Production of raw materials for batteries from European resources

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EU - H2020

CROCoDILE

Raw Materials Week *EU funded projects Clustering Workshop 14th November 2022*

First of a kind commercial Compact system for the efficient Recovery Of CObalt Designed with novel Integrated LEading technologies

This project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 776473 - https://h2020-crocodile.eu/

Outline

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  - LCA / LCC
  - Pilot and validation/demo

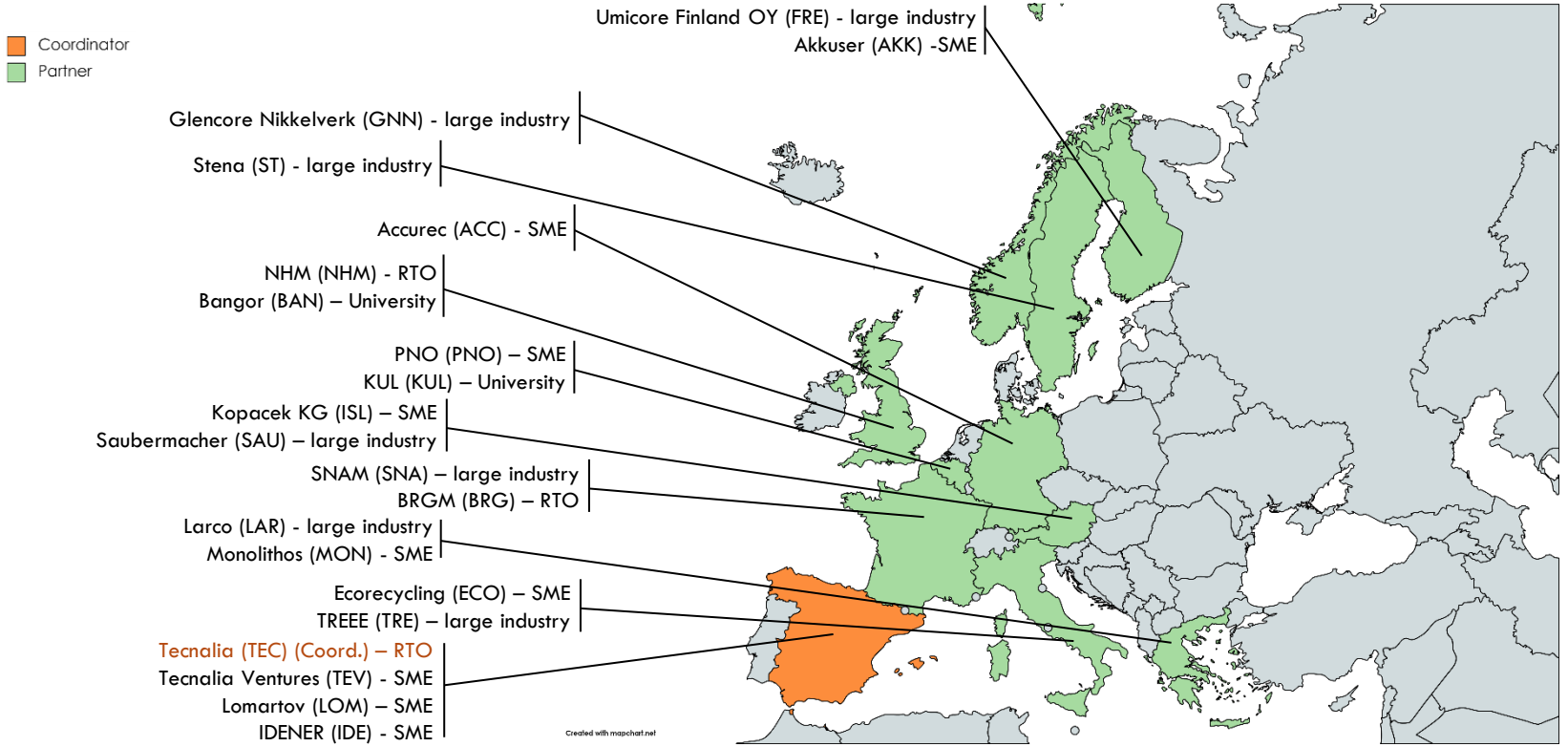
Introduction: general information

First of a kind commercial Compact system for the efficient Recovery Of CObalt Designed with novel Integrated LEading technologies

http://h2020-crocodile.eu/

- ***Funding***: Horizon 2020 -Grant Agreement No. 776473
  - Call: H2020-SC5-2017
  - Topic: Raw materials - Innovation action
- ***Duration:*** 4 years (from June 2018 to May 2022) extended to November 2022
- ***EC contribution:*** 11.6 M€
- ***Partners:*** 24 from 11 different countries
- ***Coordinator:*** TECNALIA

Introduction: partners



Introduction: partners

CROCODILE

The CROCODILE project has received funding from the European Union's EU Framework Programme for Research and Innovation Horizon 2020 under Grant Agreement No 776473

Introduction: objectives

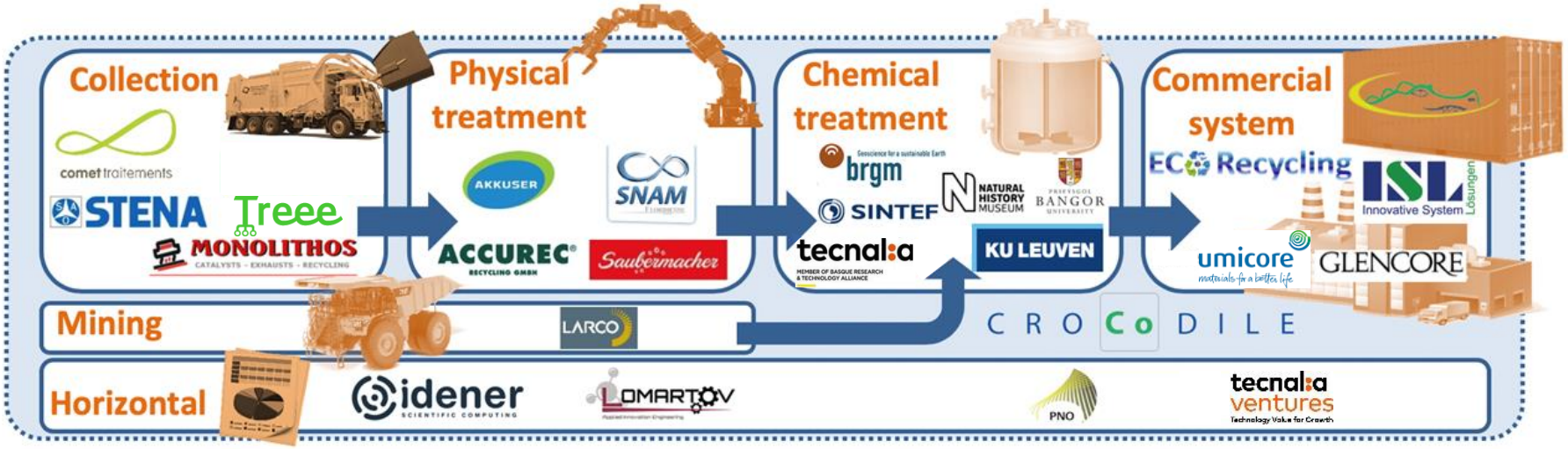
- Optimise the pretreatment step of secondary waste rich in cobalt by advanced mechanical, wet mechanical process and pyrometallurgy;
- Establish a bio-processing route for primary resources;
- Develop a new mobile pilot with the capability of producing cobalt metal to enable new business opportunities and expand the business across the EU
- Assess the performance of the CROCODILE value chains from the environmental, economic and technical point of view
- Arrange and set up the post-project life of the CROCODILE solution, based on market analysis, strong value chain and business plan
- Spread the gained knowledge to the relevant audience to obtain a social license to operate

The concept

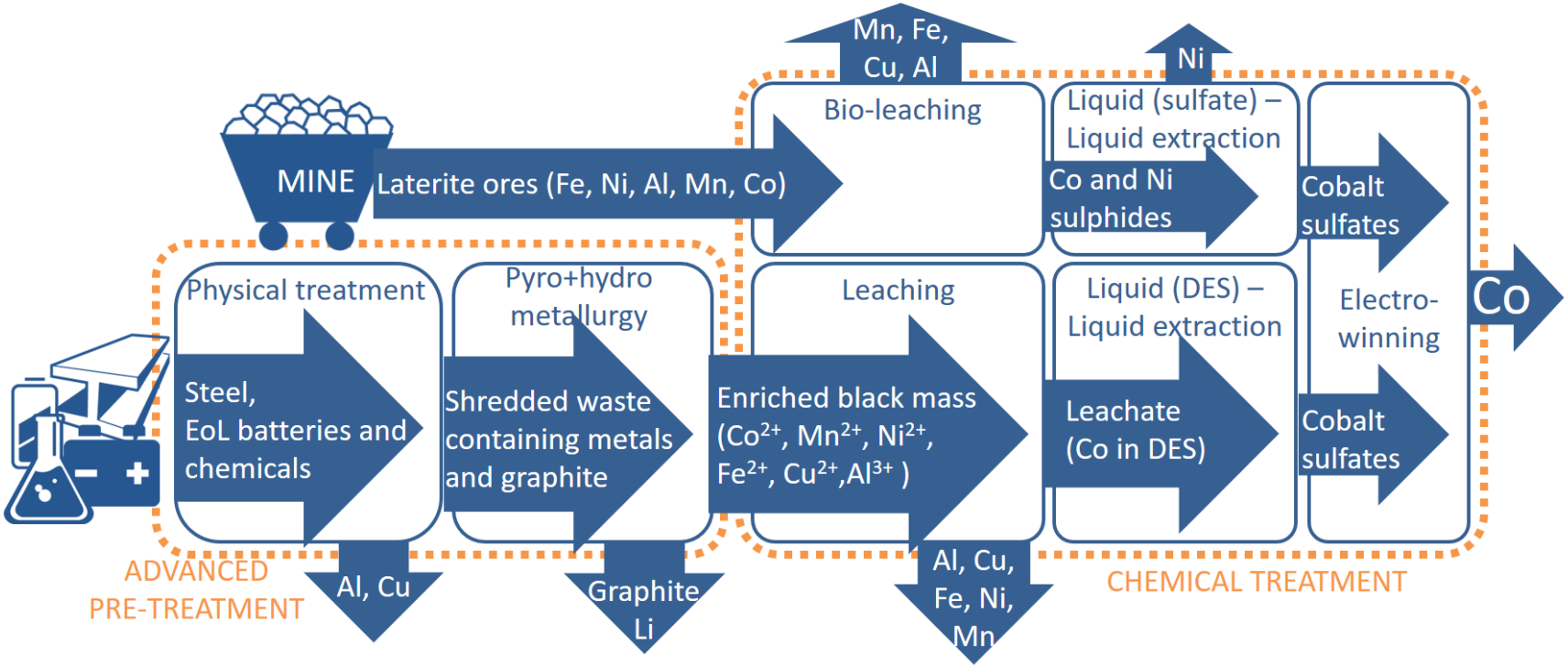
Current SoA is mainly driven by pyrometallurgy / hydrometallurgy

- High energetic cost
- Use of strong inorganic acids such as sulfuric and hydrochloric acids
- High environmental impact
- Not all metals are recovered from batteries
- High generation of waste (slag and gas emissions)
- High CAPEX

The concept


Collection
comet traitements
STENA
Treee
MONOLITHOS
CATALYSTS - EXHAUSTS - RECYCLING
Physical treatment
AKKUSER
SNAM
ACCUREC
RECYCLING GMBH
Saubermacher
Chemical treatment
brgm
SINTEF
NATURAL HISTORY MUSEUM
BANGOR UNIVERSITY
tecnalia
KU LEUVEN
Commercial system
ECO Recycling
ISL
Innovative System Lösungen
umicore
materials for a better life
GLENCORE
Mining
LARCO
CROCODILE
Horizontal
idener
SCIENTIFIC COMPUTING
LOMARTOV
PNO
tecnalia ventures
Technology Value for Growth

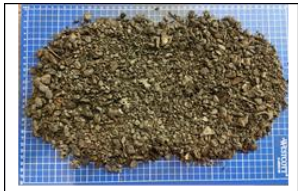
The concept


Mn, Fe, Cu, Al
Ni
MINE
Laterite ores (Fe, Ni, Al, Mn, Co)
Bio-leaching
Liquid (sulfate) – Liquid extraction
Co and Ni sulphides
Cobalt sulfates
Physical treatment
Steel, EoL batteries and chemicals
Pyro+hydro metallurgy
Shredded waste containing metals and graphite
Leaching
Enriched black mass (Co^{2+}, Mn^{2+}, Ni^{2+}, Fe^{2+}, Cu^{2+}, Al^{3+})
Liquid (DES) – Liquid extraction
Leachate (Co in DES)
Electro-winning
Co
Cobalt sulfates
ADVANCED PRE-TREATMENT
Al, Cu
Graphite Li
Al, Cu, Fe, Ni, Mn
CHEMICAL TREATMENT

The concept

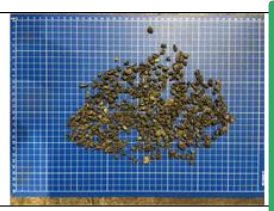
WP	WP Title
WP1	Management
WP2	Supply, characterisation and pretreatment
WP3	Chemical treatment
WP4	Use of existing European infrastructure
WP5	Commercial system construction
WP6	Commercial system validation
WP7	LCA & LCC
WP8	Stakeholder engagement, Communication and Dissemination
WP9	Exploitation
WP10	Cluster with other projects
WP11	Ethics requirements

Key findings and tips: about samples



Output coarse fraction

Output fine fraction



Output iron fraction

Output black mass fraction

➢ Sample delivery follow up table

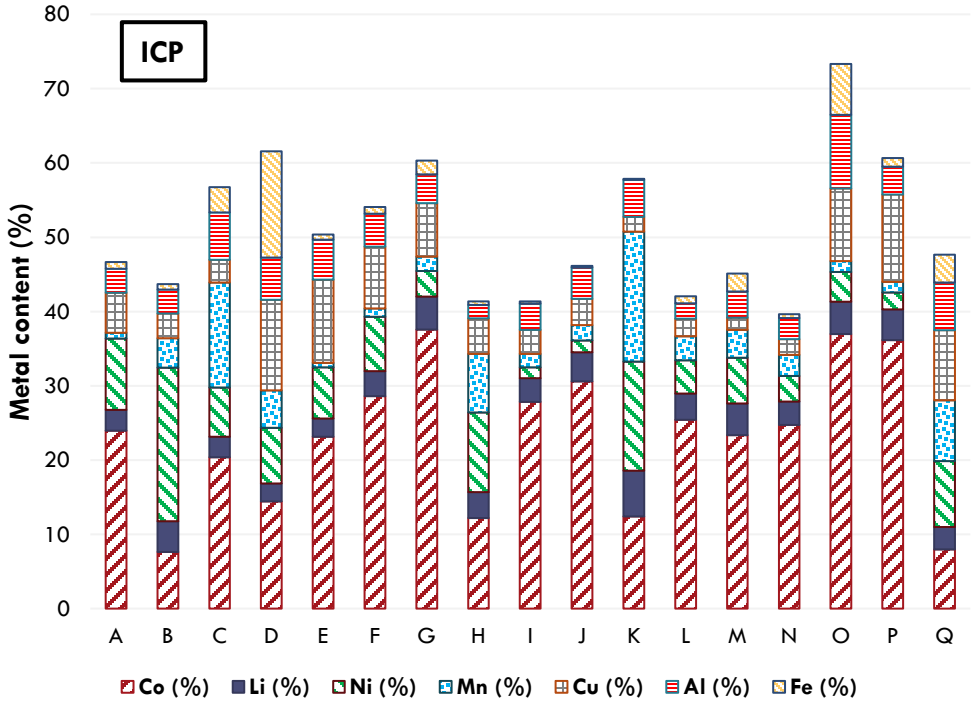
SECONDARY RESOURCES samples delivery (13/01/2021)

Samples already delivered
Samples not delivered (estimation)

			WP2									
			Task 2.1 - 2.2				Task 2.3					
Sample to WP3-4-6	**Residue type**	**Remarks**	**Collect by**	**WP2 Task**	**Delivery date to WP2 treatment**	**Quantity**	**WP2 partner**	**WP2 Task**	**Treatment**	**Characterisation for pre-treated samples Performed by partner (see tabs for results)**	**Co content (%)**	**Delivery to other WPs**
CRO 01	Batteries	Spent LIBs // Sample from another project	-	-	-	-	-	-	-	TEC (ICP)	24% (TEC)	M0 (01/Jun/2018)
CRO 02	Batteries	Spent LIBs	SNA	-	In house	?	SNA	2.3.E	Mechanical + Pyro + Sieving	TEC (ICP), SNA(ICP)	7.6% (TEC)	M4 (19/Jul/2018)
CRO 03	Catalyst	Catalyst pellets	MON	2.1.A	In house; Ground&sieved	?	-	-	-	TEC (ICP, TXRF), COM (ICP)	2.2% (TEC)	M6 (12/Nov/2018)
CRO 04	Batteries	Spent LIBs	ACC	-	In house	?	ACC	2.3.C	Rotary kiln incineration+wet separation	TEC (ICP, TXRF), ACC(ICP)	20.4% (TEC)	M7 (15/Dec/2018)

Key findings and tips: about samples

- Broad type of BM samples were characterized: ICP/TXRF, XRD, SEM-EDS.



Metal	Content range (%)
Co	8-38%
Li	2-6%
Ni	1-21%
Mn	1-17%

Key findings and tips: about samples

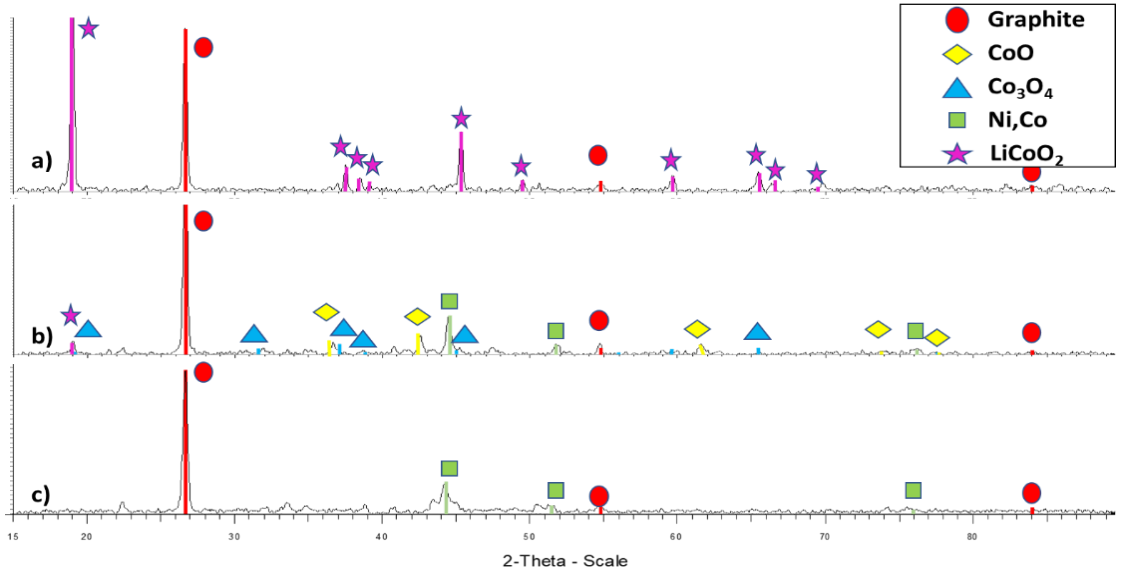
XRD

Different mineralogical species were found by XRD, depending on the BM sample and pre-treatment processes performed:

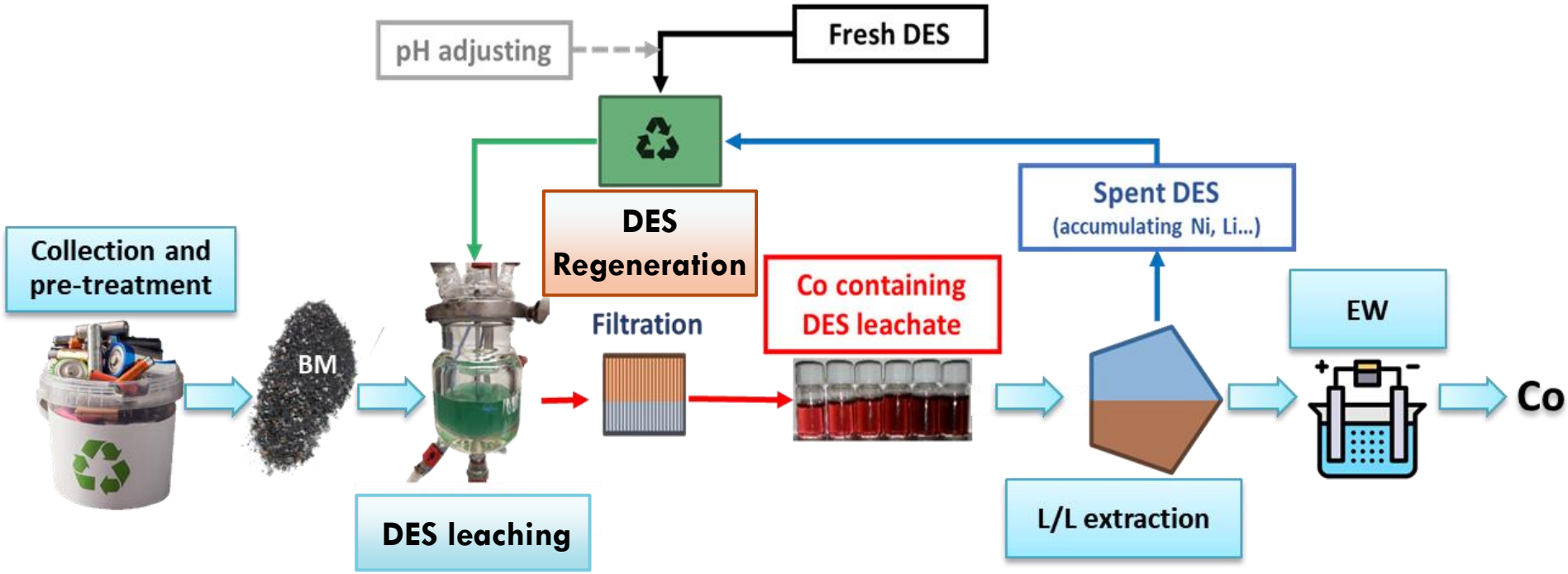
$LiCoO_2$

Co oxides (CoO, Co_3O_4)

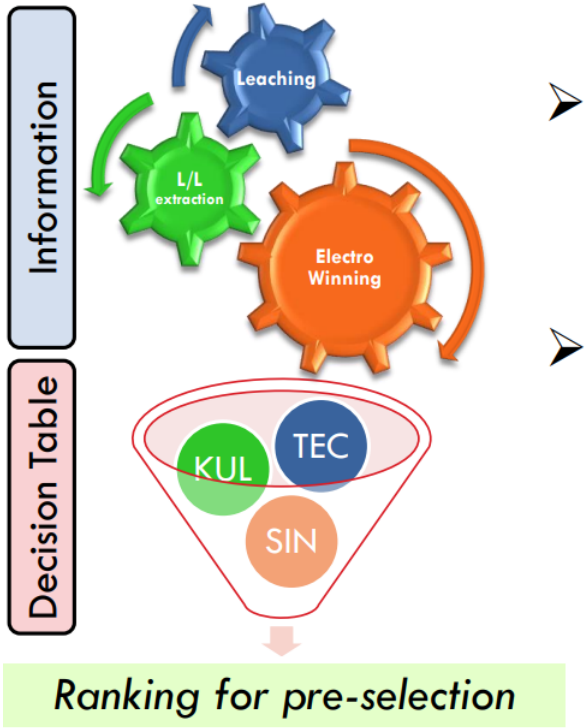
Metallic (Co, Ni)



Key findings and tips: selection of the flowsheet to be upscaled



Key findings and tips: selection of the flowsheet to be upscaled

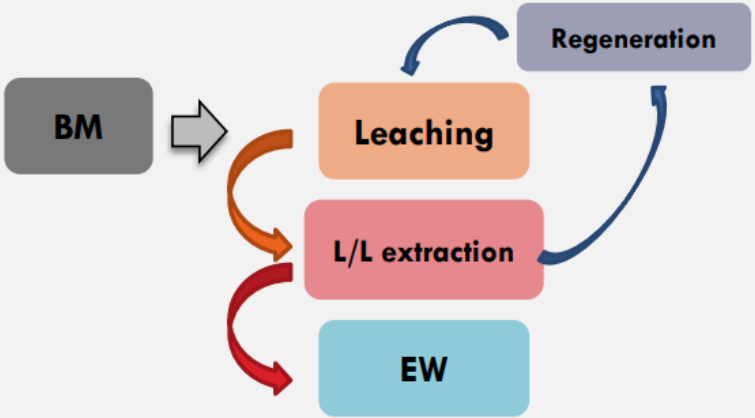


- Compile performance and relevant information for the three processes (KPIs included): Leaching, L/L extraction and EW.
- Stablish a **methodology** (parameters/ponderation) to select the flowsheet that performs best for the different experimental conditions tested => **Decision table:** *15 BM samples and several leaching routes tested*

Key findings and tips: selection of the flowsheet to be upscaled

➢ **Optimization** of the **3** pre-selected tests

Leaching, L/L extraction, DES regeneration and EW processes involving **deliveries of samples** from **TEC⇔ KUL** and **KUL to SINT**



Key findings and tips: LCA / LCC

LCA

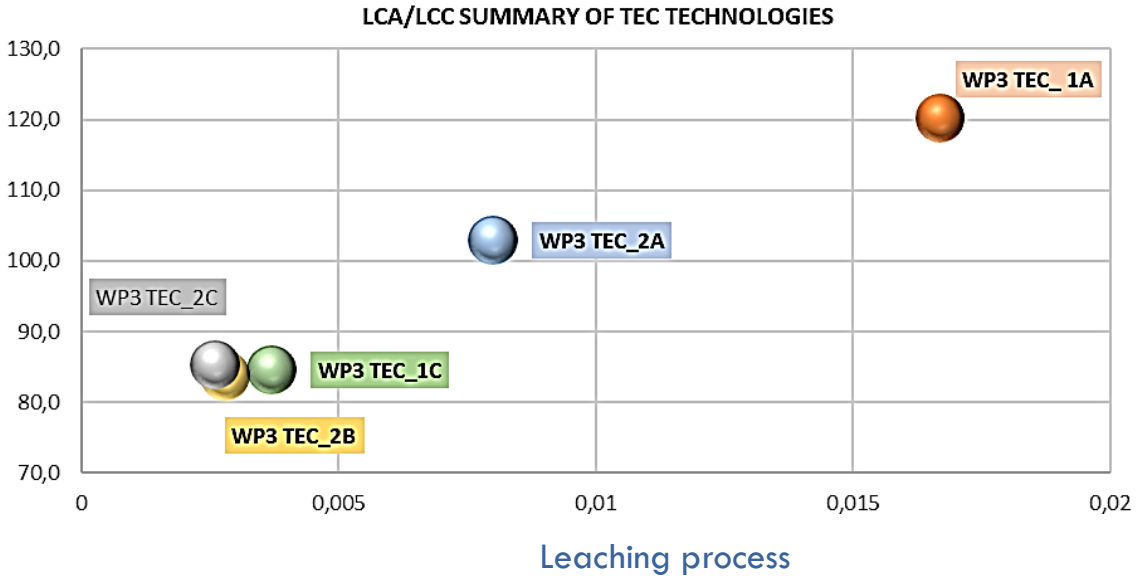
- A methodology that takes into account the health, safety and environmental risks.
- Addressing REACH, RoHS and local environmental standards.
- Environment assessment of the R&D technologies
- Modelling of the pilot unit and design.
- Environmental assessment of the pilot unit

Key findings and tips: LCA / LCC

LCC

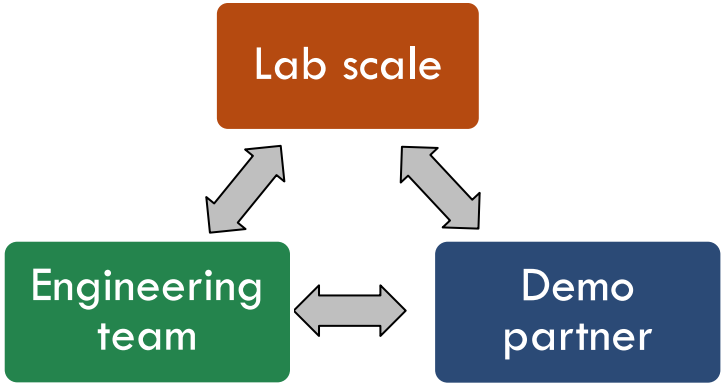
Economic assesment of the R&D
and
pre-treatement process

Integrating environment and economic data



Key findings and tips: pilot and validation/demo

- Plant authorisation
- Close link between



- Quotations & Delivery time

  (versus Budget) (versus Gantt of the Project)

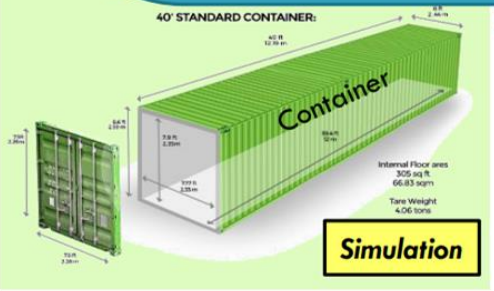
  - Equipment for pilot construction (different providers)
  - Reagents for demo

Key findings and tips: pilot and validation/demo

Gas evolution analysis

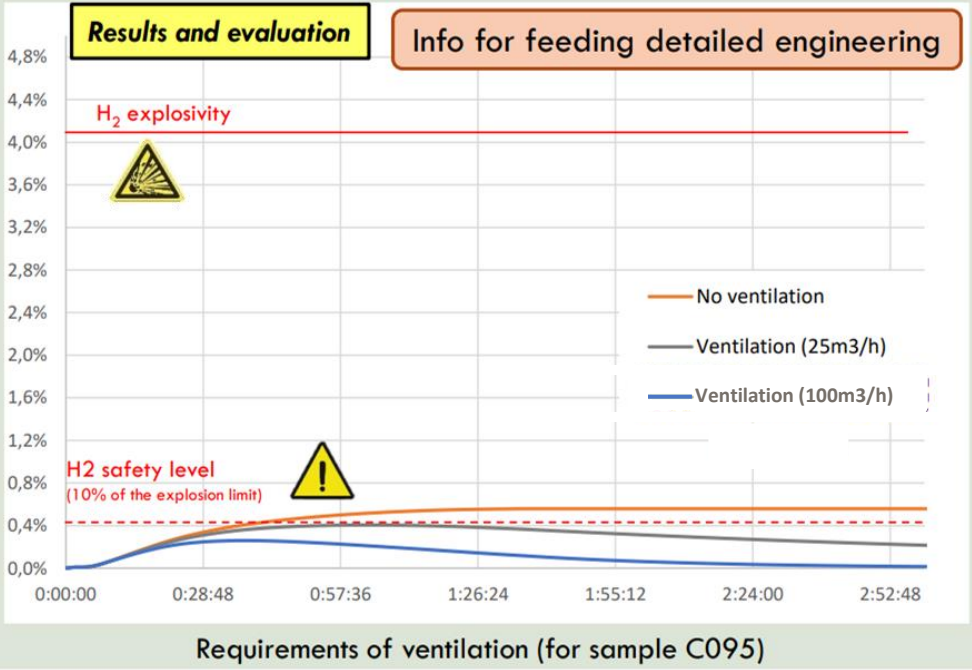
➢ **Simulations** were performed in order **to extrapolate** the lab results to the pilot scale

Sampling @ lab



Results and evaluation

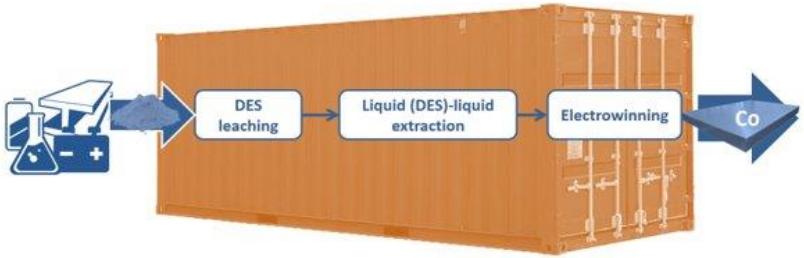
Info for feeding detailed engineering



Requirements of ventilation (for sample C095)

Key findings and tips: pilot and validation/demo

- To produce up to 35 Kg Co/day (for a BM with a 30% cobalt concentration feeding the mobile)
- LCC & LCA calculations from final figures



❖ System validation near to be finished in the pilot

Thanks for your attention

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