Tuomo Törmänen (Geological Survey of Finland) 19 October 2022

Commodity	**Cobalt (Co)**	**Data source**
Significance for the EU (2023)	*Critical and Strategic*	
Uses of the commodity	Main uses: *Li-ion batteries, superalloys, hardfacing, high-speed steel and other alloys* Minor uses: *Catalysts for the petroleum and chemical industries; drying agents for paints, varnishes, inks dyes pigments, porcelain enamels; magnets and magnetic recording media; humidity indicators; vitamin B12 production* Future uses: *Increasing demand for Li-ion batteries and superalloys.*	Latunussa et al. (2020); Schütte (2021)
Resources and potential in Nordic countries	Finland: *Known resources 453,000 t Co. Assumed ('undiscovered') additional resources: 270,000 t Co. Kevitsa and Terrafame (Talvivaara) mines are the only Co-producing mines in Europe. Mineral resources at Terrafame Mine is 1458 Mt @ 0.019% Co (as of 1.1.2020).* Greenland: *Several Ni-Co projects are in progress but no resource estimates on Co are available. Potential related to ilmenite-rich black sands and to conduit-type sulphide mineralisation.* Norway: *Known resources 11,687 t Co (in Ni-Cu magmatic deposits)* Sweden: *Known resources 32,100 t Co*	Rasilainen et al. (2017, 2020), Horn et al. (2021), Jonsson et al. (2022), Gautneb et al. (2022), Rosa et al. (2023)
Anthropogenic resources and potential in Nordic countries	*Spent Li-ion batteries, Ni-smelting slag, scrap metal, nickel mine tailings*	Church & Wuennenberg (2019), Dehaine et al. (2021)
Main deposit types in Nordic countries	*Orthomagmatic Ni-Cu-Co-PGE, black-shale hosted polymetallic, orogenic gold, IOCG, VMS, sediment-hosted Cu-Co*	Rasilainen et al. (2017, 2020), Jonsson et al. (2022)
Main global deposit types	*Sediment-hosted Cu-Co, lateritic Ni-Co, orthomagmatic Ni-Cu-Co-PGE*	Vasyukova & Williams-Jones (2022)
Global production (2022)	*Mining: 190,000 t (2023)* *Refineries: 144,035 t (2022)*	USGS (2023)
Nordic production (2022)	*Mining: Finland 1,235 t* *Refineries: Finland 12,781 t, Norway 4,300 t*	Tukes (2023)
Main producing countries (2022)	*Mining: DRC 68.4 %, Indonesia 5.3 %, Russia 4.7 %, Australia 3.1 %, Canada 2.1 %, Philippines 2 %, Madagascar and PNG 1.6 %, Turkey 1.4 %, China 1.2 %. Refineries: China 72 %, Finland 10 %*	USGS (2023)

Technological challenges in production	*As cobalt is a by-product, significant losses occur during the whole production chain.*	Dehaine et al. (2021)
Recycling	Present: *Cobalt has an estimated end-of-life recycling rate of 32 %, mostly from scrap metal, while battery recycling rate is only 5-10 % (developed countries). Globally, the total share of recycled Co is only ~10 %. Currently, the recycling rate of e-waste and batteries is low due to technological challenges in metals recovery, cost of extraction and relatively low availability of end-of-life batteries.* Future: *Recycling rate is estimated to increase due to increasing demand in the battery sector and increasing investment in development of extraction technologies in recycling.*	Church & Wuennenberg (2019), Schütte (2021), Zeng et al. (2022)

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