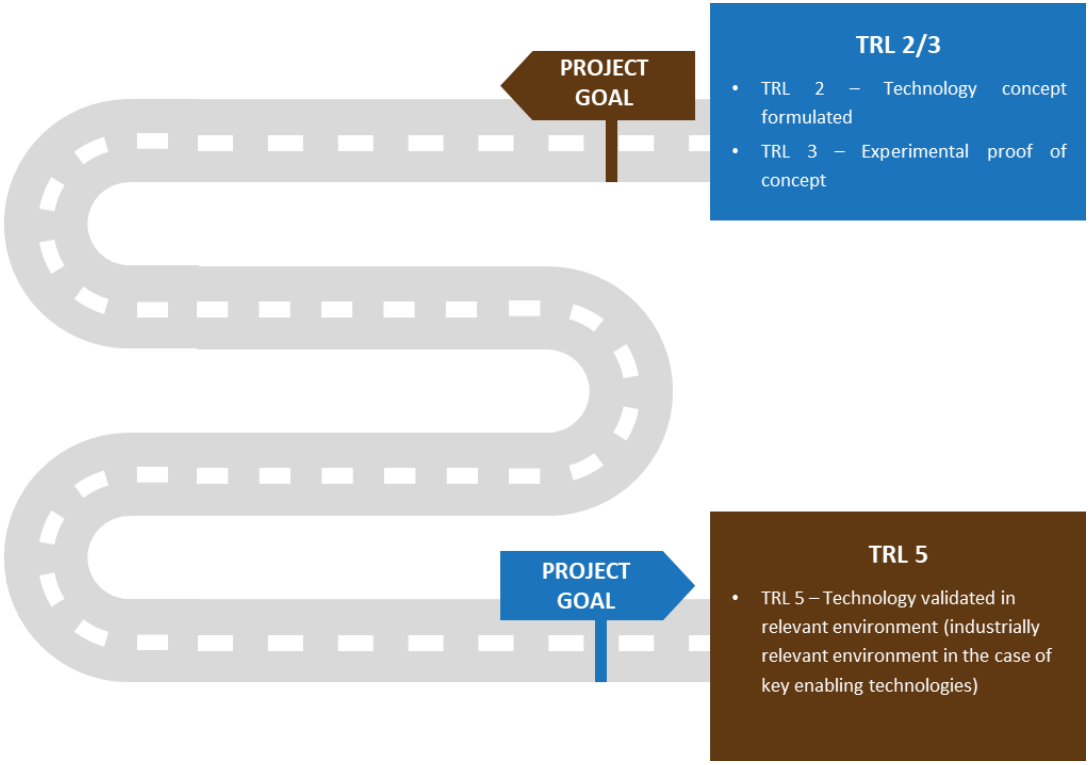
What is the aim?

- The flexibility of the process (to be demonstrated to TRL 5 through a prototype) increases its market penetration potential as a sound systemic solution.
- The technical feasibility of this concept is supported by the TRL 2-3. From this starting point, the Ion4Raw project aims to reach TRL 5 by implementing a process prototype at the TECNALIA facilities.



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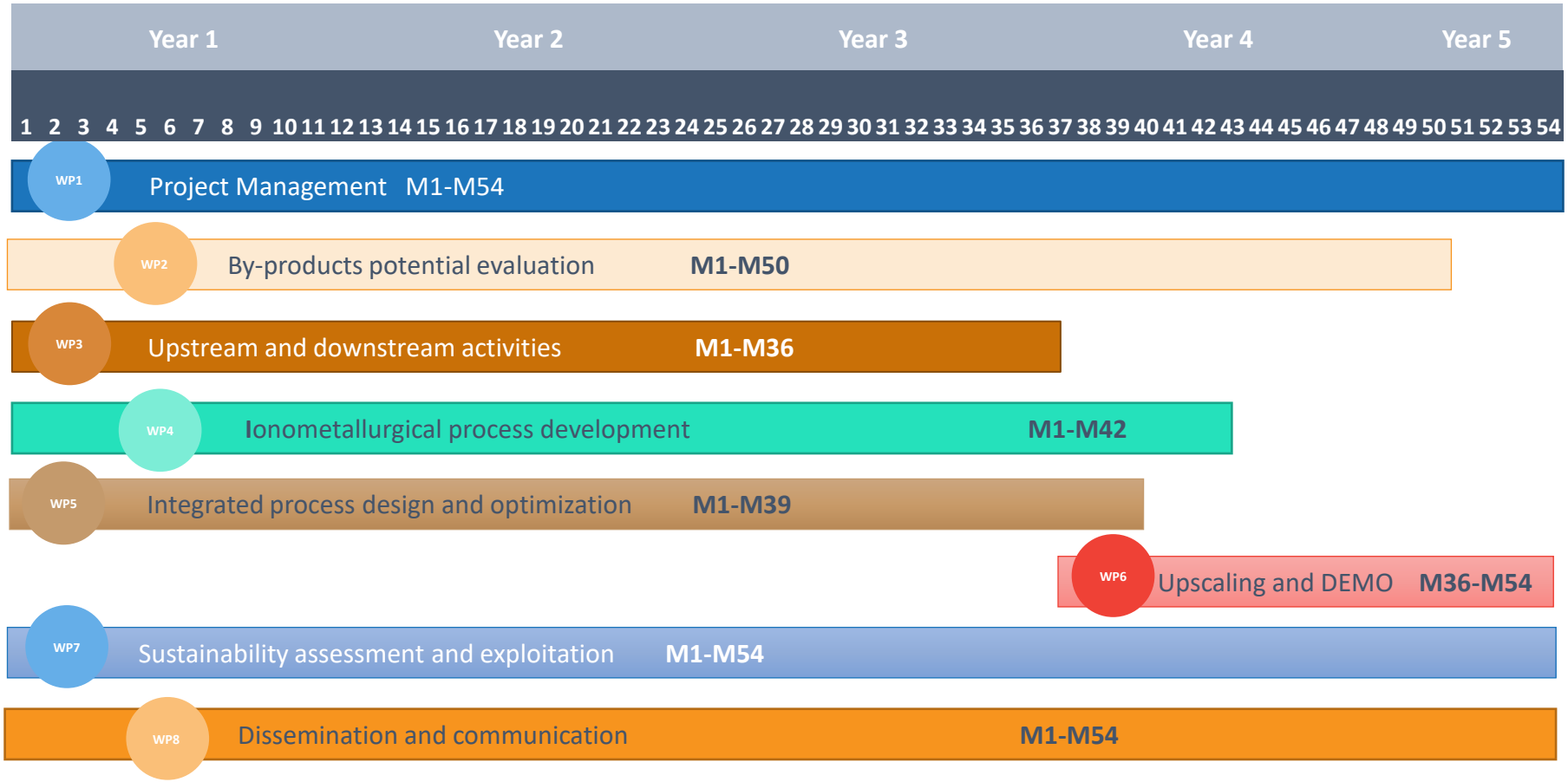
What about the timing?



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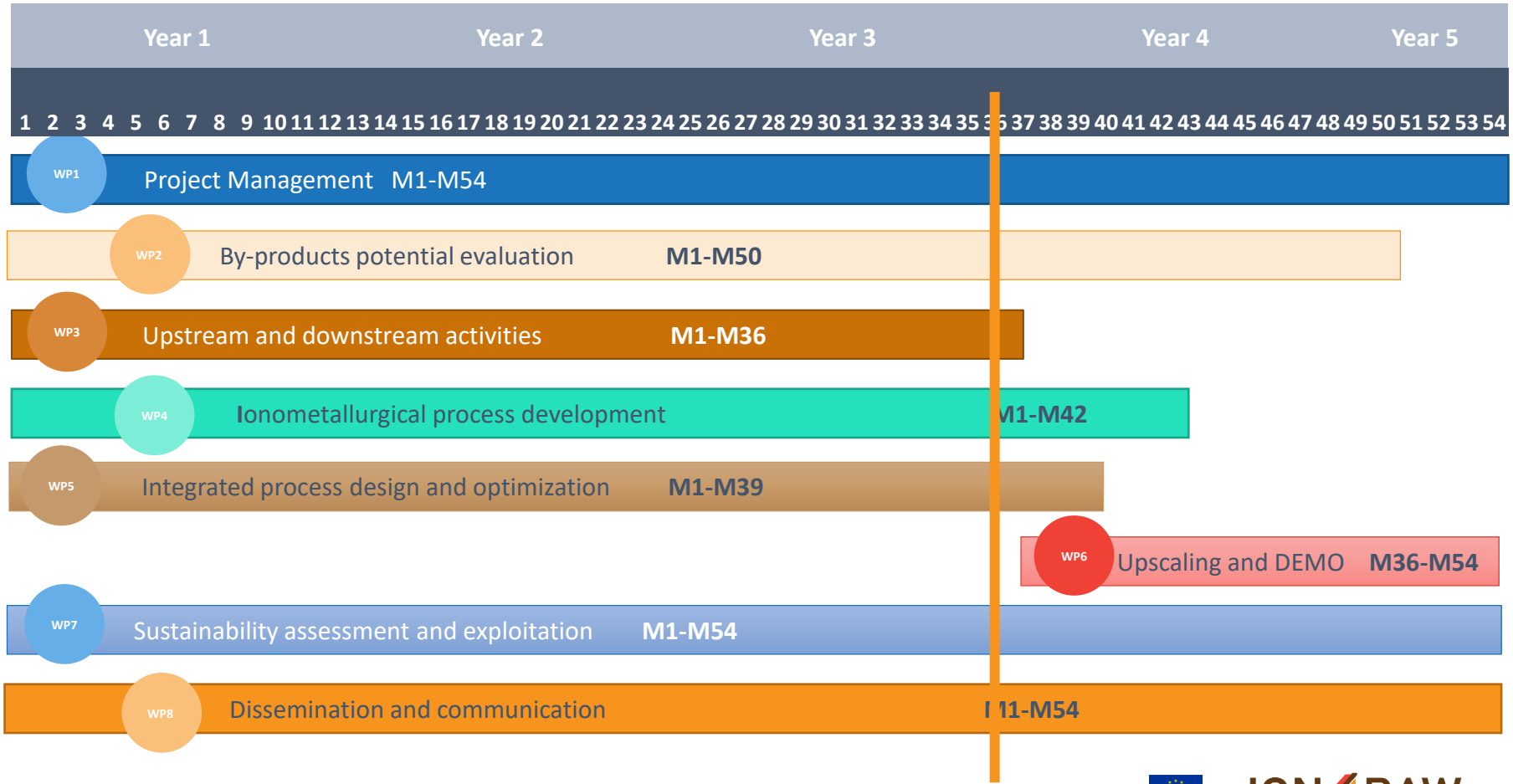
What about the timing?



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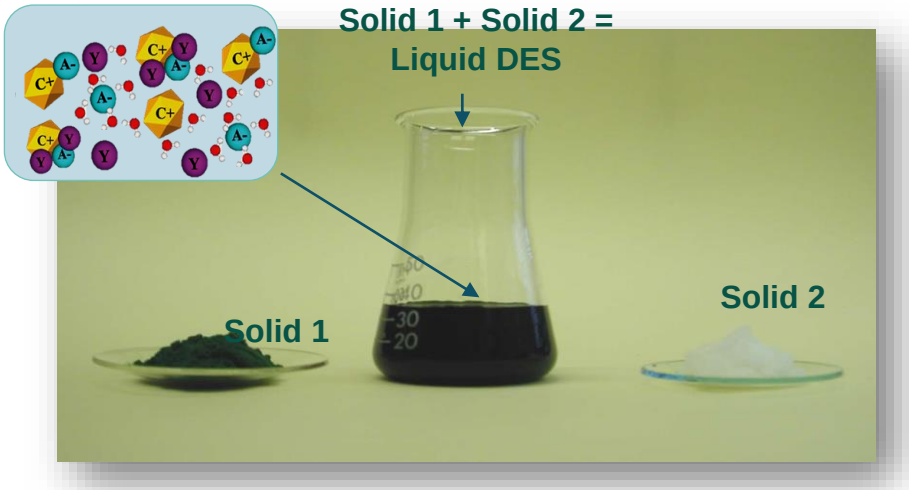
Deep Eutectic Solvents (DES)

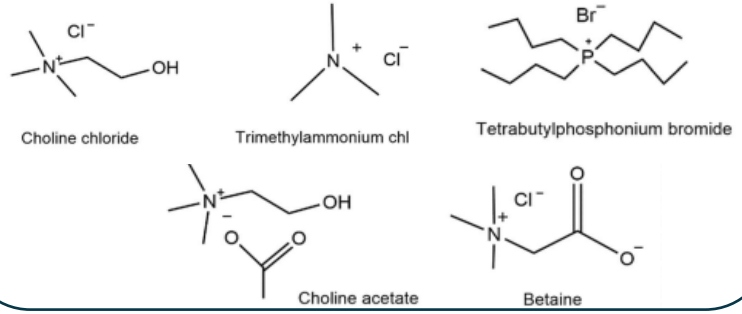
Deep Eutectic Solvents (DES) are formed from a eutectic mixture of Lewis or Brønsted acids and bases



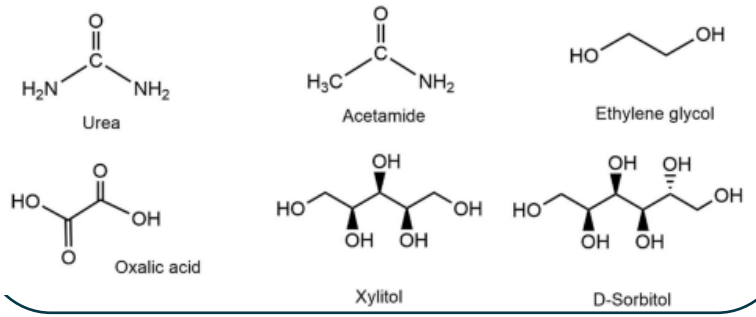
Type	Precursors
Type I	Quaternary ammonium salt + metal chloride
Type II	Quaternary ammonium salt + metal chloride hydrate
Type III	Hydrogen bond acceptor + hydrogen bond donor
Type IV	Metal chloride hydrate + hydrogen bond donor

Examples of precursors for "type III" DES

Hydrogen bond donors (HBD)



Hydrogen bond aceptors (HBA)



Why DES?

- **Green solvents,** environmentally benign compared to classical hydrometallurgical acids for leaching such as HCl, H_2SO_4 and HNO_3 or cyanide solutions.

- **Less energy consuming** alternative for sulphide ores' leaching compared to actual pyrometallurgical processes like smelting or roasting.

- **Easy to prepare,** with **low toxicity, chemically stable** and can be **biodegradable**.

- **Economically viable on a large scale**: DES can be recycled and reused in case by case in a closed circuit, so, in a pilot plant scale, the process can be economically viable even for low value metals.

DES based recovery process

Main steps:

Pre-treated ores (Concentrates)

SCOTGOLD RESOURCES LIMITED · CUMBREX · OROVALLE · CLC

- Scotgold (Au, Ag, Te)
- El Porvenir (Ag, Bi, Sb, Te, Se, Mo, In)
- Cerro Lindo (Ag, Bi, Sb, Se)
- Orovalle (Sb, Bi, Mo, Te, Au, Co)
- Cobre Las Cruces (Sb, Bi, Co)

DES leaching → Residual concentrate

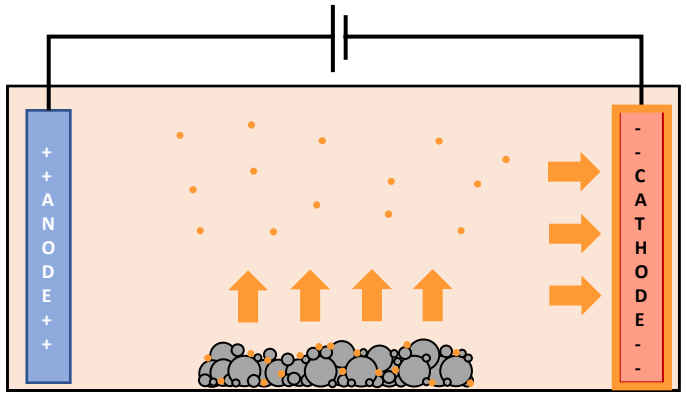
DES leachate

Recovery process

Electrodeposition → Leachate with remaining metals

Target by-products

Recovery of other metals by chemical techniques



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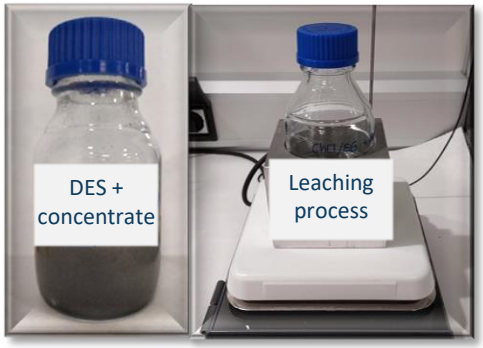
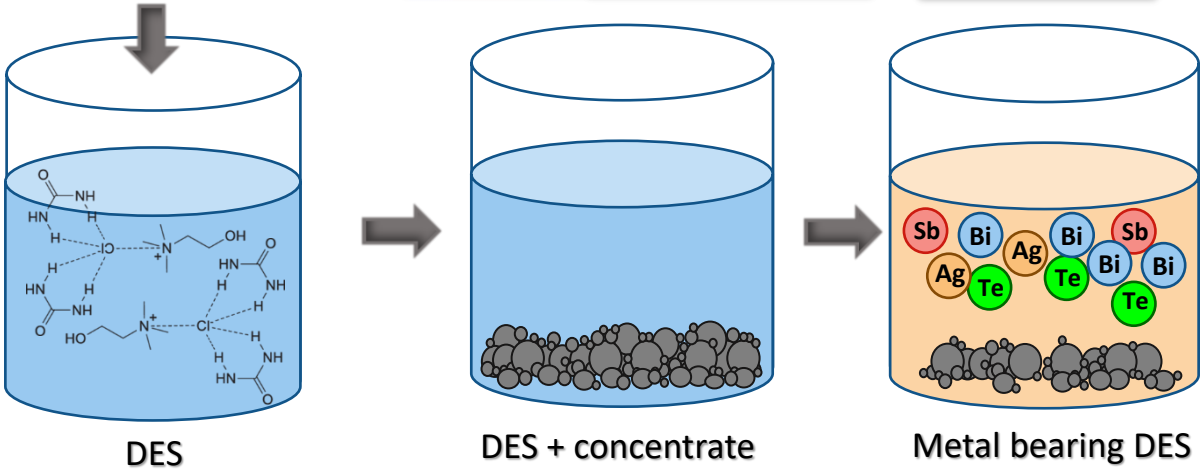
DES based recovery process

Leaching step: Experimental procedure

Ore concentrate





DES

DES + concentrate

Metal bearing DES

Parameters studied:

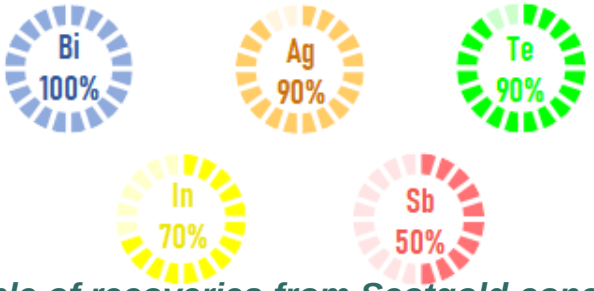
- ❑ DES chemistry
- ❑ Additives
- ❑ Solid/DES ratio
- ❑ Operating conditions (leaching time, temperature, stirring)

DES based recovery process

Leaching step: Main results

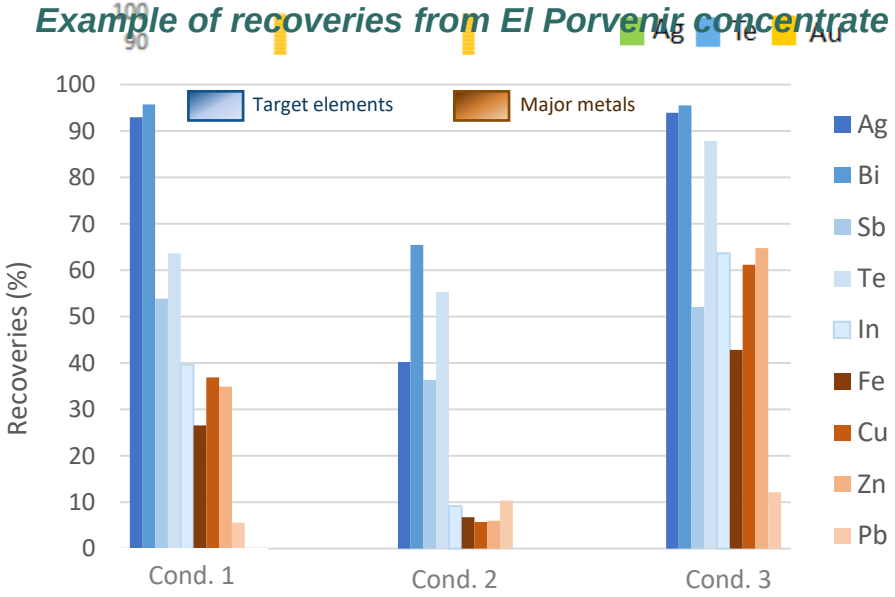
- DES are able to **greatly leach bismuth (Bi), silver (Ag) and tellurium (Te)**, and **moderately antimony (Sb) and indium (In)** from the different sulphide concentrates studied.
- The **recovery efficiencies depend on the chemistry of the DES, solid/DES ratio and leaching operating conditions** (time, temperature, etc), among others.
- In general, target by-products are leached **together with major metals like copper (Cu)** and some other base metals like iron (Fe), zinc (Zn) or lead (Pb).

Recoveries from El Porvenir concentrate



Example of recoveries from Scotgold concentrate

Example of recoveries from El Porvenir concentrate



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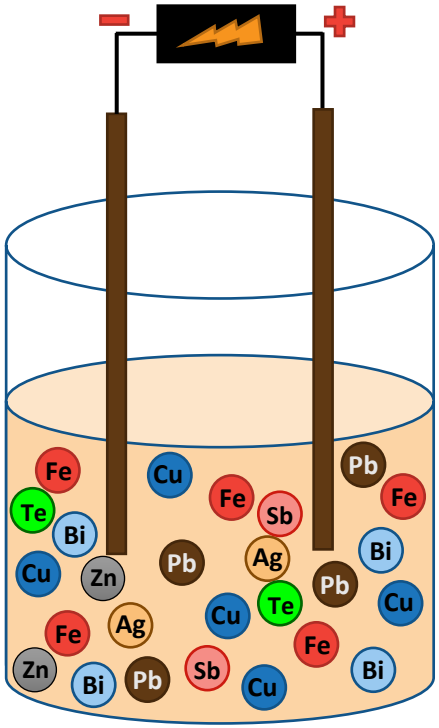
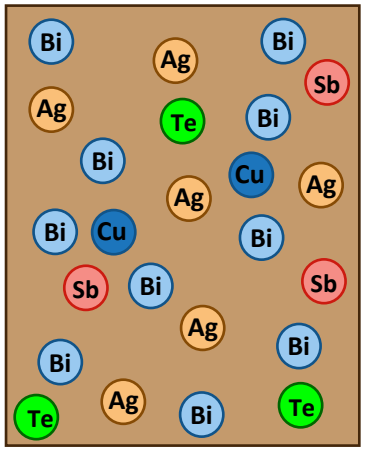
DES based recovery process

Electrodeposition step: Experimental procedure



Cathode deposit



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DES based recovery process

Electrodeposition step : Main results

- Non-selective leaching process results in **co-deposition** during electrochemical recovery
- The presence of Fe and Cu in high oxidation states in the DES-leachates leads to **low current efficiencies** of metal recovery in the electrodeposition step
- The **composition** of the deposit **depends on relative concentrations** of the metals in the DES-leachates. The resulting **deposition potential** during the electrochemical recovery also affects the **composition and morphology of the deposit**
- DES-leachates from the **El Porvenir** concentrate results in **co-deposition of the target metals Cu, Bi, Ag, Sb and Te** when depositing at optimal conditions
  - **Sulfur** species are also leached and may also co-deposit with the metals and/or affect the anode reaction

Next steps

- Optimization of the process conditions to achieve the best compromise between recovery efficiencies, quality of final products and economic feasibility
- Designing of prototype, scale-up of the process and DEMO validation.
- Optimization of DES recyclability and valorization of residual solid and rest of process outputs.

Thank you. Get in touch for more information!

Follow the progress of the project on the ION4RAW website.

Project coordinator: Maria Tripiana, IDENER
Contact us: contact@ion4raw.eu

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