Innovative MSA-based flowsheet to produce Made-in-Europe NMC cathodes

BATTERY 2030+ roadmap workshop, Oslo, June 27. 2024

This work was supported by the European Union's Framework Programme for Research and Innovation Horizon Europe, via projects CICERO [Grant number 101137560] and ENICON [Grant number 101058124].

Consortium

Input streams

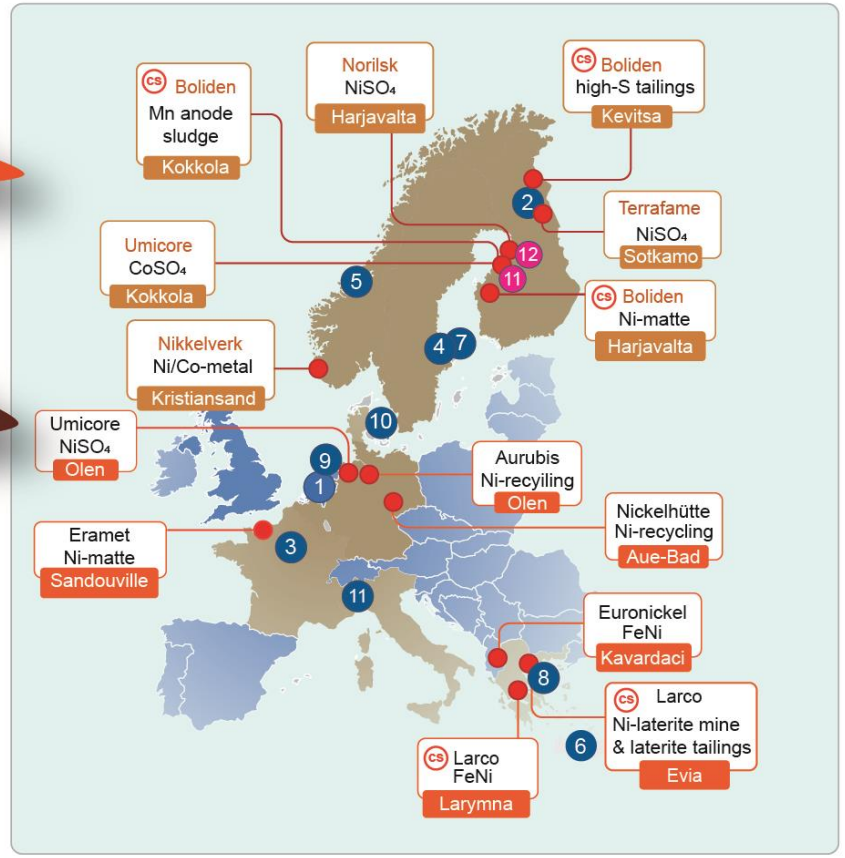
Low-grade post-mining raw materials: laterite & sulphidic tailings

Intermediates: Ni-matte/FeNi & MSP/MHP & Mn anode sludge

Associated partners

11 [BOKA]	NEW B	BOLIDEN KOKKOLA OY
12 [BOHA]	NEW B	BOLIDEN HARJAVALTA OY

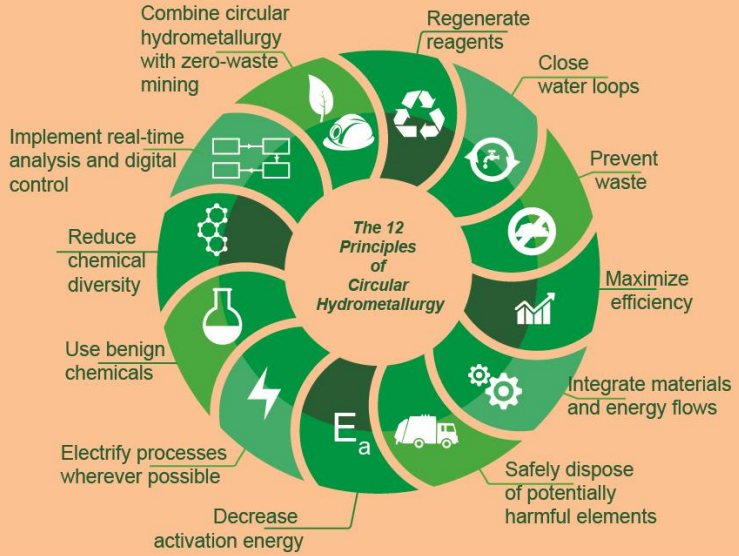
CS Case-study materials



Project partners

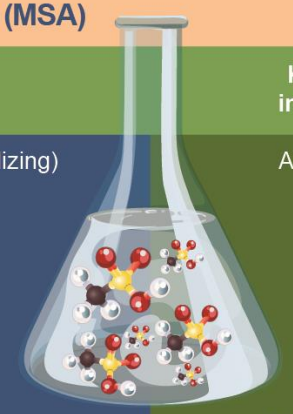
1 [KUL]	KU	KU LEUVEN
2 [VTT]	VTT	TEKNOLOGIAN TUTKIMUSKESKUS VTT OY
3 [BRGM]	brgm	BUREAU DE RECHERCHES GEOLOGIQUES ET MINIERES
4 [KTH]	KTH	KUNGLIGA TEKNISKA HOEGSKOLAN
5 [SINTEF]	S	SINTEF AS
6 [TUC]		POLYTECHNEIO KRITIS
7 [BOMIN]	NEW B	BOLIDEN MINERAL AB
8 [LARCO]	LARCO	GENIKI METALLEUTIKI KAI METALLOURGIKI ANONIMIETAIRIA
9 [AURUBIS]	AA	AURUBIS BEERSE
10 [BASF]	BASF	BASF SE
11	ITAL	ITALMATCH

Project Overview



Methanesulfonic acid (MSA)

Properties	Key applications in hydrometallurgy
Non-oxidizing (+ H_2O_2: oxidizing)	Alternative to HBF_4 or H_2SiF_6 in Pb hydrometallurgy
Readily biodegradable	Electrorefining of Cu, Ag, Co/Ni, Zn
High chemical stability	Electrowinning of Sn
Strong organic acid	Urban mining of WEEE
Low corrosivity	Acid leaching of ores and concentrates (e.g., Cu, REEs, Zn, Mn)
Low vapor pressure	
Highly soluble metal salts	
Low environmental impact	



Low-grade post-mining raw materials: laterite & sulphidic tailings

+ "responsibly sourced"

Intermediates: Ni-matte/FeNi & MSP/MHP & Mn anode sludge

Input streams

- Materials ▶
- Resources ▶
- Energy ▶

WP1

Advanced leaching and solution purification (WPL: KUL)

Pure solutions of $Ni(MSA)_2$ & $Mn(MSA)_2$ & $Co(MSA)_2$

WP2

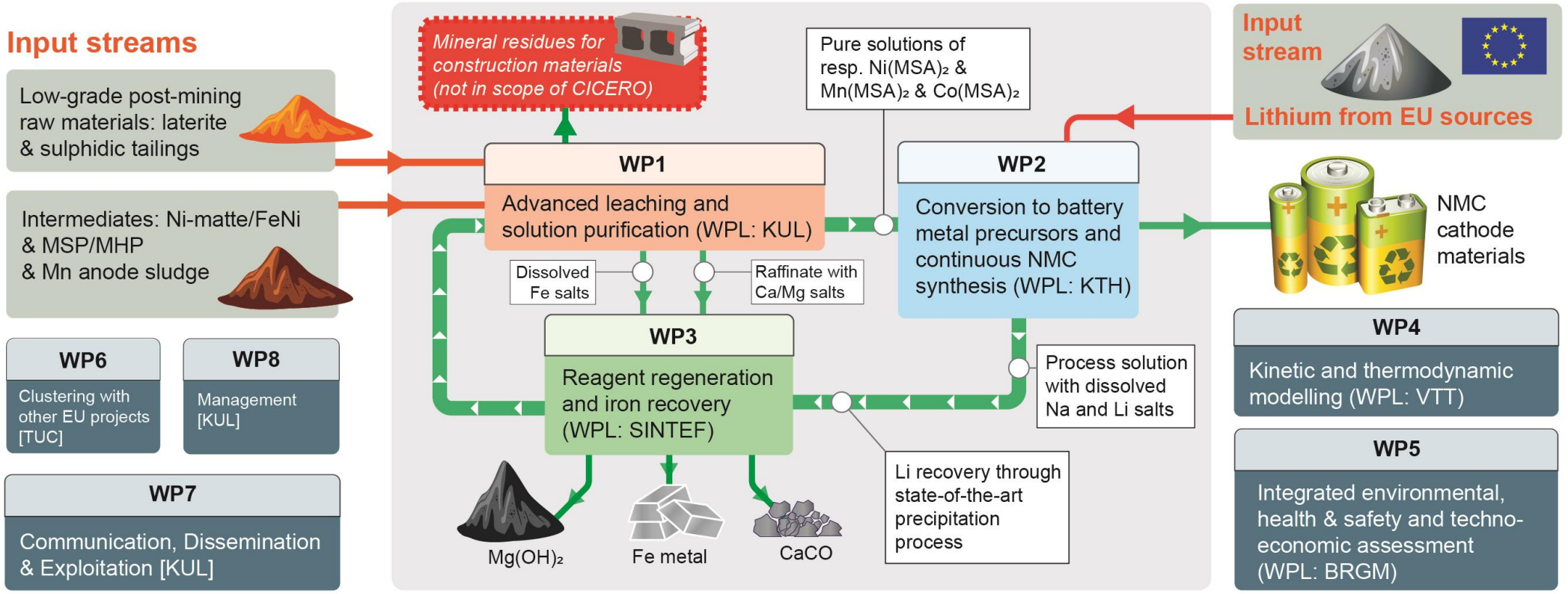
Conversion to battery metal precursors and continuous NMC synthesis (WPL: KTH)

WP3

Reagent regeneration and iron recovery (WPL: SINTEF)

Made-in-Europe NMC cathode materials

Project Overview



High-level scientific objectives

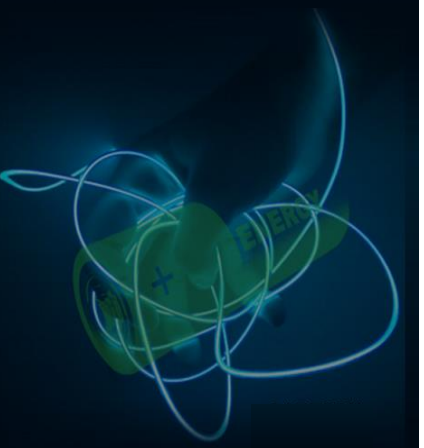
- To develop next-generation, scalable **leaching** setups and **solution purification** unit processes in **MSA** media, which when smartly combined, can extract and recover **Ni, Co and Mn** from:

  (a) low-grade post-mining raw materials (tailings);

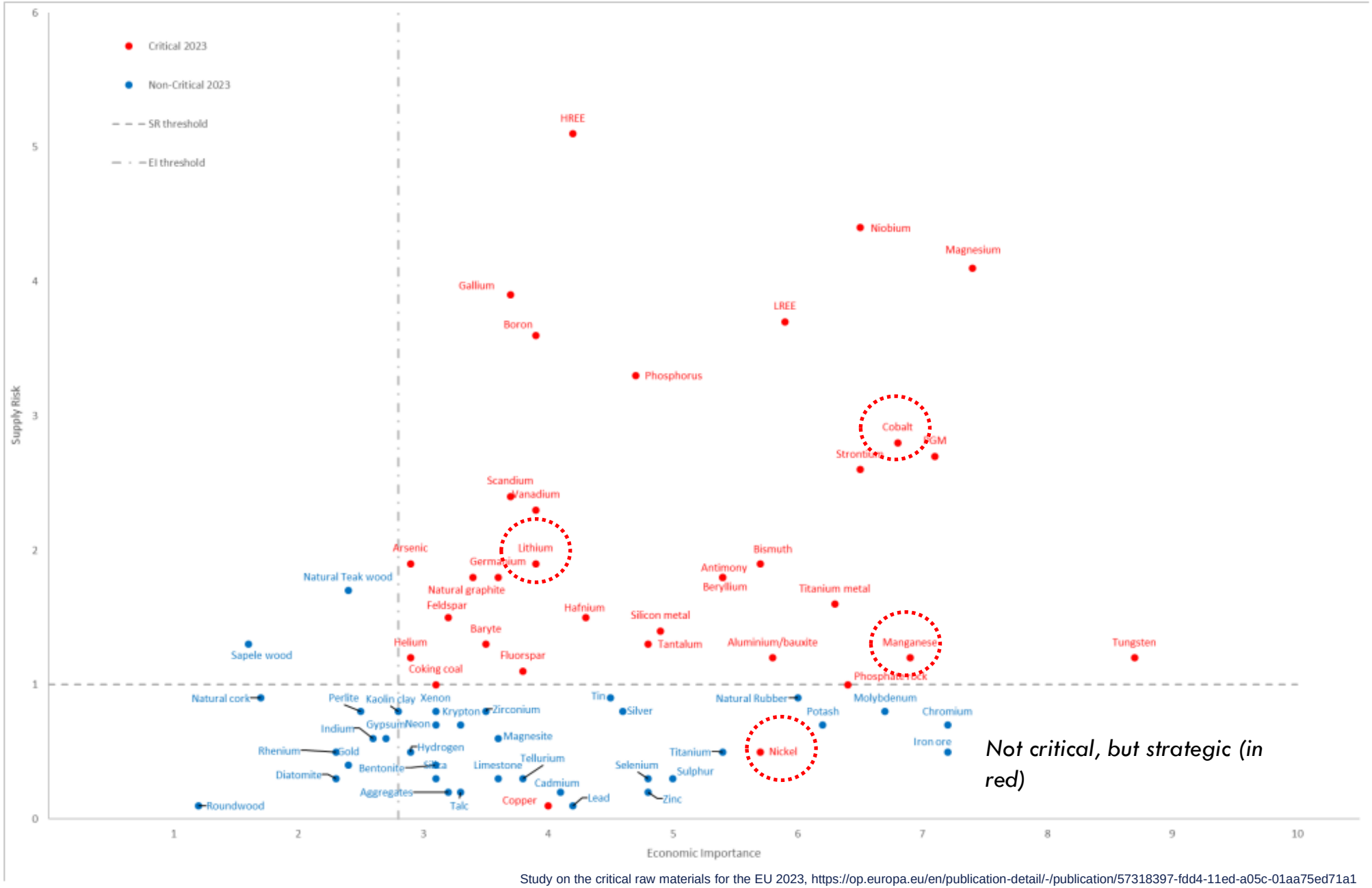
  (b) distinct intermediates,

  thereby producing pure solutions of $Ni(MSA)_2$, $Mn(MSA)_2$ & $Co(MSA)_2$ salts (or Ni, Mn, Co metals) for downstream NMC synthesis.

- To develop next-generation, scalable unit processes to convert pure solutions of $Ni(MSA)_2$, $Mn(MSA)_2$ & $Co(MSA)_2$ salts in battery-grade metals or solid MSA salts that are **synthesized in NMC.**
- To develop scalable unit processes for the **regeneration of reagents** (incl. MSA) and the recovery of iron, thereby allowing circular hydrometallurgical flowsheets to come to fruition.
- To develop an integrated **environmental, health & safety and techno-economic assessment** for the novel unit processes and the combined processing routes and to identify environmental & economic hotspots and suggest improvements to process and energy efficiency.



Critical Raw Materials Act



Not critical, but strategic (in red)

Study on the critical raw materials for the EU 2023, https://op.europa.eu/en/publication-detail/-/publication/57318397-fdd4-11ed-a05c-01aa75ed71a1

BATTERY 2030+

1) **Which objectives of my project could be added to the roadmap goals?**

Establish an independent European value chain from raw materials to battery grade materials

Use and valorization of secondary raw materials and intermediates

Circular process with minimal waste generation for both recycling and processing of battery materials from primary and secondary sources

2) **What are the expectations of my project from the future roadmap?**

Develop green and circular processes to obtain battery materials and contribution to an European battery value chain and to the CRMA