* Nickel consumed for the energy transition: mostly/100% for batteries (https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/mineral-requirements-for-clean-energy-transitions)
* EV-battery industry : 100% class 1 nickel (source: <https://www.americanexperiment.org/a-closer-look-at-the-nickel-supply-chain/>; <https://www.mckinsey.com/~/media/McKinsey/Industries/Metals%20and%20Mining/Our%20Insights/The%20future%20of%20nickel%20A%20class%20act/The%20future%20of%20nickel%20A%20class%20act.ashx>)
* Class 1 nickel: 46% of today’s world production
* Production of class 1 nickel
  + According to this source: https://www.americanexperiment.org/a-closer-look-at-the-nickel-supply-chain/):
    - 70 percent originating from sulfide ores, which are concentrated, smelted, and refined
    - 30 percent from limonite ores, which are leached commonly using high-pressure acid leaching (HPAL)
    - According to IEA’s GHG estimates, 0.7\*10+0.3\*19-59kgCO2e=12.7-24.7 kgCO2e for primary class 1 nickel (source: <https://www.iea.org/data-and-statistics/charts/ghg-emissions-intensity-for-class-1-nickel-by-resource-type-and-processing-route>)
    - From sulfide, it would be 5.3 kgCO2e/kg for mining nickel class I and 4.7 for processing (source: https://www.iea.org/reports/the-role-of-critical-minerals-in-clean-energy-transitions/sustainable-and-responsible-development-of-minerals
  + The Nickel institute provides similar figures (73% and 27% resp) (https://nickelinstitute.org/media/4809/lca-nickel-metal-final.pdf)
  + According to this LCA: <https://link.springer.com/article/10.1007/s11367-016-1085-x>
    - 100% class 1 nickel produced based on sulphidic ore (see production stages in fig 1)
* See statistics of regional productions here (mines and refineries: <https://www.americanexperiment.org/a-closer-look-at-the-nickel-supply-chain/>
* We can consider some nickel recycled for the specific use of batteries in the supply chain according to statistics from IEA (<https://www.cnbc.com/2021/11/12/northvolt-produces-battery-with-recycled-nickel-manganese-cobalt.html>)
* Co-production: “nickel production typically yields several other products, such as platinum group metals (PGMs), cobalt, copper, iron, energy (steam and electricity) and sulphuric acid.” (<https://link.springer.com/article/10.1007/s11367-016-1085-x#Sec2>)
* Energy-related inventories of class 1 nickel production in table 2 (not super useful): <https://link.springer.com/article/10.1007/s11367-016-1085-x#Tab2>

LCA:

* Life cycle of the production of class 1 nickel on Fig 1: <https://nickelinstitute.org/media/8da2dba6e789edd/202204-lme-passport-guidance-nickel-institute.pdf>
* Mining technologies for class 1 nickel (source: <https://www.britannica.com/technology/nickel-processing>):
  + Sulfide deposits are usually mined by underground techniques in a manner similar to copper, although some deposits have been mined using open pits in the early stages.
  + The mining of laterites is basically an earth-moving operation, with large shovels, draglines, or front-end loaders extracting the nickel-rich strata and discarding large boulders and waste material. The ore is loaded into trucks at the face, as would be the case in an open pit, and hauled to the smelter.
* The environmental impacts of nickel production in ecoinvent is probably very underestimated, especially to represent class 1 nickel (e.g, fig 3, great study, I requested the datasets, I would like to use the GREET 2021 model for class 1 metal): <https://www.sciencedirect.com/science/article/pii/S2212827123000689>
  + 6kgCO2e/kg in ei v2 (because nickel’s market)
  + 4kgCO2e/kg in ei v3.8 (same)
  + Nickel in GREET’s models: 10-20 kgCO2e/kg
    - Primary nickel: 20 kgCO2e/kg
    - MHP primary metal: 13 kgCO2e/kg
    - MHP primary & secondary metal: 10 kgCO2e/kg (40% class I (44% virgin and 56% recycled), 60% mixed-hydroxide products (MHP)
* The only problem in GREET is the regionalization for the American market of consumption of nickel (we could regionalize the electricity consumption based on production statistics)
* Otherwise, let’s use the nickel production class 1 of ecoinvent (by extrapolation of the article that writes in EI 3.8, 92% co-product cobalt production and 8% nickel class I => spot the right process for class I), including some recycled class I
* Detail of the GREET model: “Nickel sulfate consists of a blend of Class I and mixed hydroxide precipitate (MHP) nickel sources, 40% and 60%, respectively. The Class I nickel and MHP sourcing locations are available in the SI, in Table S2.” (https://www.sciencedirect.com/science/article/pii/S221499372200029X#bb0140)
* Apparently the inventories are foundable somewhere on the Argonne National Lab page: <https://greet.anl.gov/index.php?content=greetdotnet> (Susie could know)
* Nickel is co-produced with copper from sulphidic ore (https://link.springer.com/article/10.1065/lca2004.11.181.5#citeas)
* For a lack of data, the secondary nickel production could not be inventoried (https://link.springer.com/article/10.1065/lca2004.11.181.5#citeas)