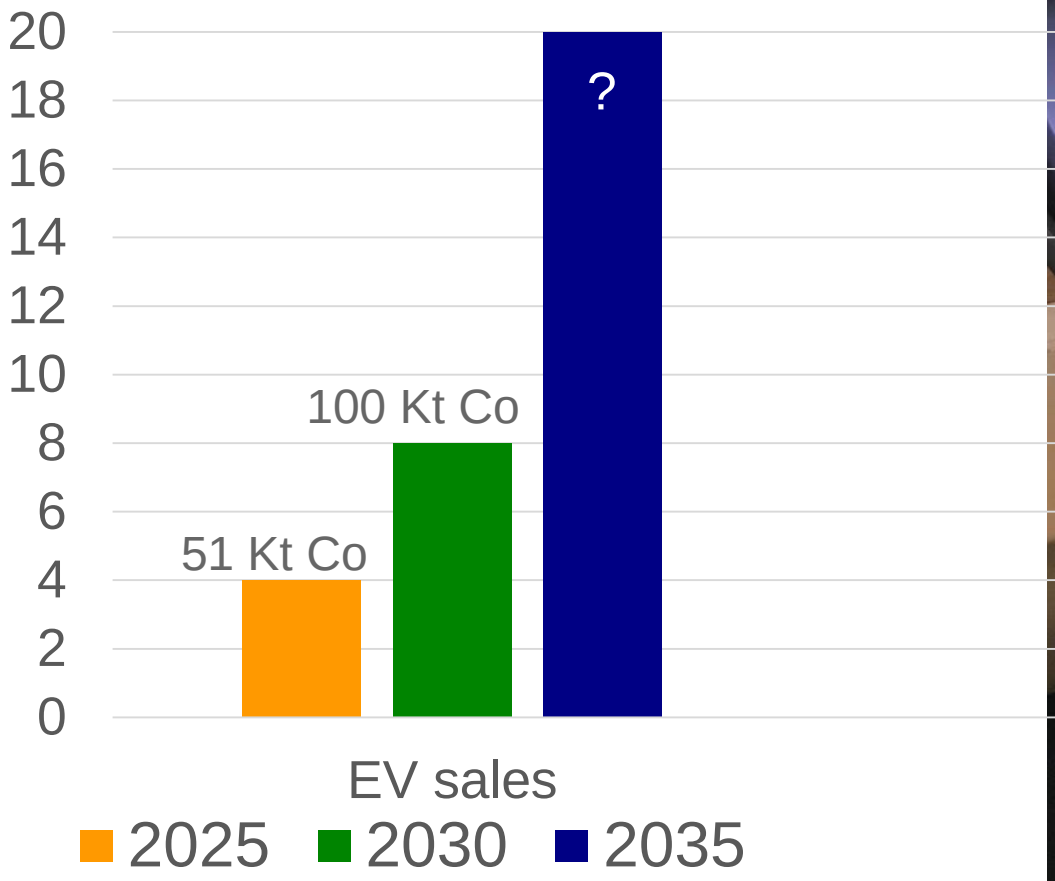
BATCircle

Consortium Seminar with Advisory board

13.00 – 13.15 Opening words – Introduction to BATCircle

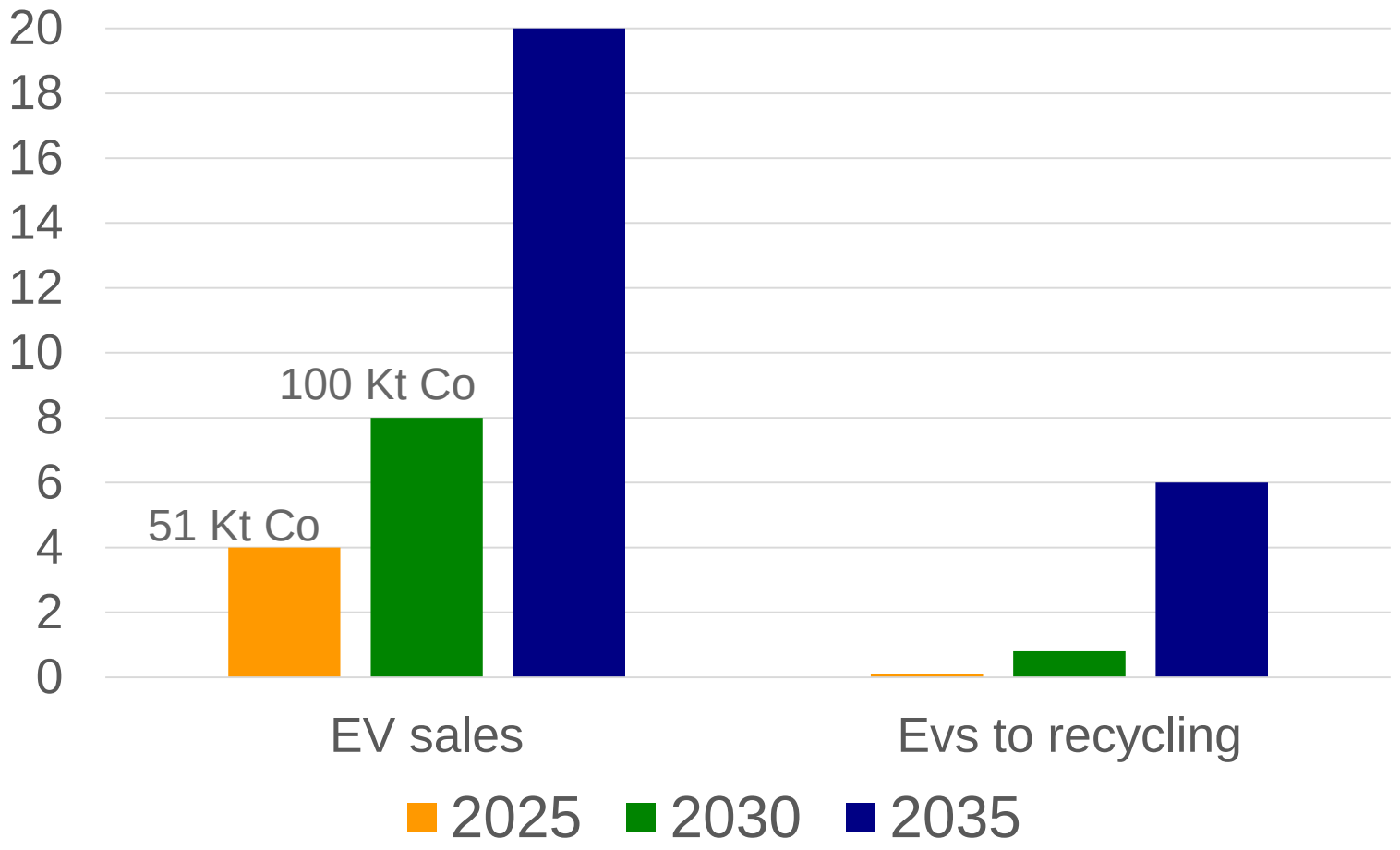
Prof. Mari Lundström, Aalto University (Finland)
PI of BATCircle

EV Cars in Europe (milj)



Aalto-yliopisto
Aalto-universitetet
Aalto University

EV Batteries in Europe (milj cars)



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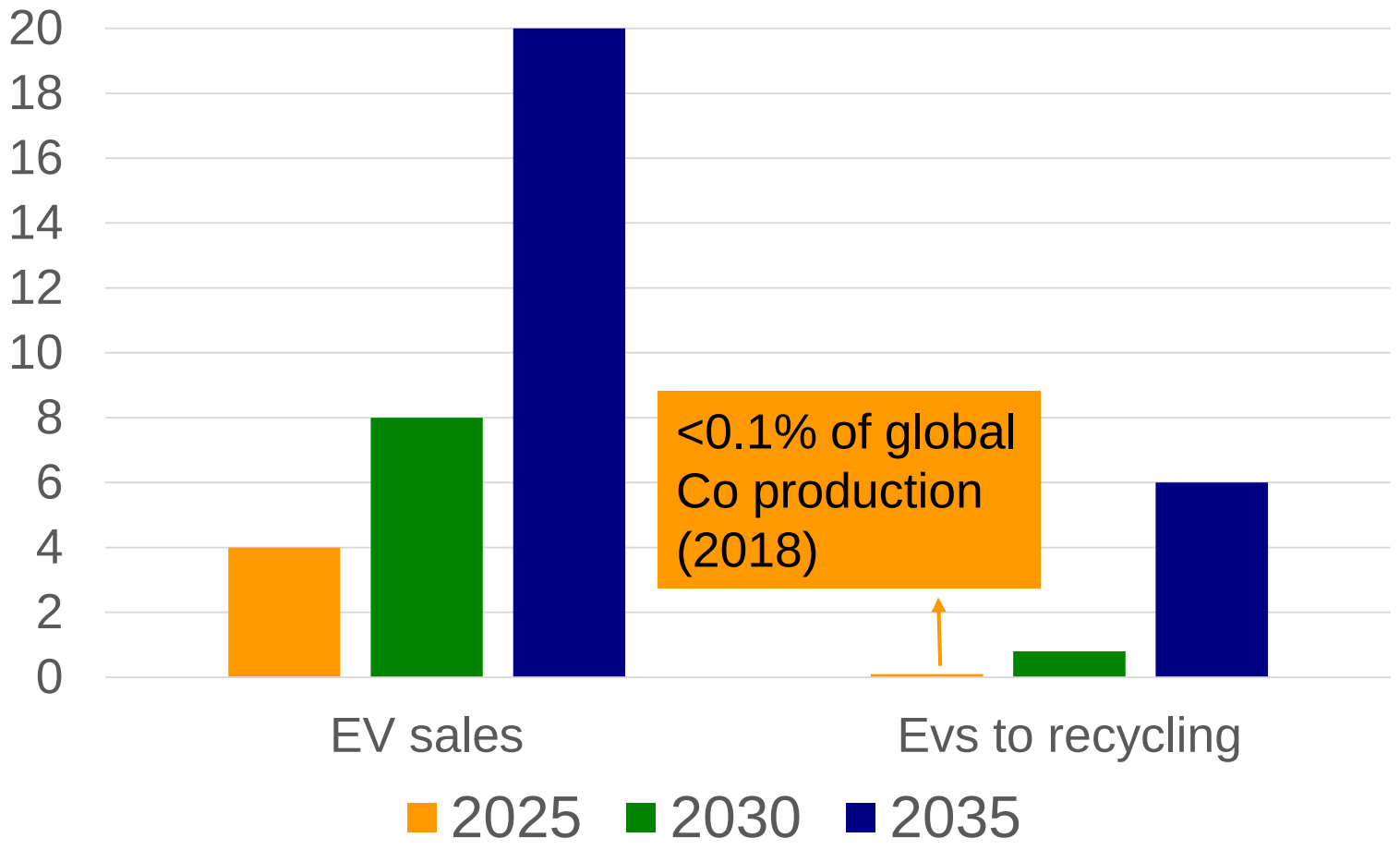
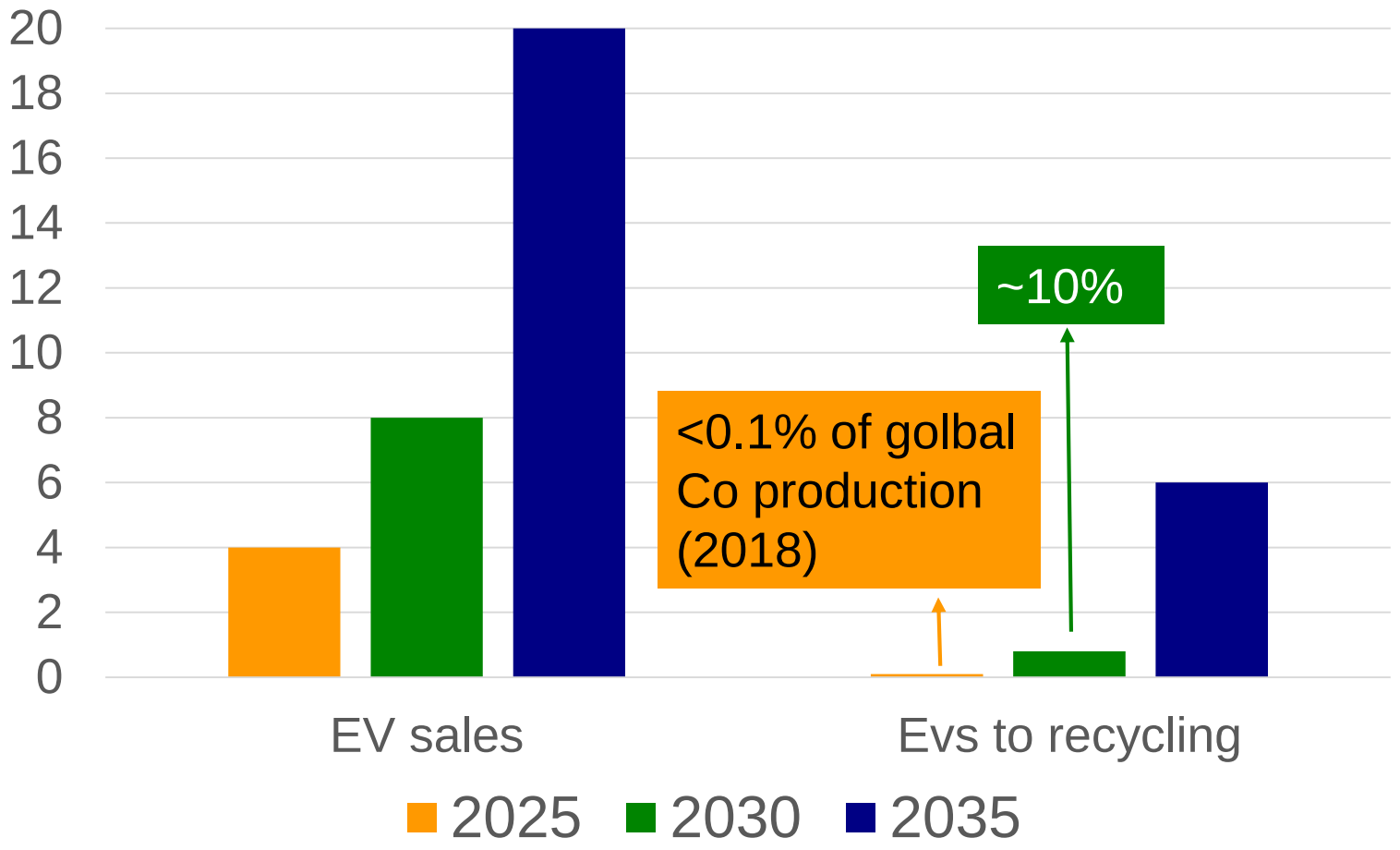
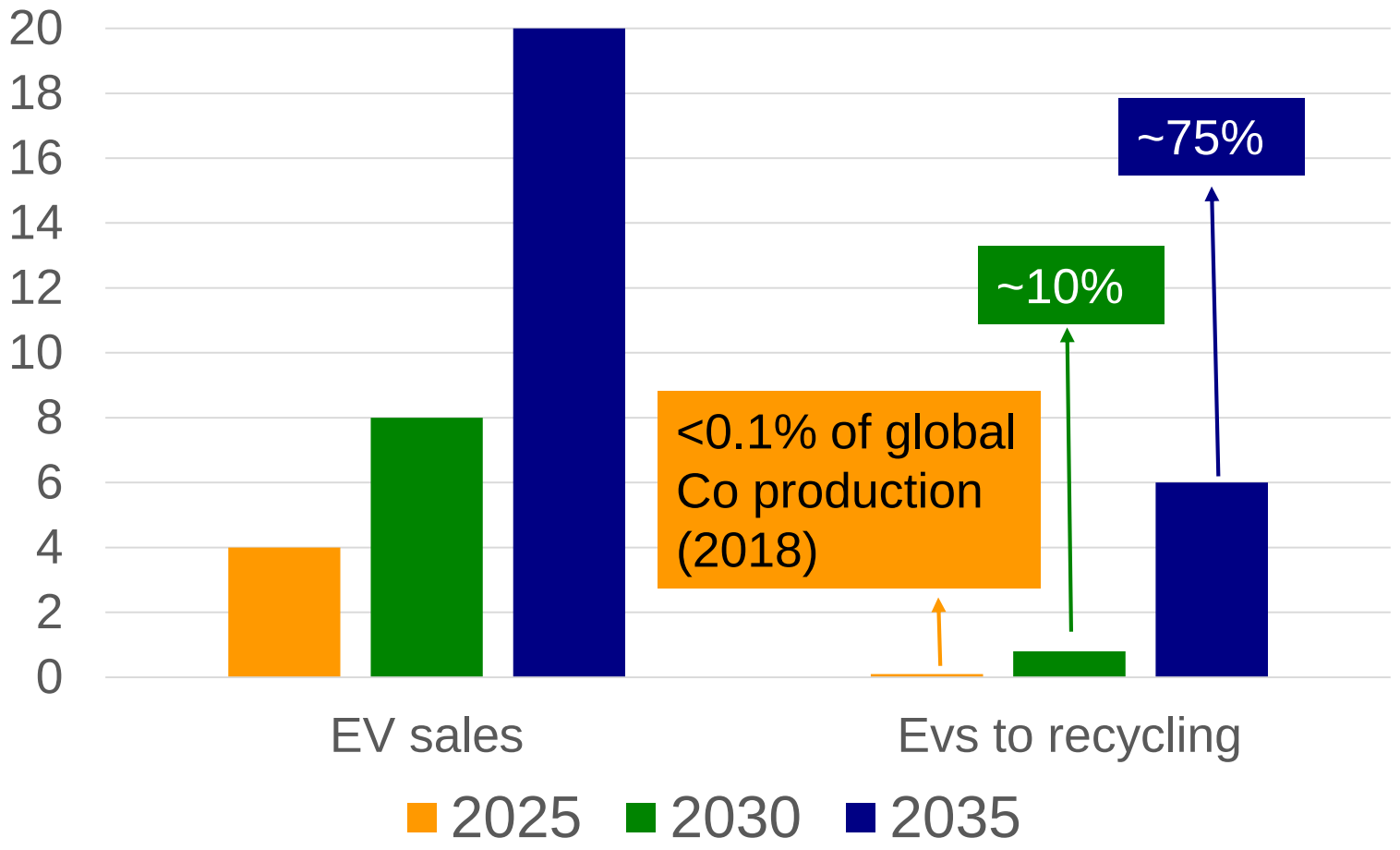


EV Batteries in Europe (milj)



EV Batteries in Europe (milj)



Primary Mining AND Recycling needed!

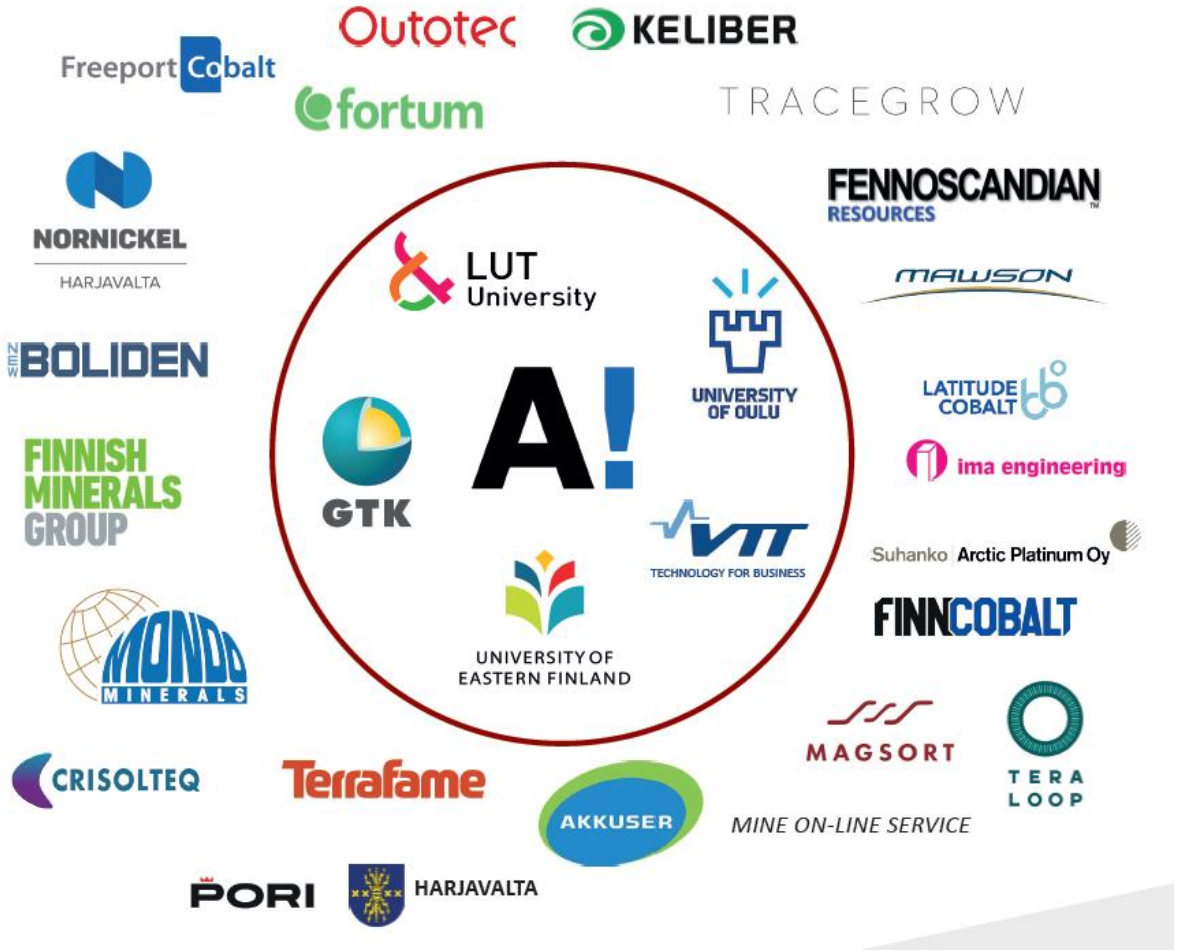
Finland

- One of the largest Li deposit in EU
- Rich in primary raw materials
- >10% of global Co refining
- 4% of global Ni refining
- Wide industrial infrastructure
- Globally known metallurgical knowledge

BATCircle

Years 2019-2020

Finland-based circular ecosystem of battery metals



2 September 2019, Prof. Mari Lundström, PI BATCircle,
Aalto University

SUSTAINABLE LIVING FOR THE NEXT GENERATIONS


SUSTAINABLE LIVING FOR THE NEXT GENERATIONS
7 RENEWABLE ENERGY
THE GLOBAL GOALS
For Sustainable Development
16 PEACE AND JUSTICE
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION
14 LIFE BELOW WATER
9 INNOVATION AND INFRASTRUCTURE
13 CLIMATE ACTION
3 GOOD HEALTH
6 CLEAN WATER AND SANITATION
15 LIFE ON LAND
2 September 2019, Prof. Mari Lundström, PI BATCircle, Aalto University

BATCircle - 22 M€

Sustainable primary resources

BATCircle - 22 M€

Sustainable primary resources

Value addition in metals production

BATCircle - 22 M€

BATCircle

Suhanko | Arctic Platinum Oy

FENNOSCANDIAN RESOURCES

IMA

Sustainable primary resources

KELIBER

LATITUDE 66 COBALT

MAWSON

FINNISH MINERALS GROUP
SUOMEN MALMIJALOSTUS

Value addition in metals production

NEW BOLIDEN

MONDO MINERALS

Terrafame

TRACEGROW

Outotec

NORNICKEL
HARJAVALTA

Freeport Cobalt

Recycling of batteries

CRISOLTEQ

AKKUSER

TERA LOOP

MAGSORT

Fortum

A!

GTK

UNIVERSITY OF OULU

VTT

ITÄ-SUOMEN YLIOPISTO

BATCircle - 22 M€

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Tailored precursors and active electrode materials

A!

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Regional Stakeholders

PORI

BATCircle - 22 M€

BATCircle

Suhanko | Arctic Platinum Oy

FENNOSCANDIAN RESOURCES

IMA MAGSORT

WP1 Sustainable primary resources — KELIBER, LATITUDE 66 COBALT, MAWSON

FINNISH MINERALS GROUP / SUOMEN MALMIJALOSTUS

Terrafame

WP2 Value addition in metals production — BOLIDEN, MONDO MINERALS

TRACEGROW, Outotec, NORNICKEL HARJAVALTA, MAGSORT

WP3 Recycling of batteries — CRISOLTEQ, AKKUSER, TERA LOOP, Fortum

Freeport Cobalt

WP4 Tailored precursors and active electrode materials

Business potential

Project management

European network

A!, GTK, UNIVERSITY OF OULU, VTT, ITÄ-SUOMEN YLIOPISTO

Regional Stakeholders

PORI

Synergistic recovery of valuable metals from spent nickel-metal hydride batteries and lithium-ion batteries

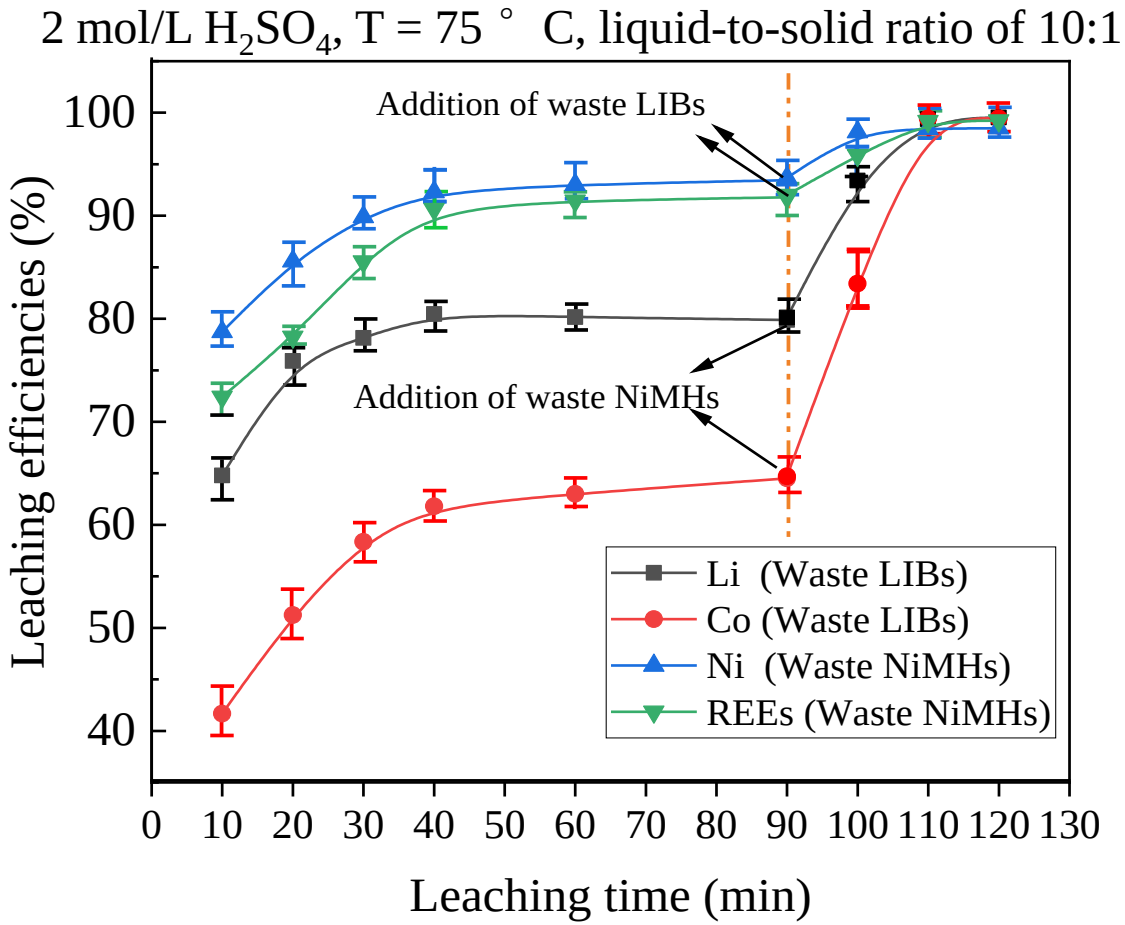
Liu, F., Peng, C., Porvali, A., Wang, Z., Wilson, B.P., Lundström M.

2019 accepted for publication

Recycling

Good: Co, Ni, Cu

BAD: Li, Al, Mn, REEs, graphite



Half Cell Reaction	E_0 (V vs. SHE)
$O_2(g)+2H^++2e^- = H_2O_2(l)$	0.619
$LiCoO_2(s) + 4H^+ + e- = Li^+ + Co^{2+} + 2H_2O$	2.152

Half Cell Reaction	E_0 (V vs. SHE)
$Cu^{2+} + 2e^- = Cu(s)$	0.337
$O_2(g)+2H^++2e^- = H_2O_2(l)$	0.619
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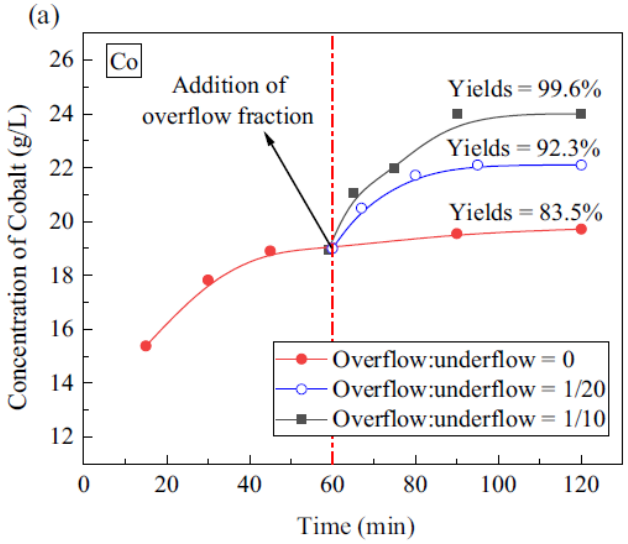
Extraction of Li and Co from industrially produced Li-ion battery waste – Using the reductive power of waste itself

Peng, C., Liu, F., Aji, A.T., Wilson, B.P., Lundström M.

95 (2019) 604-611

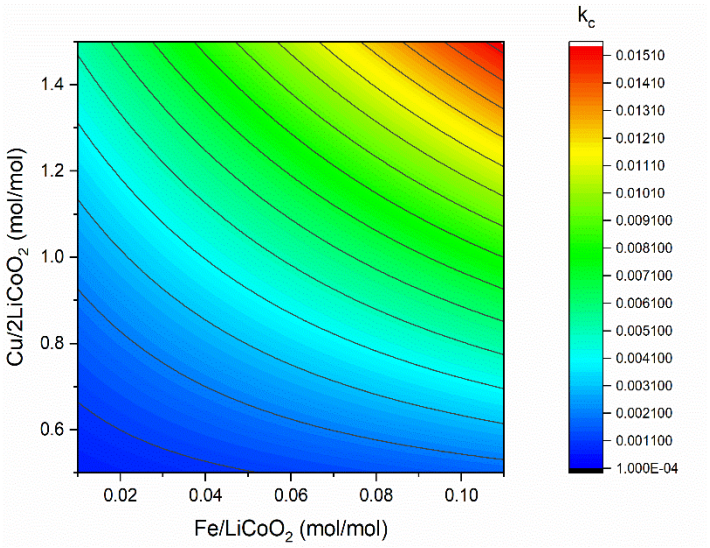


Half Cell Reaction	E_0 (V vs. SHE)
$Cu^{2+} + 2e^- = Cu(s)$	0.337
$Fe^{3+} + e^- = Fe^{2+}$	0.644
$LiCoO_2(s) + 4H^+ + e- = Li^+ + Co^{2+} + 2H_2O$	2.152

Lithium ion battery active material dissolution kinetics in Fe(II)/Fe(III) catalyzed Cu-H2SO4 leaching system

Porvali, A., Chernyaev, A., Shukla, S., Lundström M.

to be submitted



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Synergistic recovery of valuable metals from spent nickel-metal hydride batteries and lithium-ion batteries

Liu, F., Peng, C., Porvali, A., Wang, Z., Wilson, B.P., Lundström M.

2019 accepted for publication

$LaNi_5$, Ce_2Ni_7 and $AlNi_3$

Half Cell Reaction	E_0 (V vs. SHE)
$Cu^{2+} + 2e^- = Cu(s)$	0.337
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2019 submitted and revised

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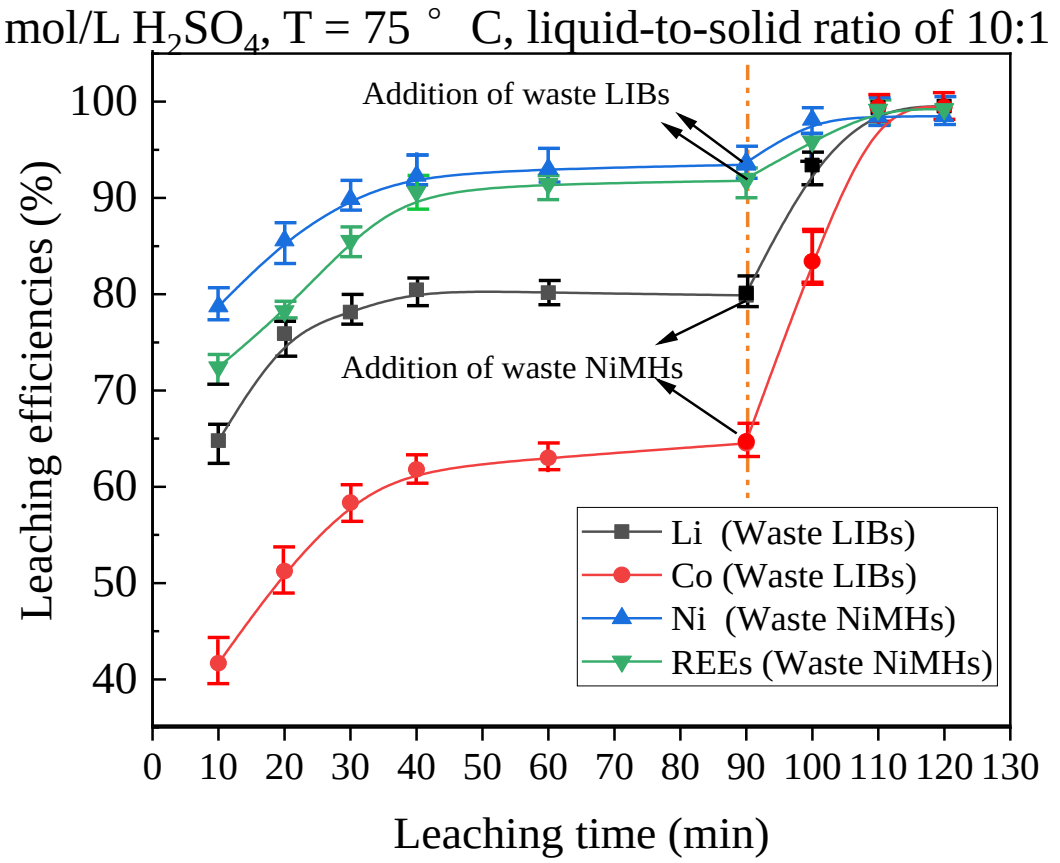

Materials	Li	Co	Ni	Cu	Mn	Fe	La	Ce	Pr	Nd	K	Na
LIBs	39.7	207.9	29.9	4.0	18.7	3.7	0.0	0.0	0.0	0.0	0.0	0.0
NiMH	0.0	55.9	432.5	1.0	30.2	3.9	88.2	79.7	12.4	37.2	0.2	0.1

ACS Sustainable Chemistry & Engineering

Synergistic recovery of valuable metals from spent nickel-metal hydride batteries and lithium-ion batteries

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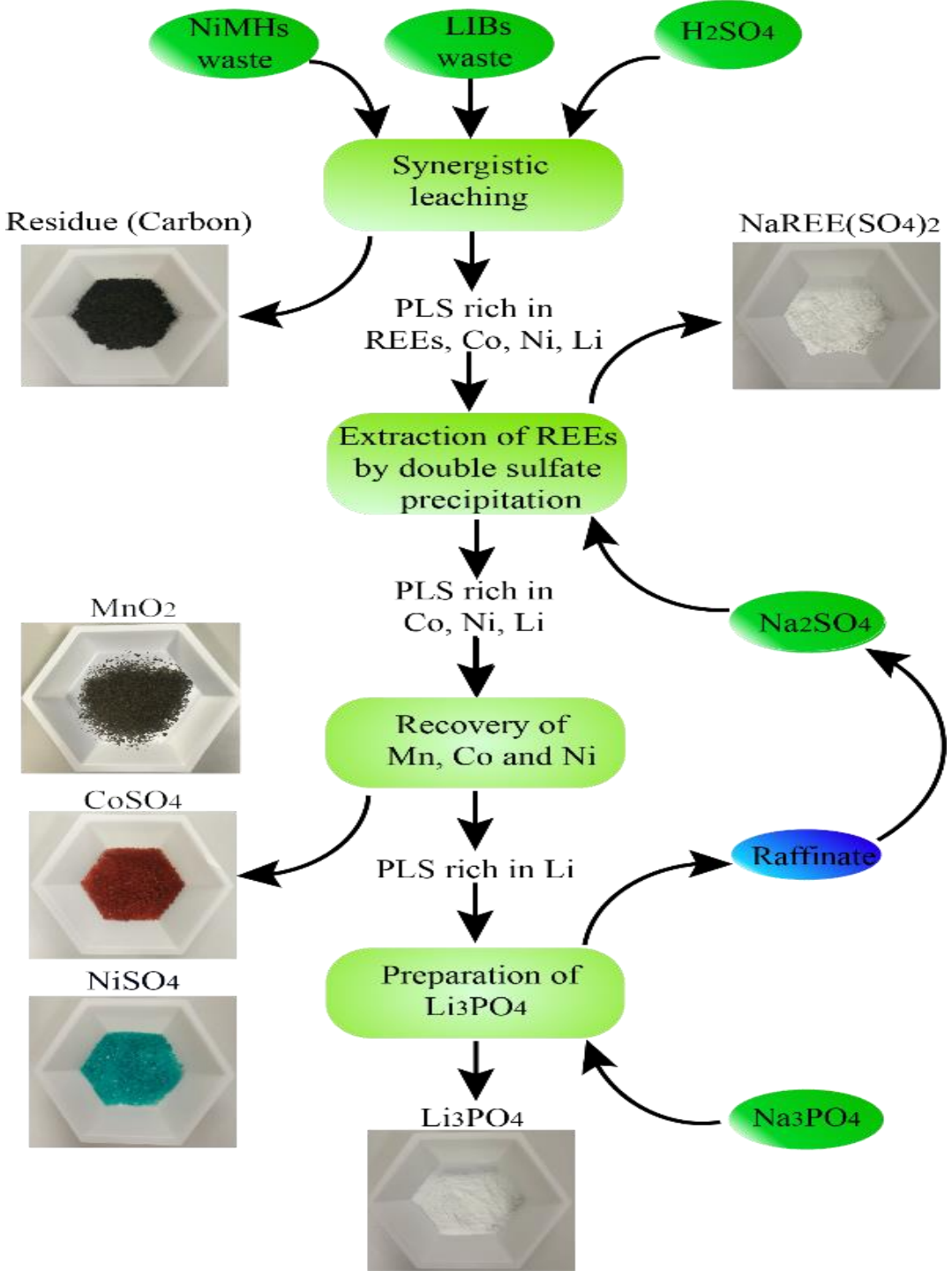
2019 submitted and revised



Recent Publications

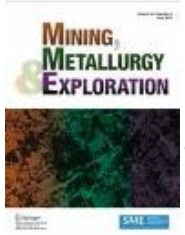
Real Battery Waste #Aalto

Selective extraction of lithium (Li) and preparation of battery grade lithium carbonate (Li_2CO_3) from spent Li-ion batteries in nitrate system

Peng C., Liu, F., Wang, F., J., Wilson B.P., Lundström M.
2019 in Journal of Power Sources, 415 (2019) 179-188
https://doi.org/10.1016/j.jpowsour.2019.01.072

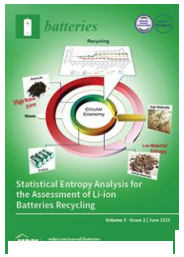
Lithium Recovery by Precipitation from Impure Solutions – Lithium Ion Battery Waste

Han, B., Porvali, A., Lundström, M., Louhi-Kultanen, M.
2018 in *Chemical Engineering & Technology (WILEY)*



Circulation of Sodium Sulfate Solution Produced During NiMH Battery Waste Processing

Porvali, A., Agarwal, V., Lundström, M.,
2019 in *Mining, Metallurgy & Exploration*



On the Use of Statistical Entropy Analysis as Assessment Parameter for the Comparison of Lithium-Ion Battery Recycling Processes

Porvali, A., Velazquez-Martinez, O., Porvali, A., van der Boogaart, K.G., Santasalo-Aarnio, A., Lundström, M. Reuter, M., Serna, R.,
2019 in *Batteries (MDPI)*

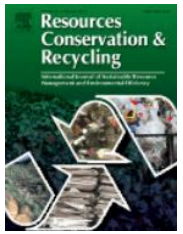
Recovery of Silver from Dilute Effluents via Electrodeposition and Redox Replacement

Wang, Z., Halli, P., Hannula, P., Liu, F., Wilson, B.P., Yliniemi, K., Lundström, M.
2019 in *Journal of the Electrochemical Society (ECS)*

Conference Proceedings:

Leaching of Crushed NiMH Battery Waste

Porvali. A, Lundström M., 2017, EMC 2017 Conference Proceedings Vol 1., Leipzig, Germany

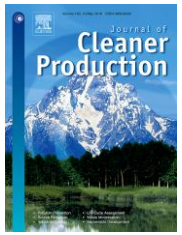


Mechanical and hydrometallurgical processes in HCl media for the recycling of valuable metals from Li-ion battery waste

Porvali, A., Aaltonen, M., Ojanen, S., Velazquez-Martinez, O., Eronen, E., Liu, F., Wilson, B. P., Serna, R., Lundström, M.
2019 in Resources, Conservation & Recycling

Challenging the concept of electrochemical discharge using salt solutions for lithium-ion batteries recycling

Ojanen, S., Lundström, M., Santasalo-Aarnio, A., Serna Guerrero, R.,
2018 in WASTE MANAGEMENT (PERGAMON-ELSEVIER SCIENCE LTD)ISSN:



Distributions of lithium-ion and nickel-metal hydride battery elements in copper converting

Tirronen, T., Sukhomlinov, D., O'Brien, H., Taskinen, P. & Lundström, M.
2017 in Journal of Cleaner Production. 168.

Lanthanide-alkali double sulfate precipitation from strong sulfuric acid NiMH battery waste leachate

Porvali, A., Wilson, B. P., Lundström, M.
2018 in WASTE MANAGEMENT (PERGAMON-ELSEVIER SCIENCE LTD)ISSN: 0956-053X

Selective reductive leaching of cobalt and lithium from industrially crushed waste Li-ion batteries in sulfuric acid system.

Peng C., Hamuyuni J., Wilson B.P., Lundström M.
2018 in WASTE MANAGEMENT (PERGAMON-ELSEVIER SCIENCE LTD)ISSN: 0956-053X

Leaching of Metals from Spent Lithium-Ion Batteries

Aaltonen, M., Peng, C., Wilson, B.P., & Lundström, M.
2017 in *Recycling (MDPI)*

BATCircle in full speed

- The main objective of BATCircle consortium is to generate added value to sectors manufacturing battery metals and chemicals, as well as their circular economy.
- BATCircle consortium **aims at improving the manufacturing processes of mining industry, metals industry and battery chemicals, and to increase the recycling of lithium-ion batteries**.
- Its goal is to
  - **strengthen the cooperation between companies and research organisations**
  - **to find new business opportunities**
- Electrification of mobility creates massive challenges to the sustainable recycling of batteries and minerals used in them. Business Finland wants to promote the development of know-how and competitiveness of Finnish companies in the area where the business potential is significant and future solutions are still to be discovered, says Director Jarmo Heinonen, Business Finland

BATCircle

Conference 5th-6th November
Register now!

INTERNATIONAL PROCESS METALLURGY SYMPOSIUM

Metallurgy as a tool for challenges in circular economy

Dipoli, Otakaari 24, 02150 Espoo, Finland

5th – 6th November, 2019

Aalto University, School of Chemical Engineering

Department of Chemical and Metallurgical Engineering

Aalto-yliopisto
Aalto-universitetet
Aalto University

http://ipms2019.aalto.fi/