

Copper recycling in Europe: End-of-Life Vehicles (ELVs)

Copper is 100% recyclable and can be reused multiple times without losing its intrinsic physical and chemical properties. Recycling depends on many factors, ranging from:

- Consumers' responsibility in returning discarded or obsolete products
- Consistent reporting of waste streams
- Products' lifespan and their subsequent decommissioning
- Overall efficiency of the waste management system

From all copper produced globally, around 8% is used in vehicles. The same applies in Europe, and is expected

to exponentially grow due to the electrification of the mobility and transport sector.

ELVs make up around 7% of the total EU End-of-Life copper in waste. Along with other metals in ELVs, copper recycling offers a great opportunity for value retention in the EU.

ELV recycling efficiencies primarily occur at collection, separation and shredding stages.

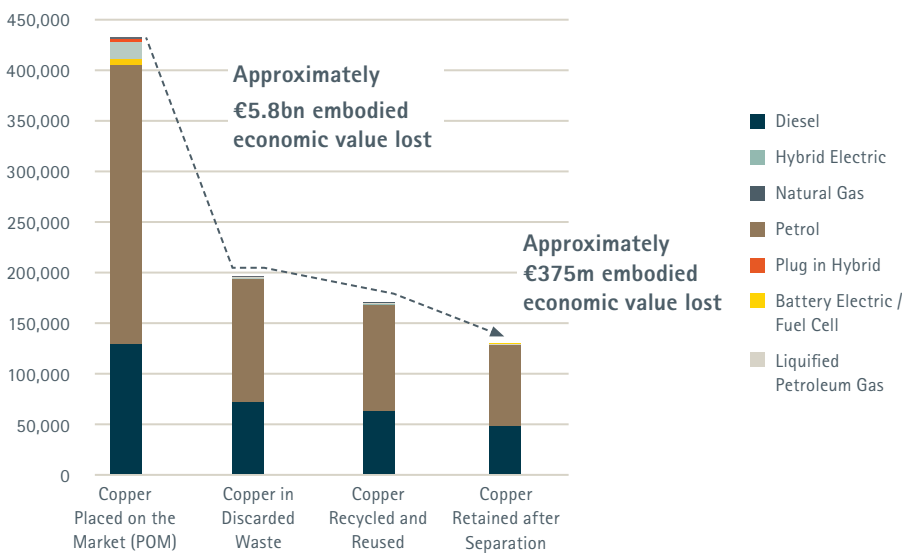


The 300kt* unrecovered copper from ELV separation and shredding results in losses of EUR 6bn (2018), making up nearly 2% of the total value losses from copper separation and shredding in Europe.

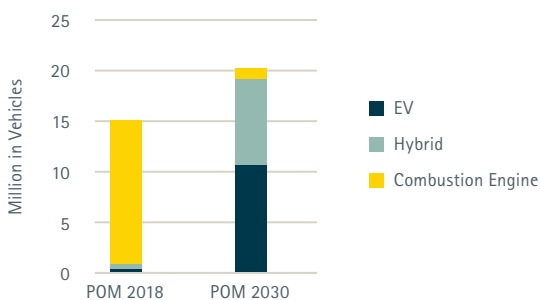
* Rough estimation because of different factors: 2018 POM copper still in use, market aspects (e.g., copper content per vehicle, actual and projected number of vehicles).

Estimated mass and embodied value of copper contained in 2018 EU-28 vehicles flows

Total tonnes of copper content in EU28 ELVs 2018



Number of vehicles Placed on the Market (POM) in 2018 and 2030



Sources: 2018 POM from ACEA | 2030 POM extrapolated from ACEA & PWC figures

Copper content in ELVs varies from up to 3% for combustion engine vehicles, to up to 5% for new energy vehicles out of the whole supply of materials.

NEW ENERGY VEHICLES:

- Battery Electric / Fuel Cell
- Hybrid Electric
- Plug in Hybrid

COMBUSTION ENGINE VEHICLES:

- Diesel
- Liquefied Petroleum Gas
- Natural Gas
- Petrol

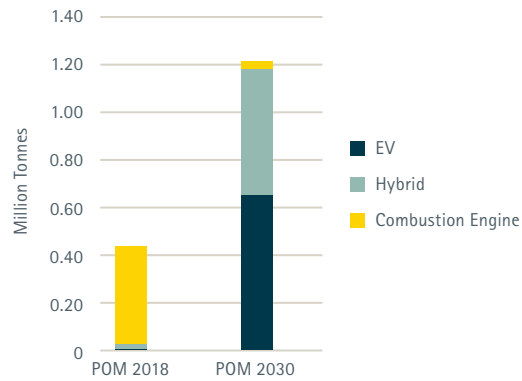
Challenges:

- Disappearing of vehicles at EoL from the internal market (unknown whereabouts: deregistered without a certificate of destruction)
- Dismantling at illegal sites or at sites with less advanced technology to secure high-quality yields
- Exports outside of Europe as used cars

Recommendations to improve copper recycling in ELVs:

- Strengthen national registration systems (e.g., register any road transport vehicle where the owner/user is resident/registered)
- Update the vehicle registration system upon change of ownership
- Require roadworthiness certification to allow a vehicle to be exported outside the EU as a used car
- Adapt Internal Combustion Engine (ICE) vehicle infrastructure and battery recycling infrastructure for use by ELVs
- Staff upskilling for improved EoL management
- Design-for-Sustainability (including disassembly and recycling) with a full life cycle perspective
- Optimize coordination of actors cross-industry and along the recycling chain to recover the multitude of different alloys
- Incentivize investments in sensor-based recovery technologies
- Proper implementation and enforcement of the EU Batteries Regulation for full recovery of batteries at EoL

Copper POM in 2018 and 2030 per vehicle fleet

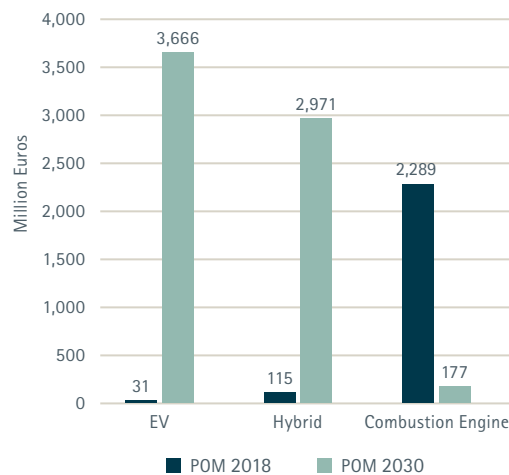


These projections, as a result of:

- the increase in the number of vehicles put on the market;
- the move towards alternative, lower carbon and higher copper content powertrains; and
- necessary charging infrastructure, suggest:

Almost 200% increase in the amount of copper put on the market by 2030.

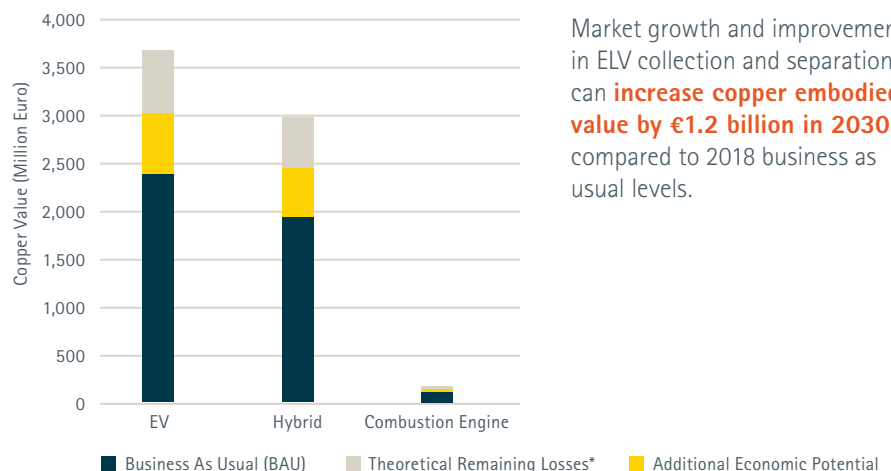
Embodied economic value of copper POM in 2018 and 2030 in vehicles



The embodied economic value of copper in vehicles is expected to triple by 2030.

It will increase from €2.4 billion in vehicles POM in 2018 to €6.8 billion. This projection takes into account only passenger vehicles. Other electric mobility devices (e.g., e-scooters, e-bikes) will also contribute to a copper demand increase.

Estimated value retention opportunities in vehicles by 2030



Market growth and improvements in ELV collection and separation can **increase copper embodied value by €1.2 billion in 2030** compared to 2018 business as usual levels.

* Cumulative losses from dissipation (e.g., inevitable due to products' complexity), collection, separation and shredding losses, further recycling losses, and potential missing vehicles flows and exports (unknown whereabouts)