# Adjustments related to the content of considered Harmonized System Codes

Some of the considered 6-digit HS codes cover materials/products that are not only part of supply chains of EVs but also part of supply chains of other final products. Information provided by the World Customs Organization30 has thus been used to identify the type of materials and products that is covered within the respective HS codes. If materials/products that are not part of Co or Al supply chains of EVs are covered by a certain HS code, the content of this HS code has been adjusted. These adjustments have been done based on global average market shares and global average cost-to-mass ratios. To simplify the procedure of adjusting the HS codes content, considered market shares are generally applied to both the trade amounts and the trade costs of materials/products. It is thus assumed that materials/products covered within the same HS code have equal cost-to-mass ratios. The adjustments of HS code contents done in the frame of the presented case study are described in the following paragraphs.

**Battery electric vehicles (BEVs) covered by the HS code 870380 and plug-in hybrid electric vehicles (PHEVs) covered by the HS codes 870370 & 870360:**

The considered HS codes cover only products that are relevant for the supply chain of EVs.

**Lithium-ion batteries (LIBs) covered by the HS code 850760:**

The considered HS code covers besides LIBs that are used in EVs also LIBs that are used in the stationary and the electronics sector. U.S. Department of Energy38 and Tsiropoulos et al.39 state average market shares of LIBs used in different end-use sectors. Considering these shares, 60% of the amount and the costs of LIBs covered by the HS code is assumed to be used for the manufacturing of EVs.

**LIB cells covered by the HS code 850790:**

The considered HS code covers battery modules as well as battery cells that are used in different types of batteries, including cells of LIBs, lead acid batteries (PbAcBs), nickel-metal hydride batteries (NMHBs) and other batteries. These batteries are applied in the electro mobility, stationary and electronics sectors. A share of 60% of these batteries are included in the electro mobility sector according to U.S. Department of Energy38 and Tsiropoulos et al.39. Grand View Research40 states market shares of all three battery types in the electro mobility sector (i.e. LIBs: 60%, PbAcBs: 30%, NMHBs: 5%, other batteries: 5%). Cost-to-mass ratios of the different battery cells are used to identify the trade amounts and costs of LIB cells. These ratios are calculated based on the energy densities reported by Wong and Chan41 (i.e. LIBs: 0.16kWh/kg, PbAcBs: 0.035kWh/kg, NMHB: 0.07kWh/kg) and the cost-to-energy ratios reported by Mongird et al.42 (i.e. LIB: 271$/kWh, PbAcBs: 260$/kWh, NMHB: 600$/kWh). Following BloombergNEF43, it is assumed that the prices of battery packs are 70% of the prices of battery cells. The resulting cost-to-mass ratios are 6 $/kg for PbAcB cells and cases, 29 $/kg for NMHB cells and cases and 30 $/kg for LIB cells and cases. Thus, the following three requirements are considered: (i) all trades with a cost-to-mass ratio below or equal to 6$/kg are assumed to be only PbAcB cells and cases, (ii) all trade with a cost-to-mass ratio between 6 and 30$/kg are assumed to be 60% LIB cells and cases, 30% PbAcB cells, 5% NMHB cells and cases and 5% other battery cells and cases and (iii) all trades with a cost-to-mass ratio above or equal to 30$/kg are assumed to be 90% LIB cells and cases and 10% NMHB and other battery cells and cases.

**Cobalt powder covered by the HS code 810520:**

The considered HS code covers Co powder used in EVs but also in other products and additionally covers Co mattes. As stated in the previous paragraph, 60% of all batteries are estimated to be used in the electro mobility sector. According to Petavratzi et al.44, 61% of the Co materials that are covered by the HS code 810520 is Co powder used in LIBs. Cost-to-mass ratios of Co powder and mattes are used to identify the trade amounts and costs of Co powder. These ratios are defined based on the average market price of cobalt metal (i.e. 26$/kg on the 29. July 2019 according to London Metal Exchange45 and Trading Economics46) and based on the average market price of Co mattes (i.e. 11$/kg according to Baars et al.19 and the European Commission47). Thus, the following three requirements are considered: (i) all trades with a cost-to-mass ration below or equal to 11$/kg are assumed to be Co mattes, (ii) following Baars et al.19, all trades with a cost-to-mass ratio between 11 and 26$/kg are assumed to be 50% Co mattes and 50% Co powder and (iii) all trades with a cost-to-mass ratio above or equal to 26$/kg are assumed to be cobalt powder.

**Cobalt intermediates that comprise cobalt mattes covered by the HS code 810520, nickel-cobalt mattes covered by the HS code 750110 and nickel-cobalt sulfide covered by the HS code 750120**

The considered HS codes cover cobalt intermediates that are used in EVs but also in other products. Furthermore, the HS code 810520 covers cobalt mattes but also cobalt powder. As stated in the two previous paragraphs, 60% of all batteries are estimated to be used in the electro mobility sector. According to Petavratzi et al.44, 46% of the global cobalt supply is applied in LIBs that are used in the electro mobility sector. To identify the trade amounts and costs of the Co mattes, the three requirements that are described in the previous paragraph are considered.

**Electric vehicle bodies and chassis covered by the HS codes 870710 and 870600, respectively:**

The considered HS codes cover car bodies and chassis that are used in EVs but also in other vehicles. According to IEA48, EVs account for 2.6% of the global car sales. Hence, 2.6% of the sold car bodies and chassis are used in EVs.

**Electric vehicle motors covered by the HS codes 850132, 850133, 850152 and 850153:**

The considered HS codes cover electric motors that are used in EVs but also in other applications. According to Grand View Research49, 46% of the globally sold electric motor sales are motors used in EVs.

**Electric vehicle wiring covered by the HS code 854430:**

The considered HS code covers wiring that is used in EVs but also in other vehicles, aircrafts and ships. Markets and Markets50, Market Reports World51 and The Business Research Company52 state the global market values of wiring used in vehicles, aircraft and ships, respectively. Considering these market values, 78% of the wiring that is covered by the HS code is used in vehicles. According to IEA48, EVs account for 2.6% of the global car sales. Hence, 2.6% of this wiring is used in EVs.

**Aluminium foil covered by the HS code 760719:**

The considered HS code covers Al foil that is used in EVs but also in other applications. According to the U.S. Department of Energy38 and Tsiropoulos et al.39, 60% of all batteries, in which the Al foil is used, are LIBs that are applied in the electro mobility sector. Based on the Al foil market shares stated by Grand View Research53, it is assumed that 6% of the globally supplied Al foil is used in EVs.

**Aluminium plate covered by the HS code 760612 and 760692:**

The considered HS codes cover Al plates that are used in EVs but also in other applications. Based on information provided by Khoday54, OECD55 and Reports and Data56, it is estimated that 18% of globally supplied Al plates are used for cars. According to IEA48, EVs account for 2.6% of the global car sales. Hence, 2.6% of these Al plates are used in EVs.

**Aluminium wire covered by the HS code 760521and 760529:**

The considered HS codes cover Al wires that are used in EVs but also in other applications. Based on information provided by Reports and Data57 and Grand View Research58, it is estimated that 15% of globally supplied Al wires are used in cars. According to IEA48, EVs account for 2.6% of the global car sales. Hence, 2.6% of these Al wires are used in EVs.

**Aluminium unwrought covered by the HS codes 760110 and 760120:**

The considered HS codes cover Al unwrought that is used in EVs but also in other applications. Based on information provided by Khoday54, Sauvage59 and Woodford60, it is estimated that 28% of globally supplied Al unwrought is used in cars. According to IEA48, EVs account for 2.6% of the global car sales. Hence, 2.6% of this Al unwrought is used in EVs.

**Aluminium oxide covered by the HS code 281820:**

The considered HS code covers Al oxide that is used in EVs but also in other applications. Based on information provided by Khoday54, Sauvage59 and Woodford60, it is estimated that 27% of the globally supplied Al oxide is used in cars. According to IEA48, EVs account for 2.6% of the global car sales. Hence, 2.6% of this Al oxide is used in EVs.