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Recycling of Li-ion batteries how to improve collection and recycling?

CEPS workshop December 7, 2017

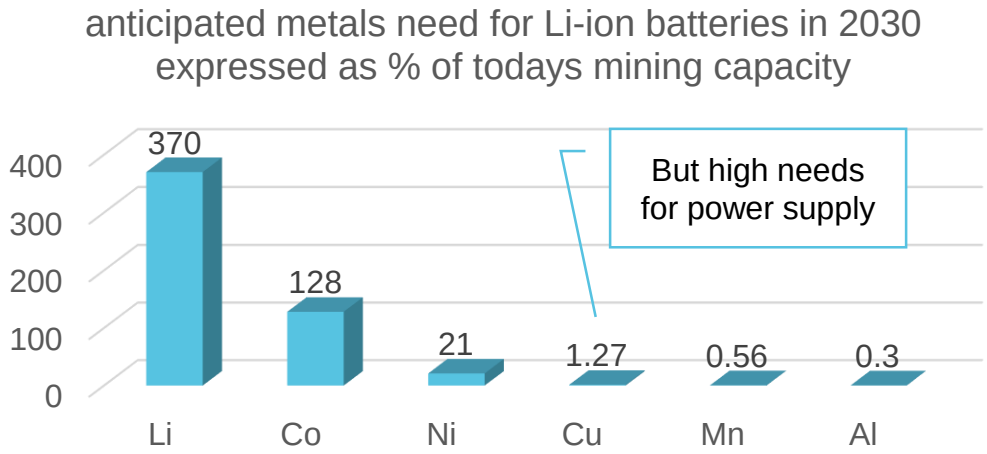
Key message

- The transition to clean mobility and renewable energy will need huge volumes of Li, Co, Ni and Cu for Li-ion battery technology
- The Batteries Directive can contribute to securing access to raw materials for Li-ion battery technology, to enable this energy/mobility transition, if:
  - Access to Li-ion batteries is improved by a separate collection target for portable rechargeable batteries and by efficient and safer reversed logistics and better separations and dismantling technologies for EV-batteries.
  - A separate battery-technology class ‘Li-ion’ would be created, with a specific recycling efficiency target to ensure recycling of Li, Co, Ni, Cu
  - Industry standards define quality requirements and end-of-waste criteria

Li-ion batteries

The essential elements

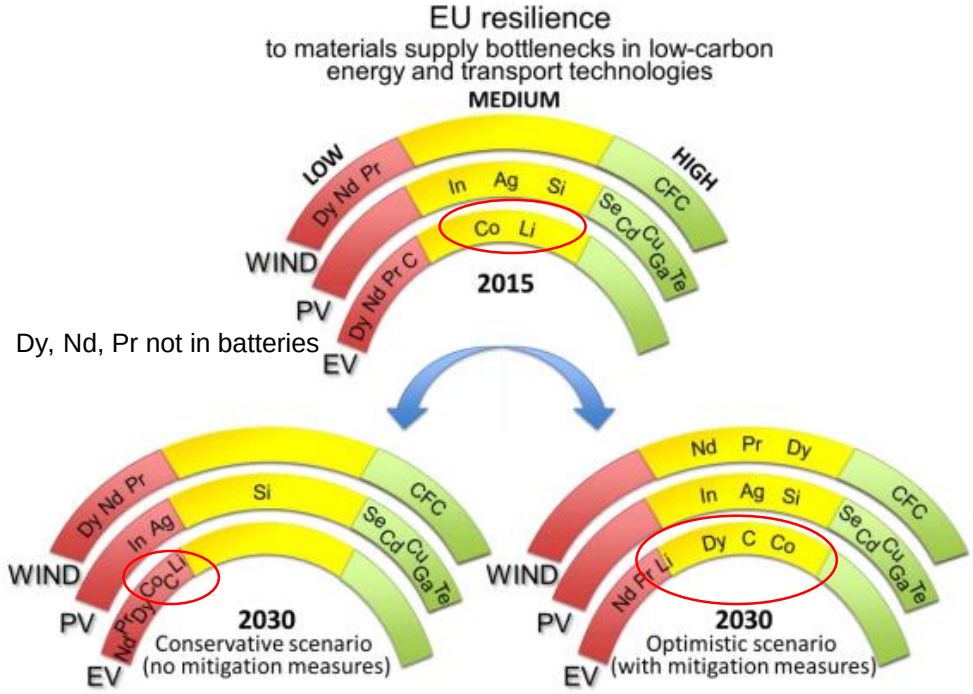
- Batteries will need massive quantities of Li, Co, Ni; the roll out of e-mobility will also need Cu, mainly for power supply (grid and in car: an EV contains 100 kg more Cu than an ICE car)
- Other metals are less critical in terms of supply risks



➔ Focus on recycling of Li, Co, Ni, Cu

Li-ion batteries

The essential elements



Source:
http://publications.jrc.ec.europa.eu/repository/bitstream/JRC103778/materials%20supply%20bottleneck_online%20version.pdf

An analysis made by the **Joint Research Centre (JRC)** shows a medium resilience for Co and Li and a high resilience for C (other high resilience elements are from the magnets, not the batteries)

However, if no mitigation measures will be taken, resilience towards Co and Li will be poor by 2030.

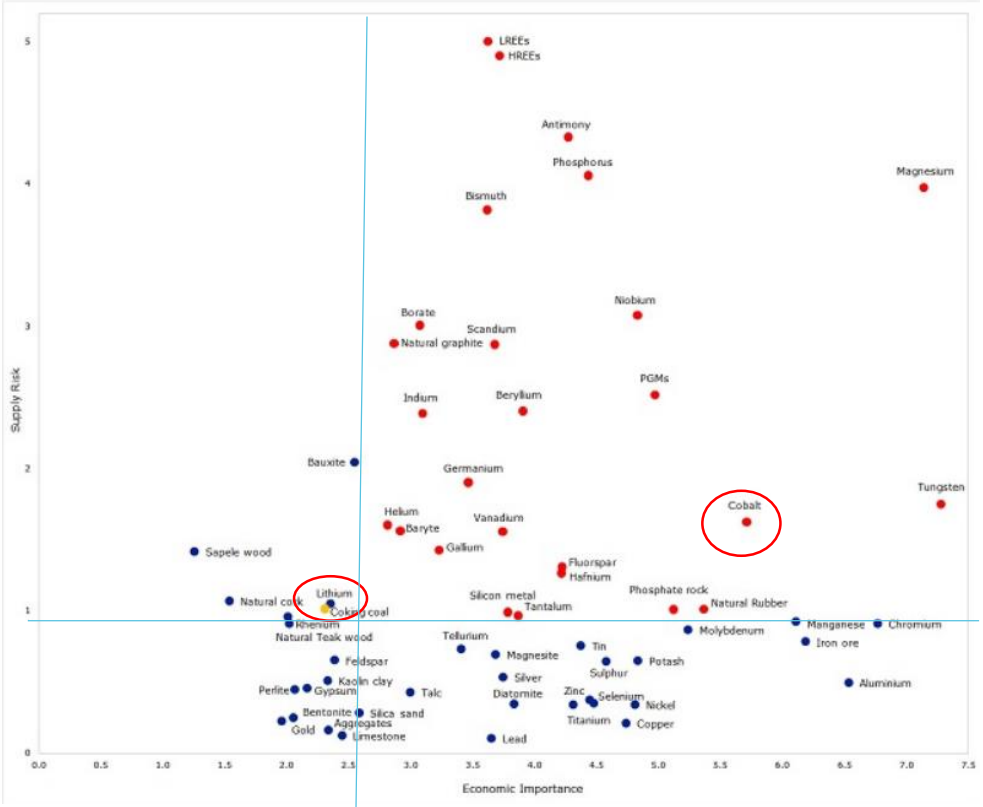
In an optimistic scenario (adequate mitigation measures) EU resilience towards Co and Li stays medium. Mitigation measures include recycling

➔ Focus on recycling of Li and Co

(Graphite C can be synthetized chemically from pitch)

Li-ion batteries

The essential elements



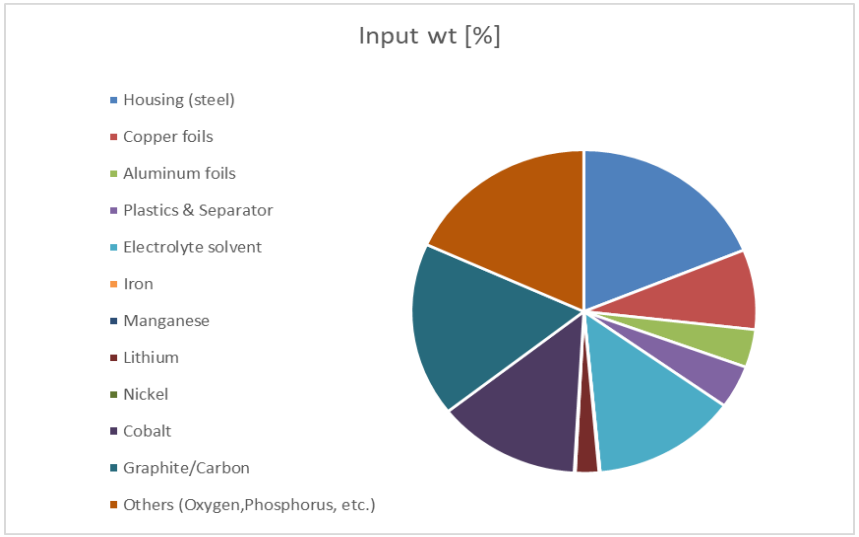
EU Critical raw materials list:

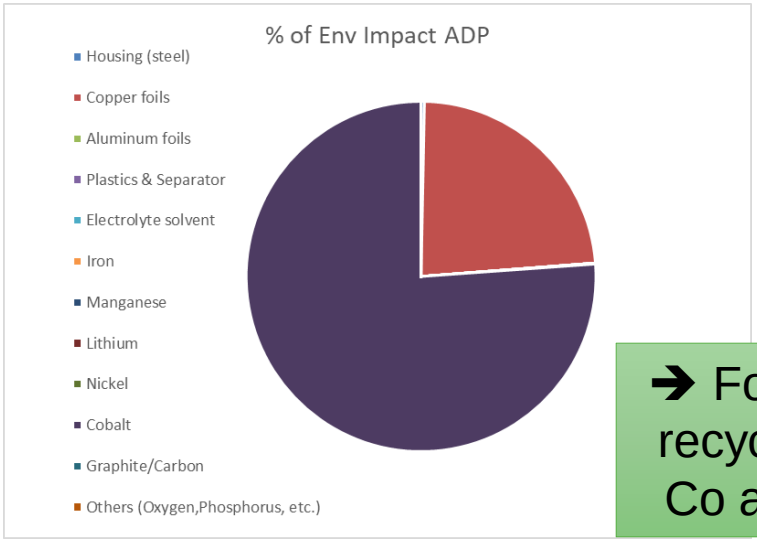
- Co is classified as ‘critical’,
- Li already at supply risk, economic importance expected to grow exponentially

➔ Focus on recycling of Li and Co

Li-ion batteries

The essential elements





➔ Focus on recycling of Co and Cu

Weight based and Abiotic Depletion Potential based composition of a Li-ion battery (LCO)

(ADP is an indicator for the relative scarcity of a material)

Li-ion batteries

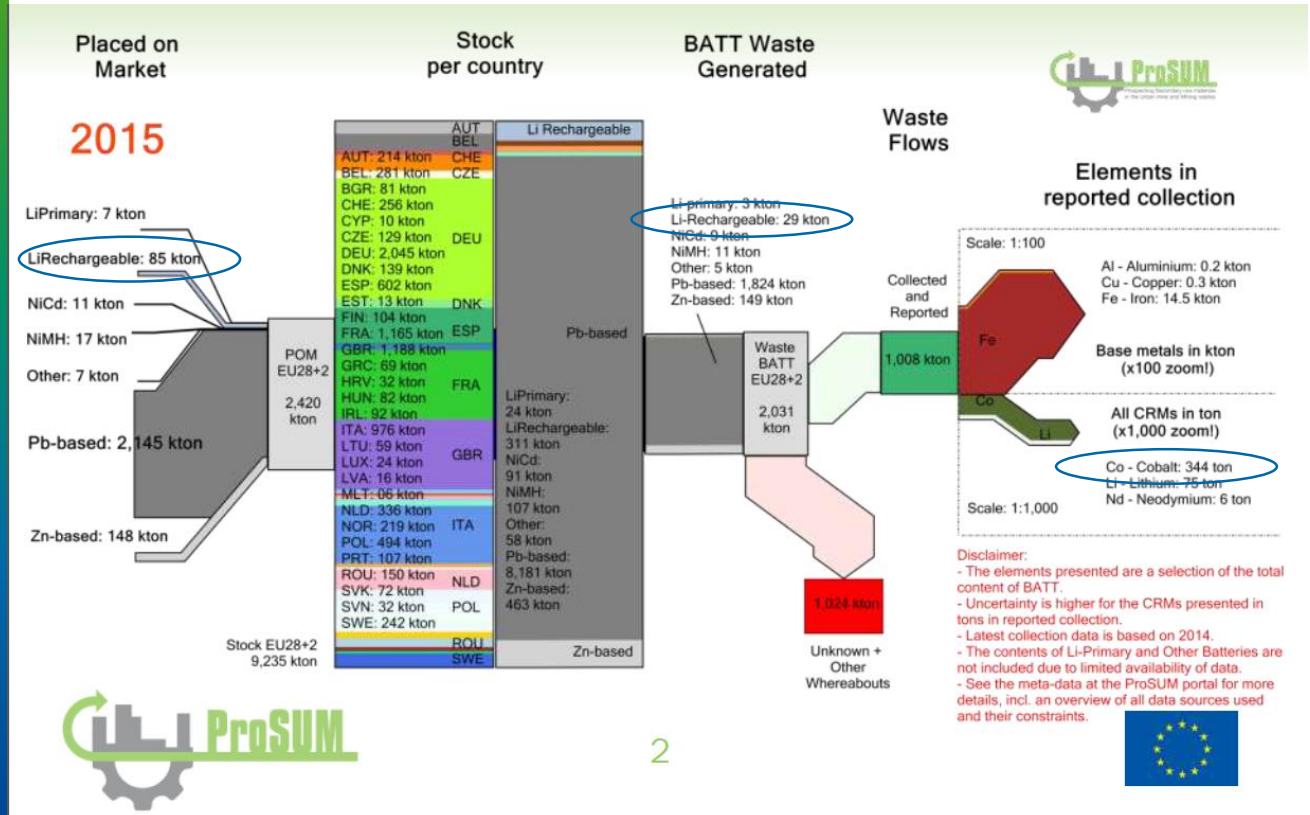
The essential elements: conclusion

- All analyses show that Co is the most critical element. The main reasons are
  - Co is mainly a by-product from Cu- and Ni mining: doubling Cu/Ni mining to double Co-output will not happen
  - 60% of Co is mined in DRC; political, social and health & safety issues
- Strong warning signals for Li:
  - Li is not scarce, largest resources concentrated in S. America (brine) and Australia (spodumene ore)
  - Mining licence and export restrictions could apply
- Ni: as Co is partially substituted by Ni, need of Ni for batteries will increase significantly
  - Need to invest in mining and refinery capacity
- Cu: relative share of Cu used in batteries stays small, but EV-roll out will require large volumes of Cu in cars and charging infrastructure
- Other metals: relative small share for use in batteries

➔ Focus on recycling of Li, Co, Ni and Cu

Li-ion batteries: access for recycling

Li-ion batteries are not ending up in recycling



Only 344 ton of Co recycled from batteries, although 29000 ton of LiB-waste has been generated (potential of 3000 ton of Co). More Co is on idle stock in the society.

Potential to recycle 3000 ton of Co ➔ > 400 000 (PH)EV's

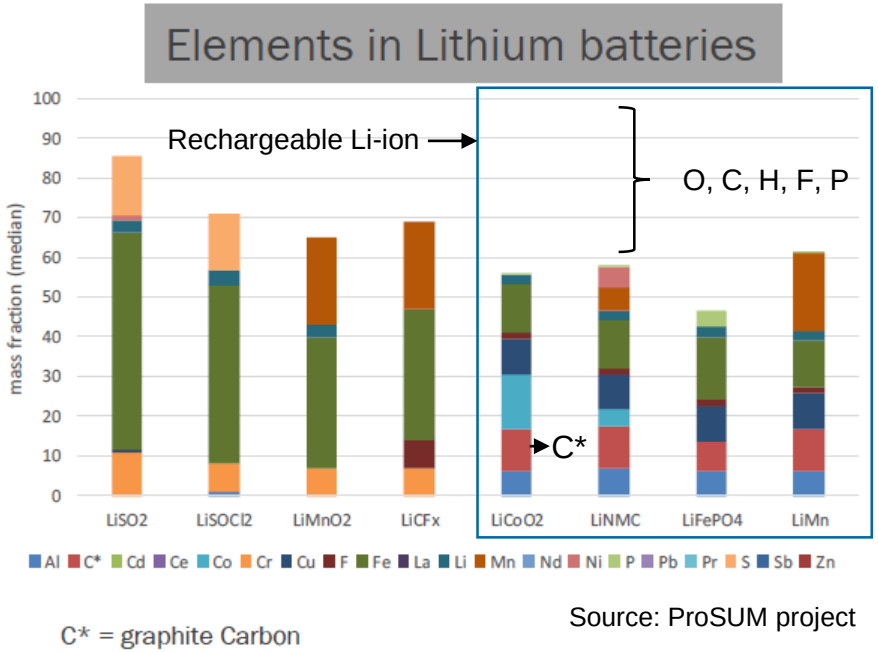
Li-ion batteries: access for recycling

Where are all those batteries?

- Hoarding effect: although use phase of consumer electronics is < 3 years, average age of *collected* Li-ion batteries is > 6 years (study Möbius); the study doesn't estimate the age of wasted or 'not in use' *non-collected* batteries
- Not removed from WEEE: batteries that are not removed form WEEE is WEEE-dismantling facilities are lost for recycling
- Export of EEE for 2nd hand use. 2nd hand use in developing countries is OK, but they way how end of life EEE is treated is not
- Waste bin: significant traces of Co and Li in municipal waste incinerator bottom ashes

Recycling efficiency

Is the 50% target ambitious and relevant?



C* = graphite Carbon

Source: ProSUM project

- In rechargeable Li-ion batteries, < 50% of the mass fraction are metals
- The 50 % target can be achieved by recycling O, C, Fe, Al, Mn and wasting Li, Co, Ni, Cu

➔ The 50 % target is ambitious but only relevant if the essential elements (Li, Co, Ni, Cu) are recycled

Research

Research focus on safe reversed logistics and on dismantling

- No need for public support for fundamental metallurgical and chemical research
  - In FP7 and H2020, public money has been invested in chemical and metallurgical processes for LiB recycling;
  - Several processes have been developed and published
  - Scaling up is to pilot/demo/industrial scale is ongoing, but lack of volume is a ‘showstopper’
- Reversed logistics and dismantling are underestimated issues
  - Reversed logistics (especially of damaged and defective EB-batteries) is ‘transport of dangerous goods’ and (sometimes) hazardous waste:
    - affordable and effective packaging needed;
    - training to safely remove batteries from ELV’s
  - EV-packs need to be dismantled to get access to modules and cells
    - Efficient disassembly for massive quantities of EV-packs need to be developed
    - Not ‘reversed assembly’ because of diversity and different ‘states of health’

Recommendations for the revision of the BD

- **A separate collection rate target for portable rechargeable batteries**, to be negotiated with the sector
- **The actual 50% recycling efficiency target** should be combined with a sentence: **including recycling of the Co, Li, Ni and Cu content** to the highest degree that is technically feasible while avoiding excessive costs
- **Quality requirements** and **end-of-waste criteria** to be developed in **industry standards**
- **Research efforts on Li-ion battery recycling should be focused on safe conditioning for reversed logistics and efficient dismantling of EV-batteries.** Dismantling gives immediate environmental credits for Cu, Al and steel and gives access to the battery cells, containing the metals that matter (Co, Li, Ni) and creates local employment