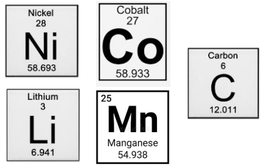
# Old batteries and manufacturing scrap make future EV batteries

Batteries of the future need large quantities of Nickel, Lithium and Cobalt to supply the growing EV market

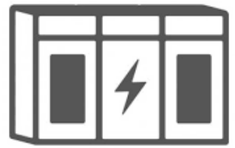
Recovered battery materials are critical to making new cells and reducing the carbon intensity of manufacturing

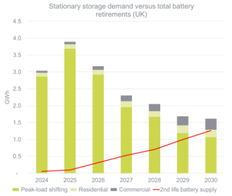



## Sources of end-of-life EV battery cells and outcomes

| | |
|---|---|
| EV retirements (End-of-life) | Insufficient supply for stationary storage but good for cell prod. |
| Warranty returns (e.g. recent recalls form GM, Hyundai, Ford & BMW) | Uncertain, but provides a recycling feedstock |
| Cell production scrap (~4-11% of output) | Constant feedstock and growing with gigafactories |

EV retirements **cannot** satisfy stationary storage supply needs






**21,000 tns** of waste cell materials in the UK by **2026**

**28,000 tns** of waste cell materials in the UK by **2030**

**235,000 tns** of waste cell materials in the UK by **2040**

**2 to 3 large material recovery recycling facilities in the UK, processing 10,000 tonnes pa**

**Multiple large scale recovery & reuse facilities**

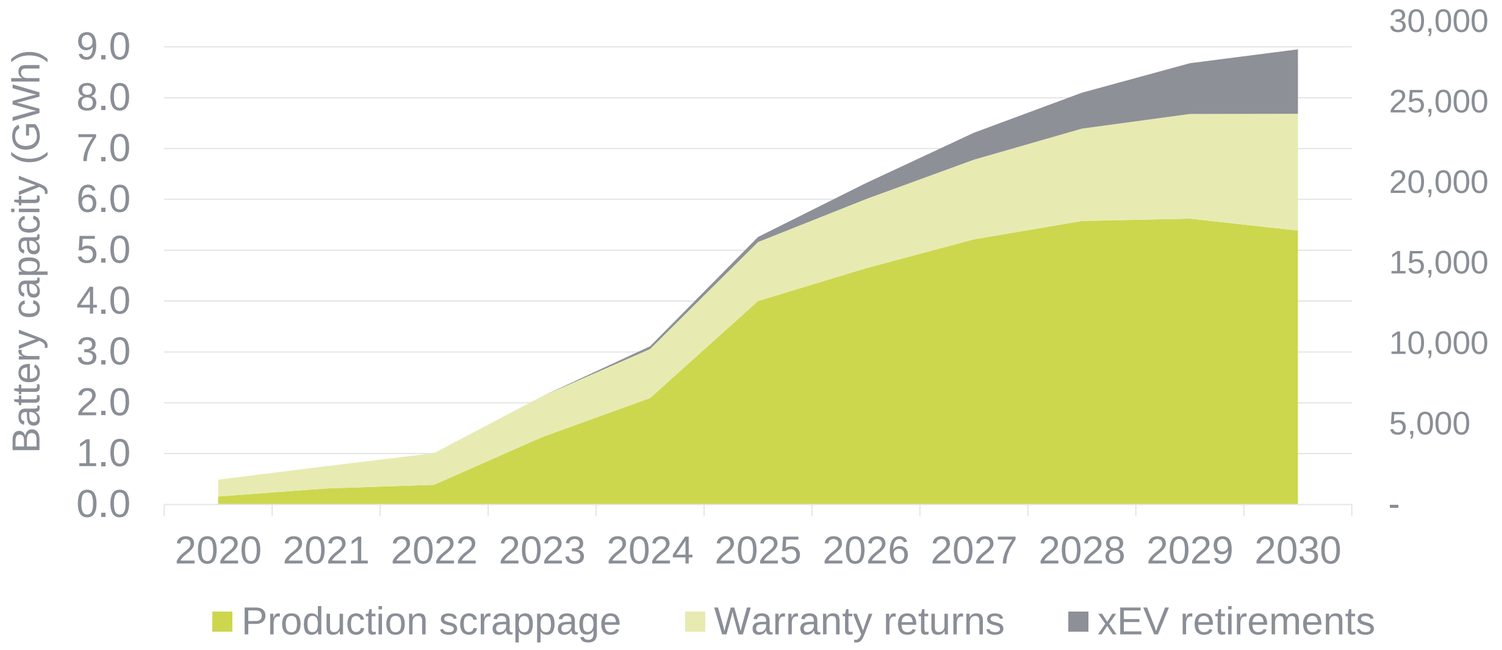
# The UK will be generating 28,000 tonnes of reusable battery cell waste by 2030

**Cell production scrap** | **Warranty recalls** | **EV retirements**

Recycling & material recovery

Second life & repurposing

## UK battery capacity available for recycling and reuse




EV retirements (BEV and PHEV based on UK sales)

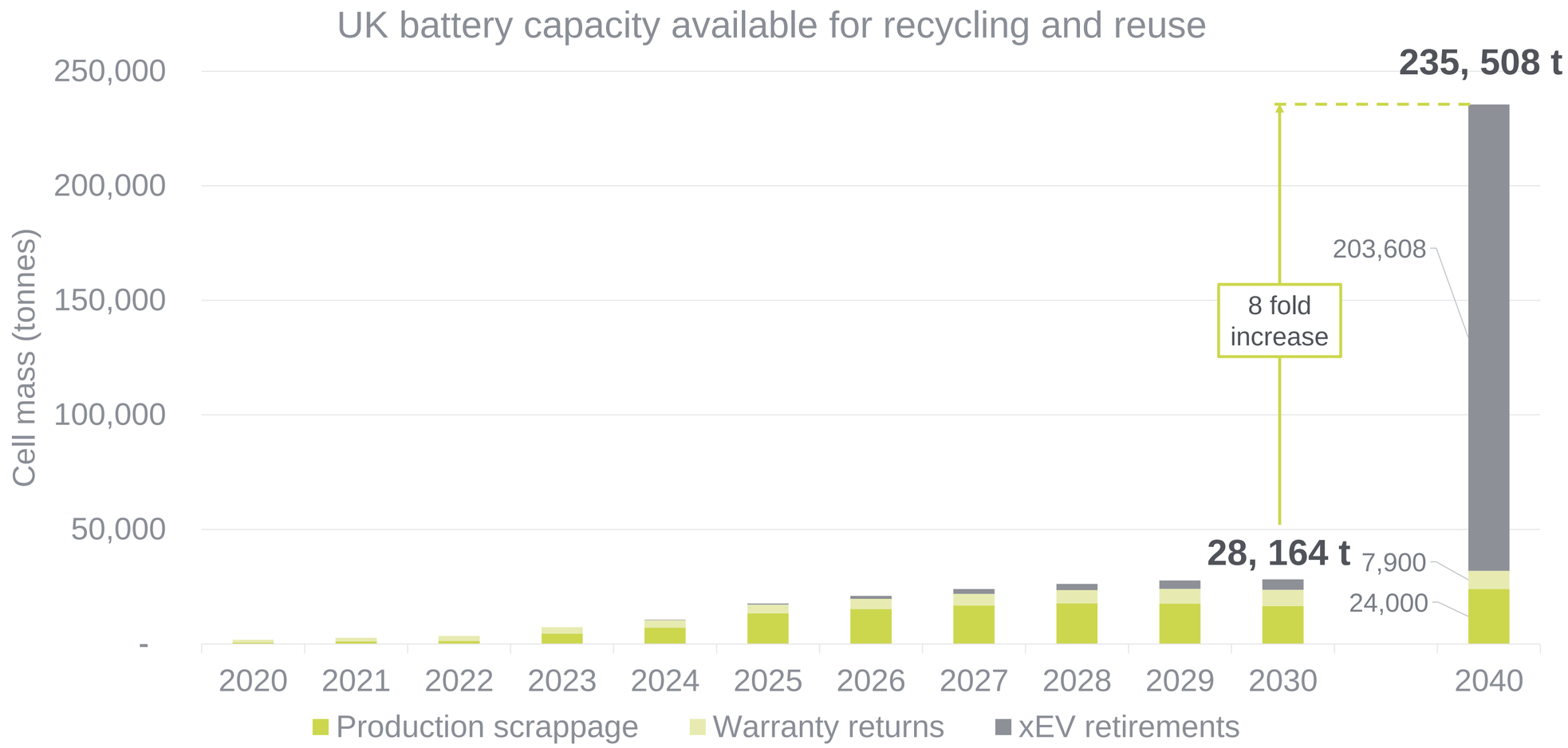
Warranty returns (based on recalls in 2020)

Production scrap (based on industry average of 4-11%)

**3 large recycling plants required by 2025**

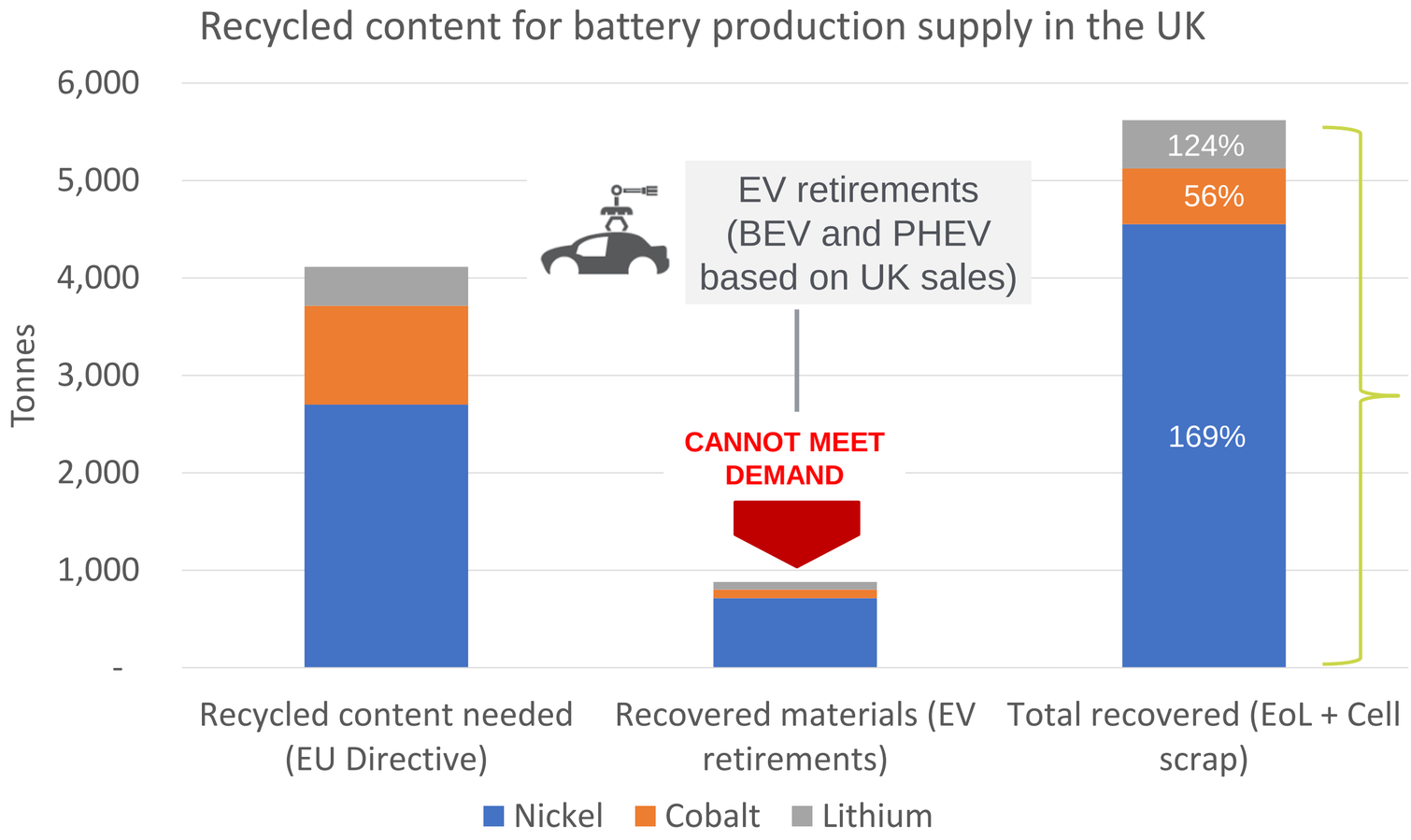
**Notes:** Analysis based on BEV and PHEV sales in the UK from 2012, warranty recalls based on 2020 BNEF data and cell production forecasts published by the APC

# By 2040, the dominant feedstock for battery materials will be from EoL vehicle retirements. A total of 235,000 tonnes will be available for recycling and reuse by 2040, almost 8 times that in 2030.




**Notes:** Analysis based on BEV and PHEV sales in the UK from 2012, warranty recalls based on 2020 BNEF data and cell production forecasts published by the APC

# Extending the recovery of critical materials to include cell production scrap, has the opportunity to meet Nickel and Lithium demand but not Cobalt in 2030




Adding production scrap can fulfil the cell production demand for Ni and Li.

Cobalt may be supplied from recycled phones.

EV retirements (BEV and PHEV based on UK sales)

+

Production scrap (based on industry average of 4-11%)

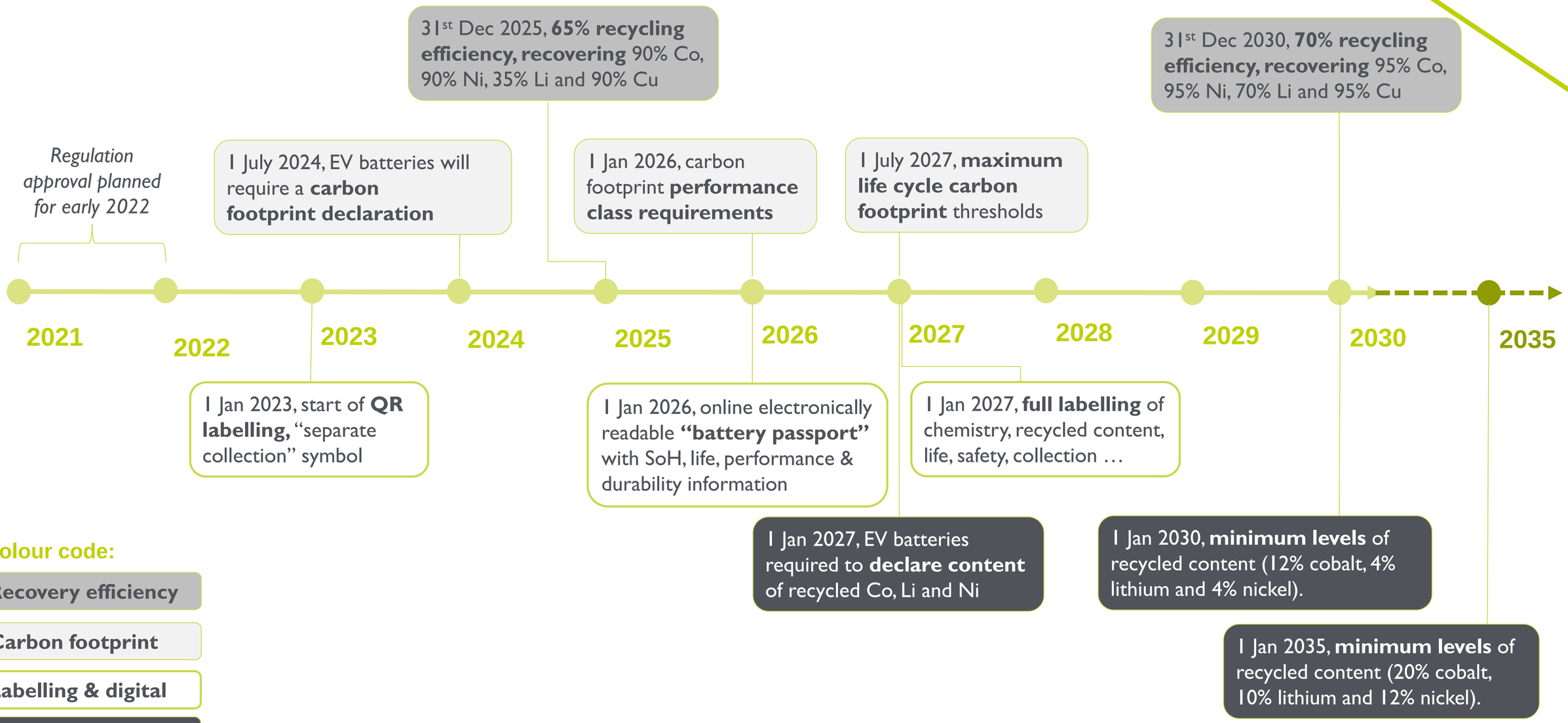
1 tonne of Cobalt is approximately 90,000 iPhones (3227 mAh. 3.84V) ~11-16 g / iPhone

500 tonnes Co → 45 million iPhones

**NOTES:**
Based on battery recovery rates and minimum recycled content in batteries stated in the EU Battery Directive and UK cell production forecasts published by the APC (90GWh in 2030).
2030 recycled content: 4% Ni, 12% Co, 4% Li @ recovery rates of 95% Ni, 95% Co, 70% Li

# Summary of proposed EU EV battery regulation introduction timeline

ADVANCED PROPULSION CENTRE UK




**Colour code:**

- Recovery efficiency
- Carbon footprint
- Labelling & digital
- Recycled content

EU Battery Directive Proposal 2020

# End of life vehicle (ELV) directive and EU battery regulation proposal brings a new economic stream of activities for second life and battery recycling

## Current ELV Directive


| | As of 1 January 2006 | As of 1 January 2015 |
|---|---|---|
| Reuse & Recycling | 80% | 85% |
| Reuse & Recovery | 85% | 95% |

Vehicle collection → Dismantling and airbag deployment → Fluid removal → Cables and circuit board removal → Triage and value assessment → Streaming materials / segregation → Shredding / metals recovery

- Steel
- Aluminium
- Copper

## EU Battery Regulation (NEW)

**EV batteries**


Battery removal → Safe discharging → Electronics, cables & cooling → Module separation & shredding → Electrolyte evaporation / drying → Fine shredding → Material separation

- Metal foils (Cu, Al)
- Plastics
- Black mass

2nd life / repurposed

## Materials Supply

Recycled recovered metals have a 10-25% lower carbon footprint than virgin materials. Expected be the first line of supply chain into CAM and p-CAM production and deliver OEM ESG / carbon goals.

CAM supply chain

Carbon 6 C 12.011 | Nickel 28 Ni 58.693 | Cobalt 27 Co 58.933 | Lithium 3 Li 6.941 | 25 Mn Manganese 54.938

Material recovery ← Hydrometallurgy & direct recycling

*Artifact created by the APC UK*