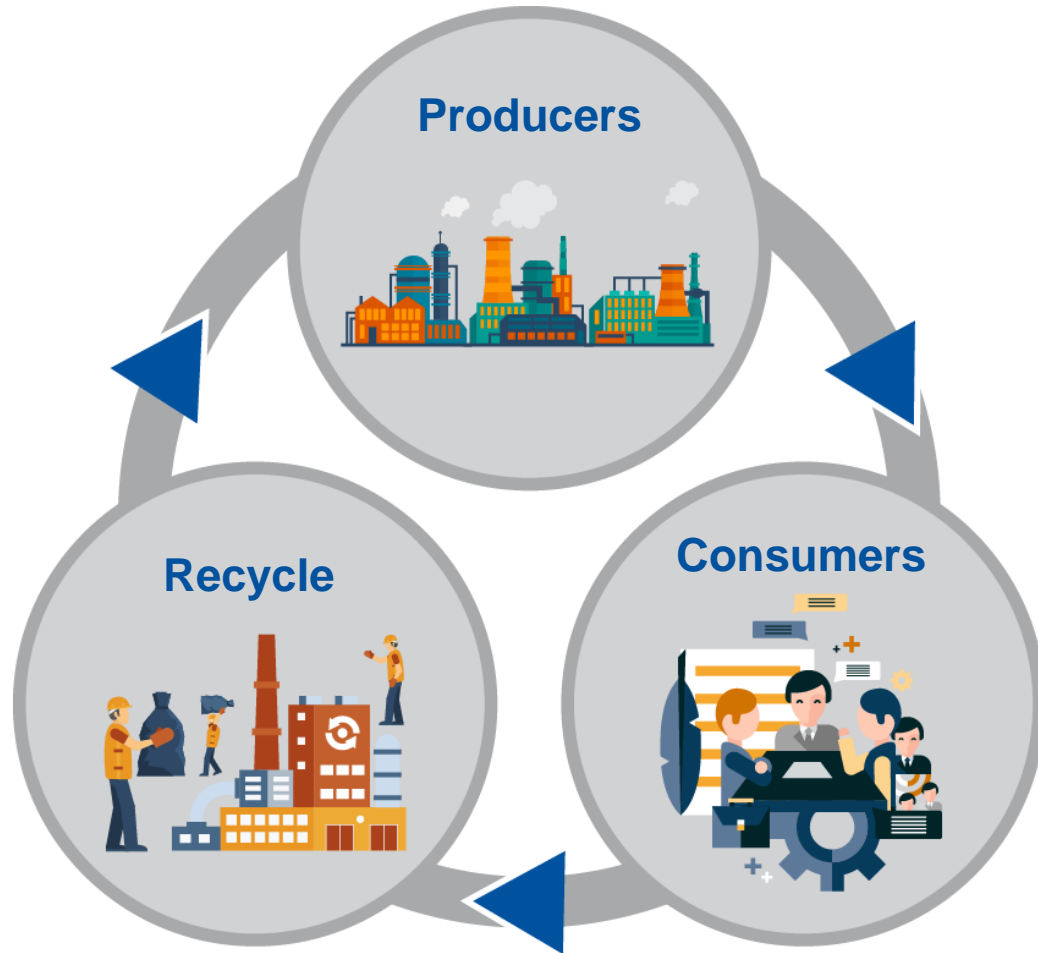


WEEE – a copper market conundrum

Rebecca Gordon
Divisional Director, CRU Consulting



WEEE recycling challenges faced by all participants




- Global WEEE volumes increasing:
 - collection legislation,
 - electronics market penetration,
 - product innovation, and
 - reduced product lifespans
- Appropriate waste management crucial:
 - mitigating environmental impacts
 - addressing materials criticality
- Viability requires e-waste recycling revenues exceed costs of collection, transportation and processing:
 - Precious metals being thrifted out and reduced by miniaturisation
 - End uses consuming secondary materials limited
 - Stricter environmental compliance costs incurred
- Much WEEE lost to landfill, stockpiled or exported

Copper: criticality still at 9 so further action needed

29

Cu

Copper



Criticality Score

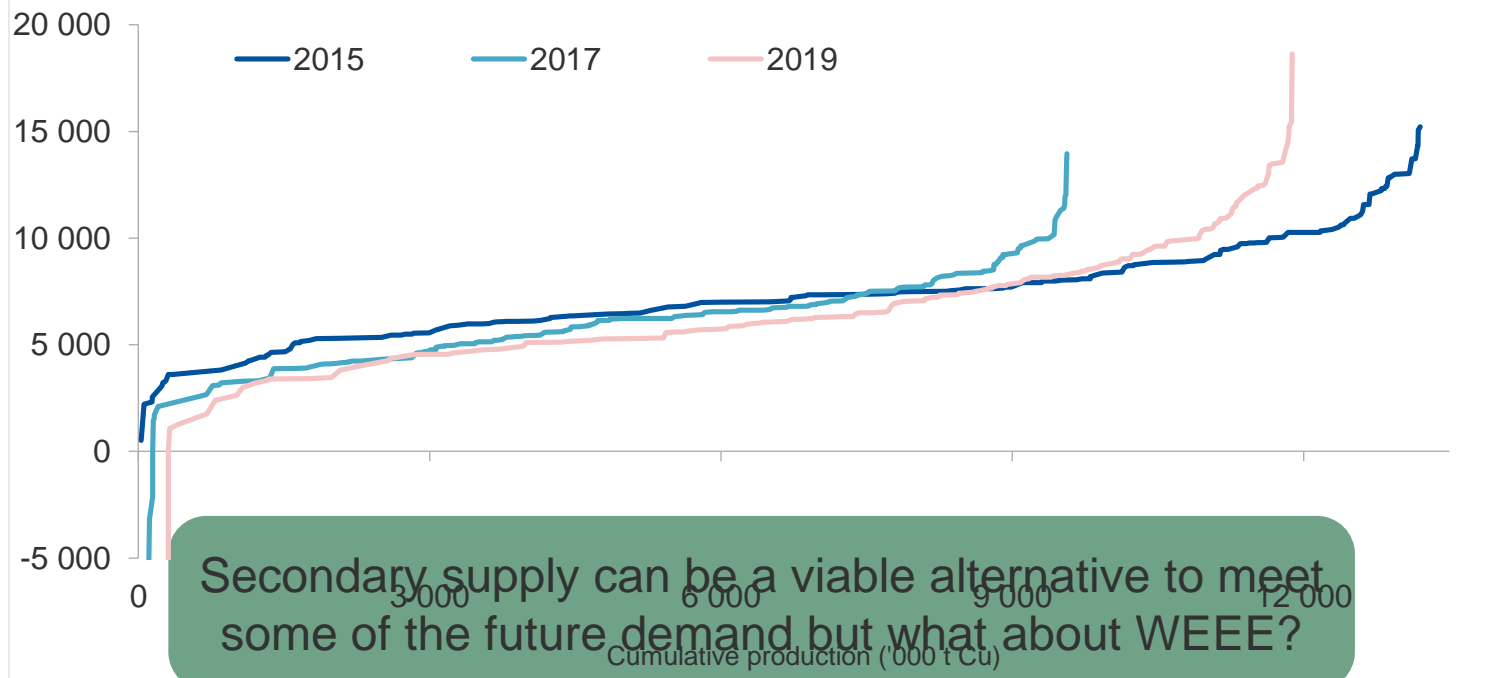


Uncertainty of supply

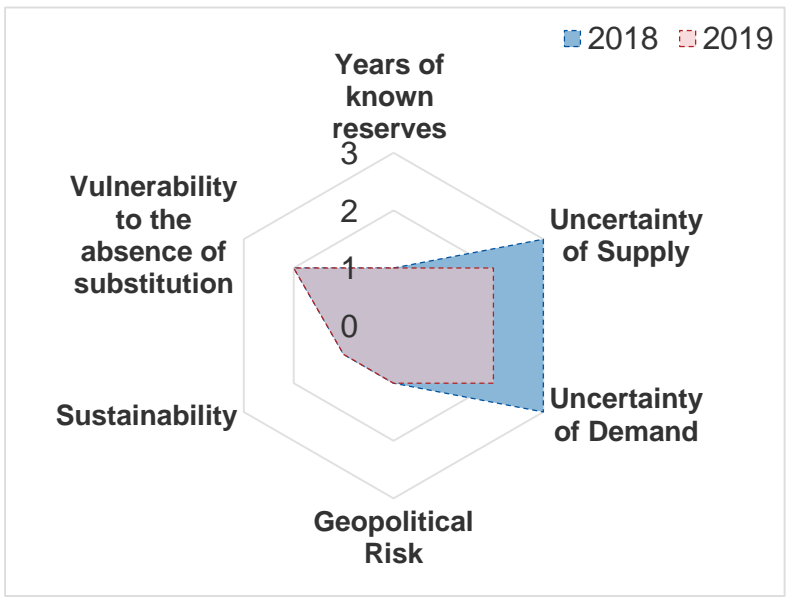
Has reduced as shelved mining projects have been fast-tracked to financing. Ten Tier 1 (>100ktpa) "Firm Projects" in January 2019 vs six in Jan 2018 and five in Jan 2017

Significantly larger pipeline of projects in the CRU 2019 report

Long run year project cost curves*, real (\$2018\$) full economic costs, \$/t

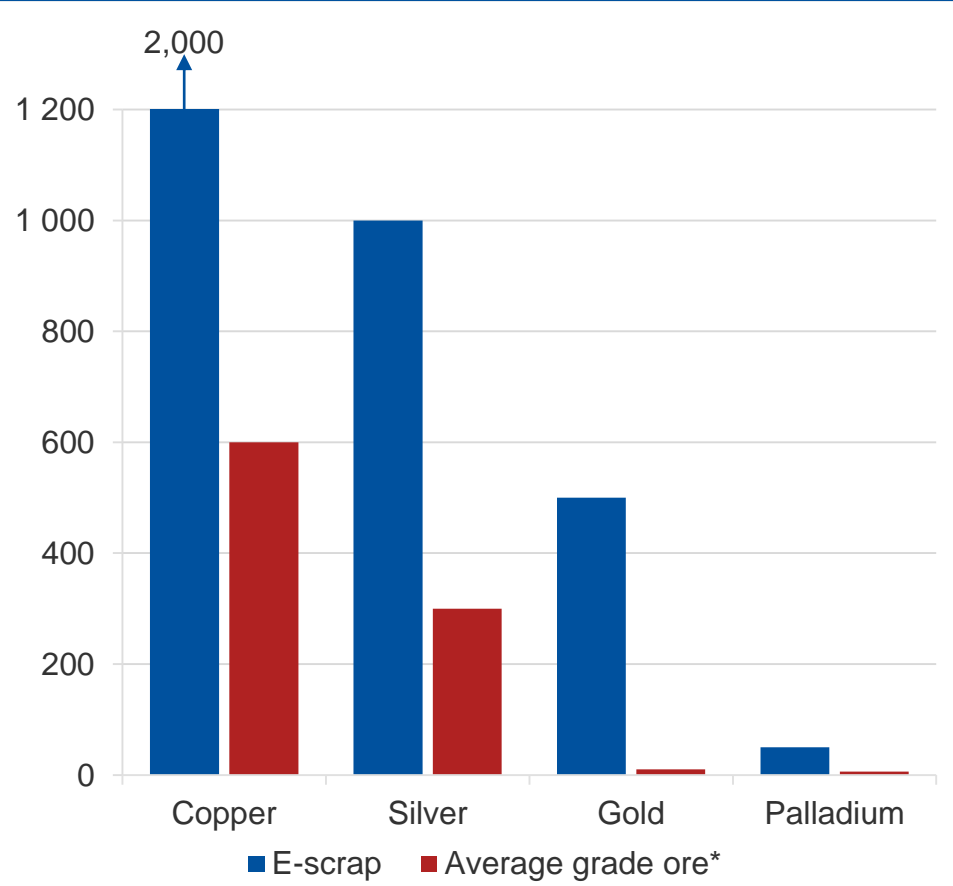


Secondary supply can be a viable alternative to meet some of the future demand but what about WEEE?

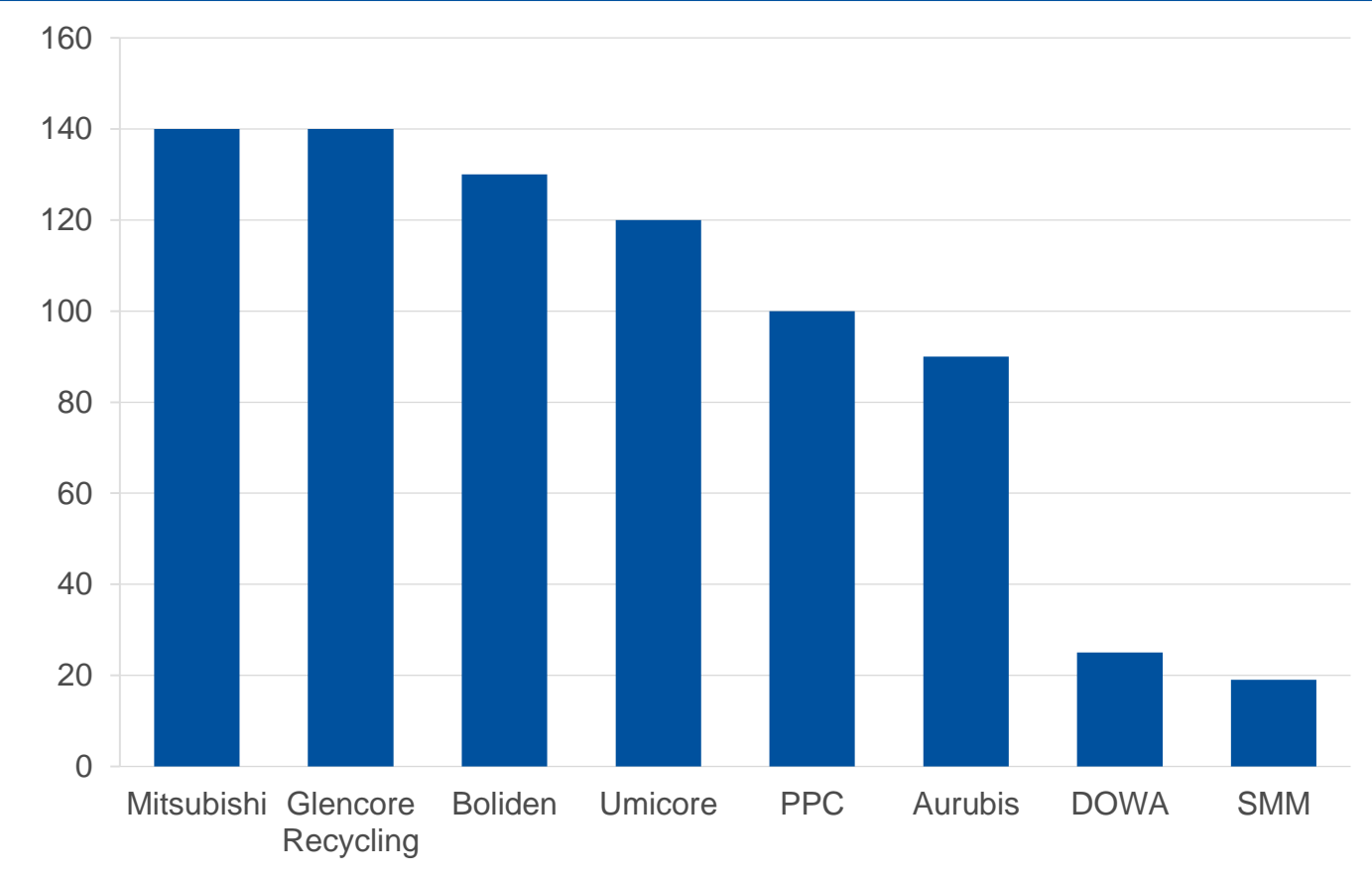


WEEE scrap is rich source of metals, but high barriers to entry

WEEE-scrap metal content can be higher than ore
Metal content of printed circuit boards (PCBs) (g/t)

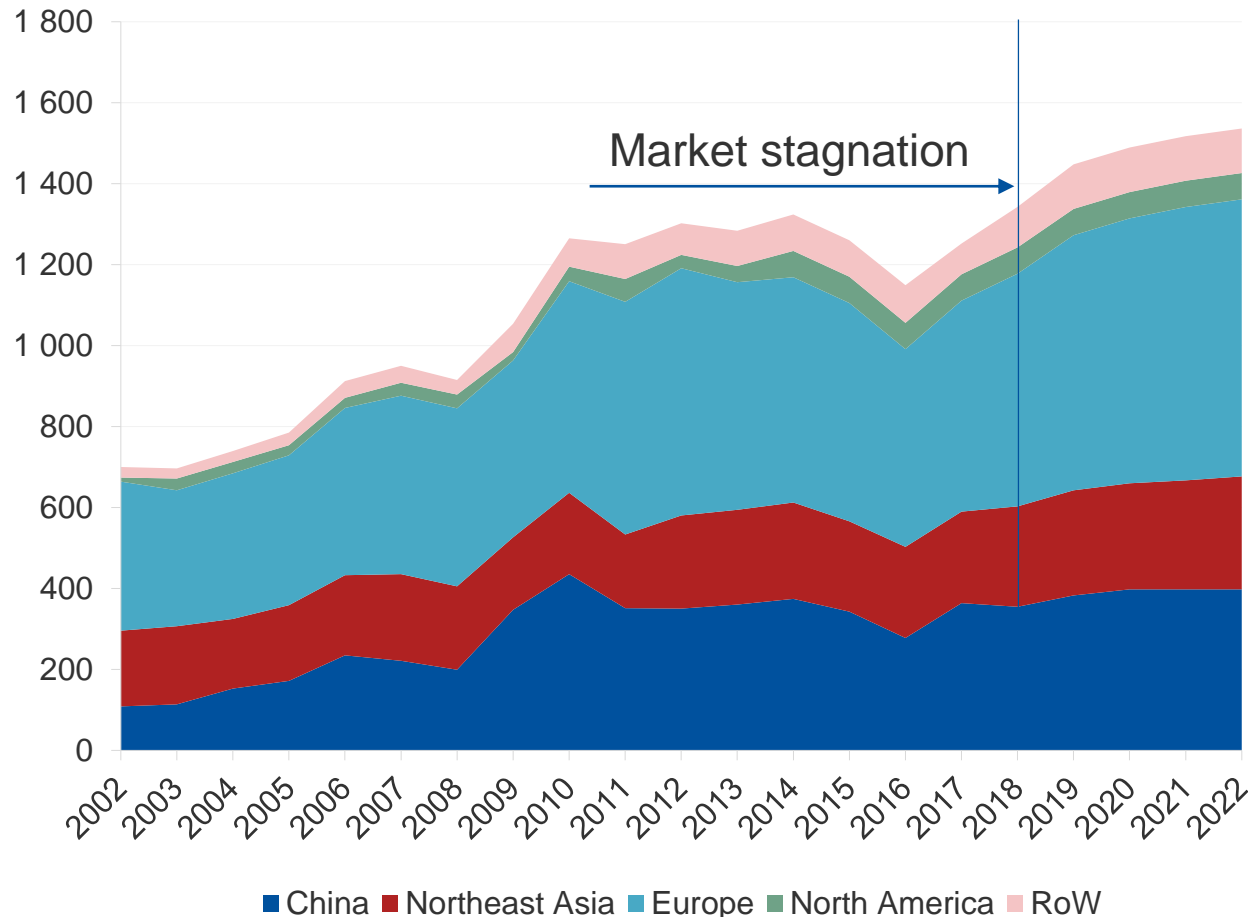


Several major players dominate E-scrap processing
Estimated E-scrap capacity in gross weight 2018, '000t



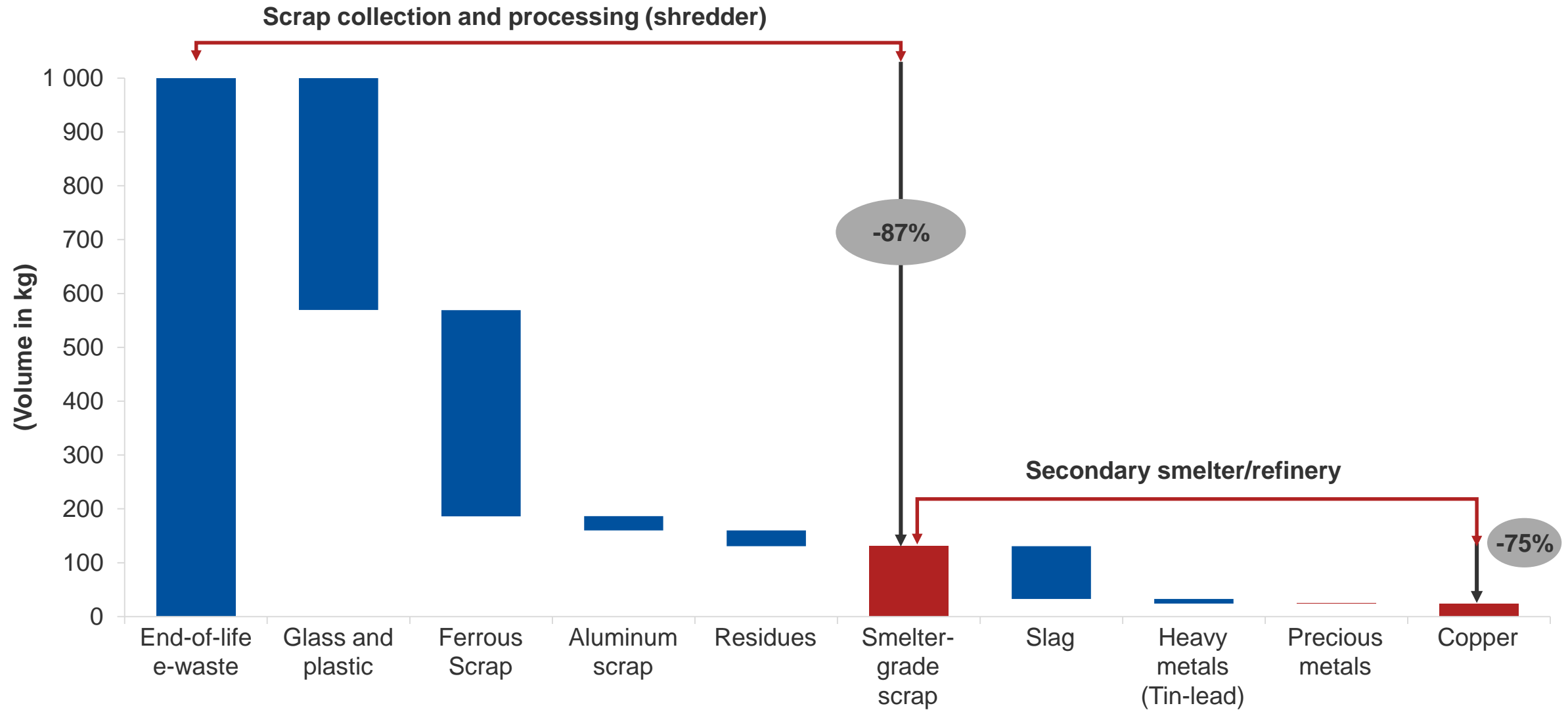
Obsolete scrap consumption increasing too slowly

Obsolete copper scrap consumption in secondary and mixed-feed smelters ('000 tonnes)

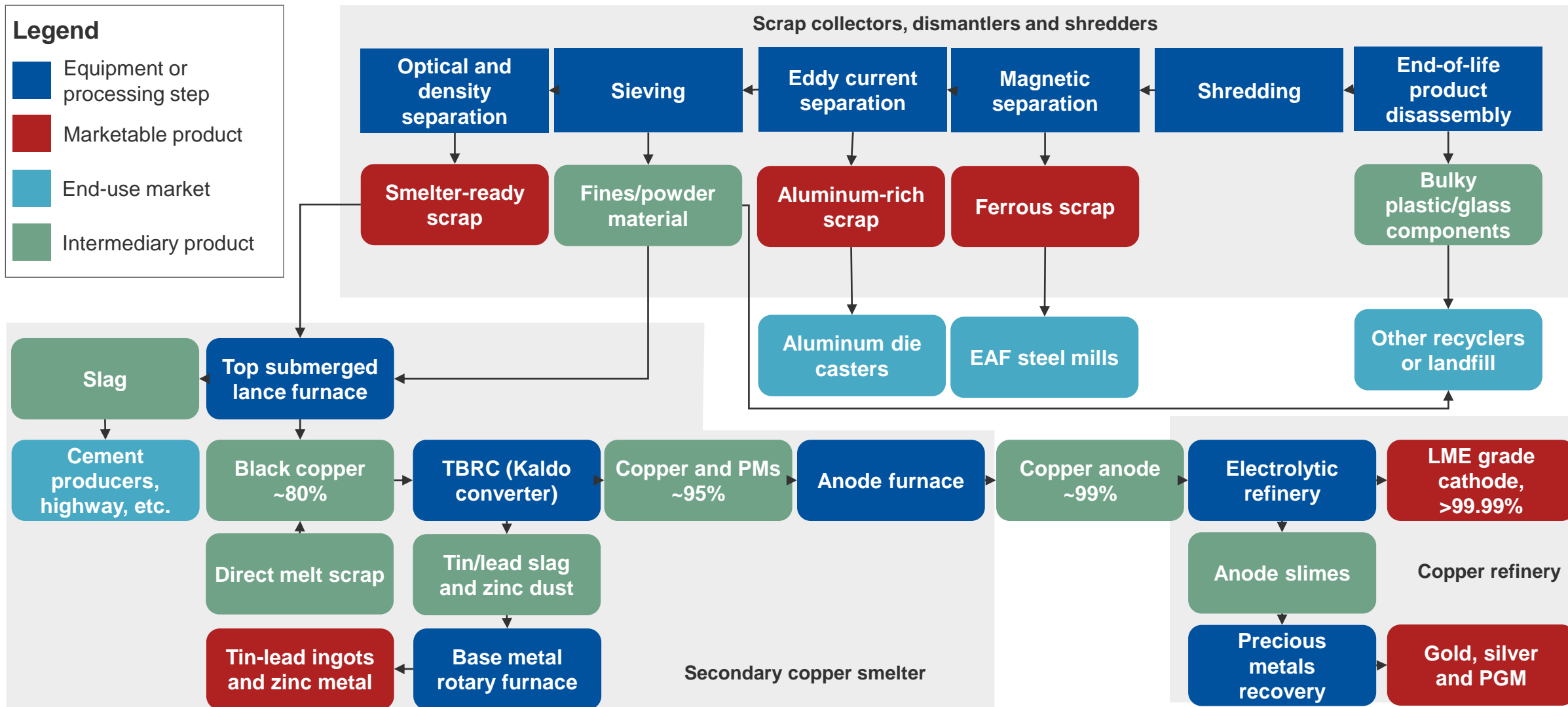


- **Europe** largest obsolete scrap-consuming region:
 - well-established smelters, complex waste streams focus on WEEE & low-grade Cu scrap
- **Chinese** obsolete scrap processing capacities have increased slightly in recent years
 - most planned smelters are high end concentrate-only or mixed-feed smelters
 - significant technical barriers for low grade feed smelters
 - scrap collection infrastructure in its infancy
- **Japan & South Korea** several secondary smelters
- **North America** only one secondary smelter and no operation that can effectively process lower grades of scrap
- Effective obsolete scrap processing capacity outside of these regions limited and likely to remain low

Yield can be low starting with 1 tonne of end of life WEEE material

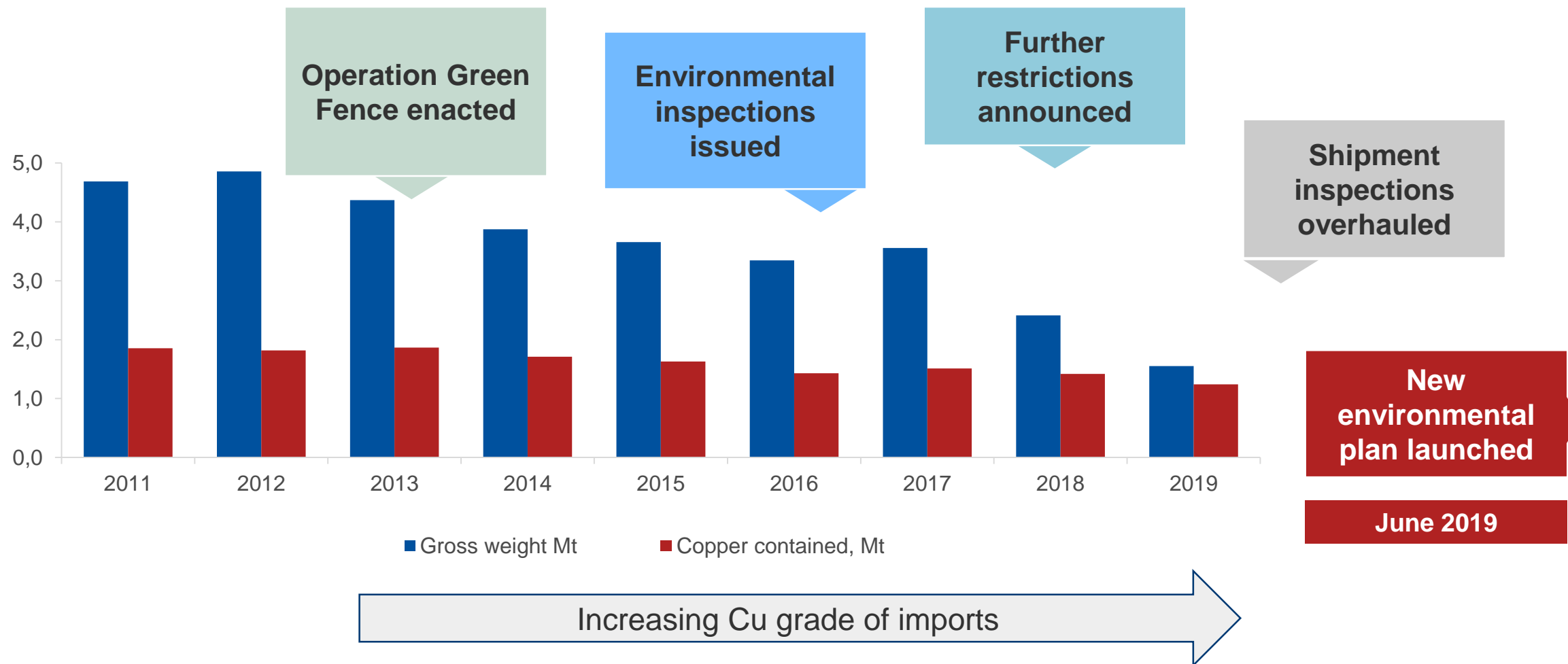


And the process is not simple...



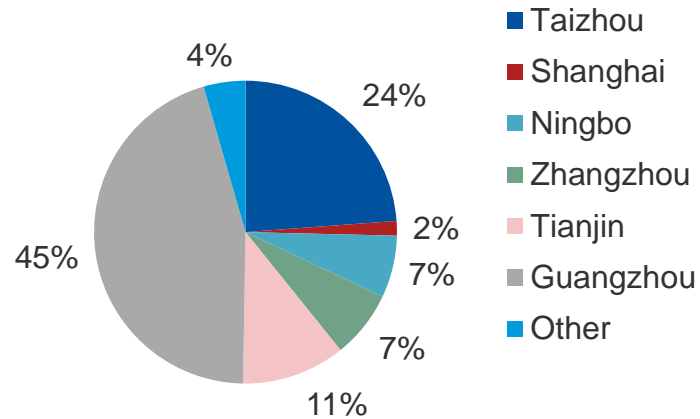
Another challenge is the changing regulatory framework

Chinese Cu Scrap imports fall as Chinese legislation is systematically tightened, 2011-2019, Mt

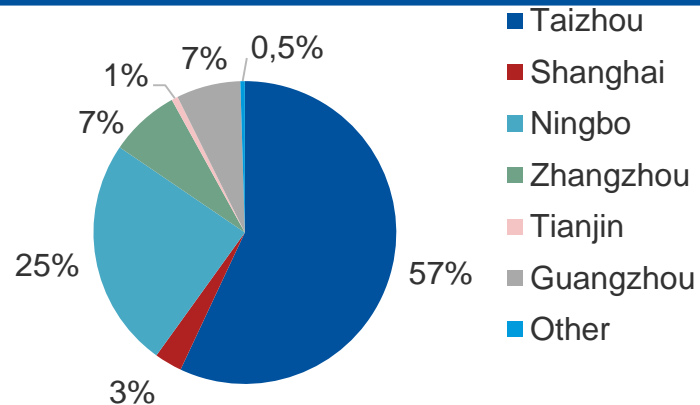


Regulation and inspection has changed landscape in China

Approved Category 7 import quotas by province - 2017



Approved Category 7 import quotas by province - 2018



- **Tianjin District** 7% imports 2017
- Major player: **China Metal Recycling (CMR)**
- Highly fragmented, labour intensive
- Licenses revoked
- **2018: ~<3% imports**

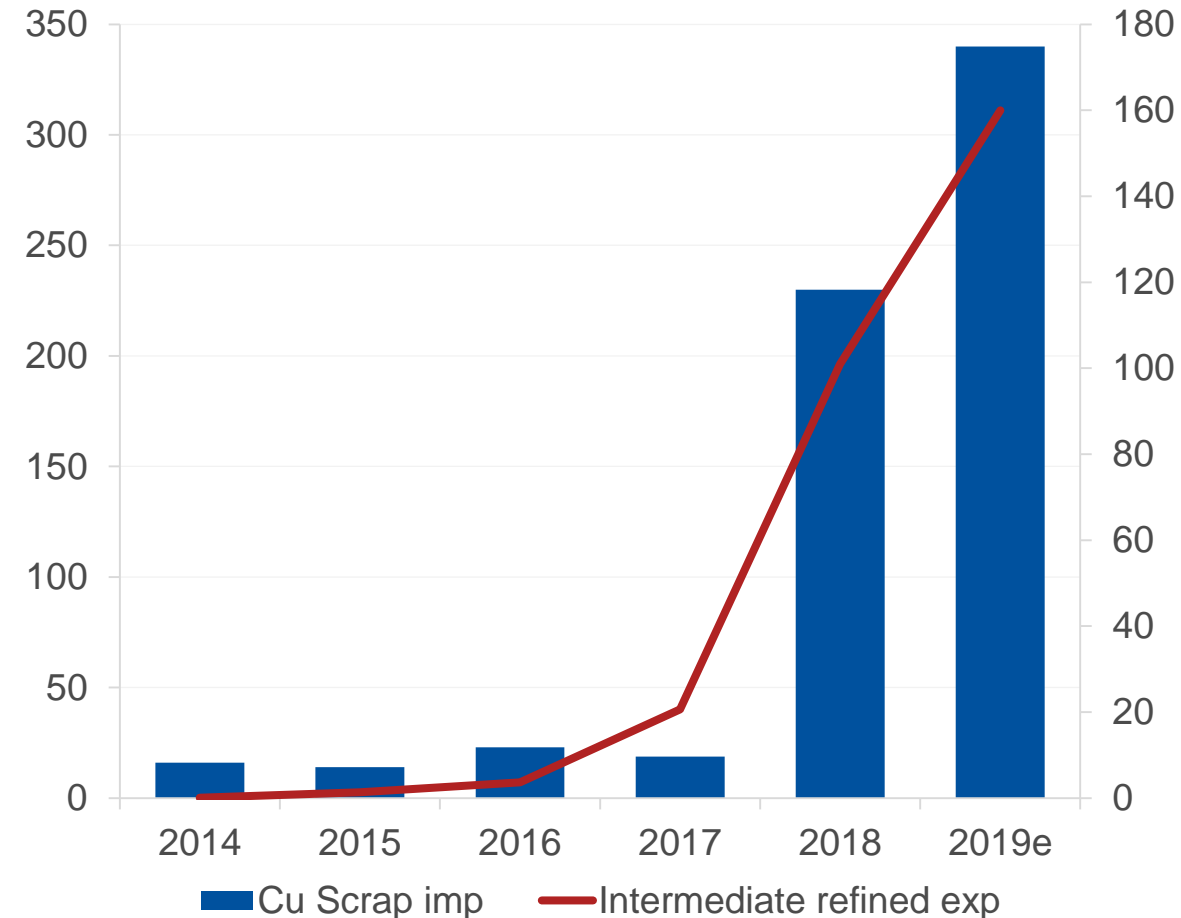
- **Hangzhou District:** 17% imports 2017
- Major processor: **Zili Copper Industry Co**
- Mostly processes insulated wire & low grade residues for blister production
- Most licenses renewed
- **2018: ~23% imports**

- **Ningbo / Taizhou District:** 25% imports 2017
- Major player: **Chiho Group**, Taizhou, China's largest scrap processing facility
- Highly mechanized dismantling & sorting, well managed facilities
- **2018: ~45% imports**

- **Guangzhou District:** 42% imports 2017
- Major port adjacent to Hong Kong
- 75% licenses revoked
- **2018: ~<20% imports**

Malaysia is importing Cu scrap previously destined for China

Malaysian Cu scrap imports could rise dramatically in 2019
Scrap imports (lhs) and matte exports (rhs) in gross weight, '000t

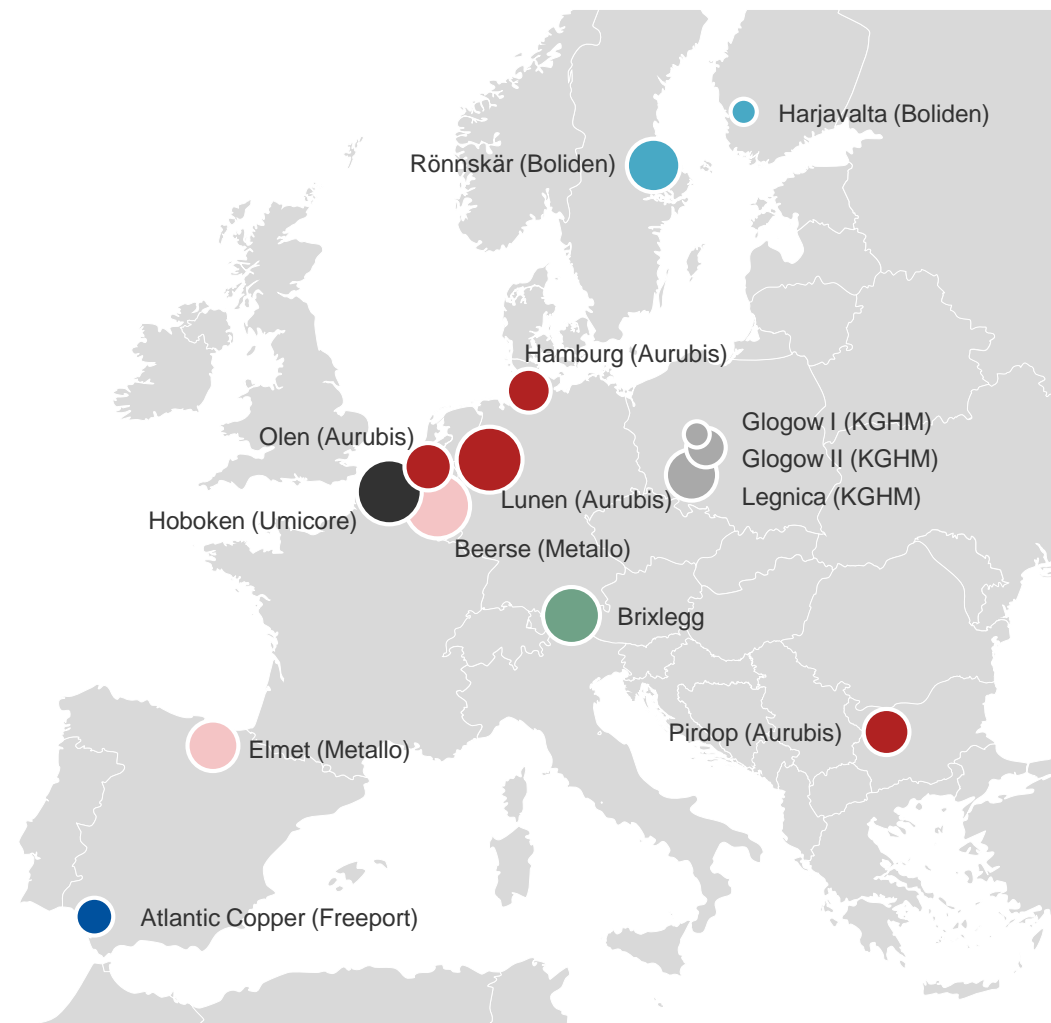


Malaysia:

- Emerged as a key importer of low-grade scrap in 2018 mostly from USA
- Could grow to >340kt in 2019, on the back of strong imports in the opening months of the year
- Reports that there are now several facilities of >100kt/y processing capacity in Malaysia, gross weight
- Exports to China of what we believe to be processed scrap (under the HS code for Matte) exceeded 100kt in 2018; up 500% on 2017 levels
- E-scrap pollution possible from unregulated and illegal processors
- Government considering a ban on this industry

Who will process this material?

Europe is the best served market for copper scrap recycling



Size of bubble denotes volume of secondary raw materials used.

Aurubis

Lunen, Hamburg, Pirdop and Olen operations all utilise Cu scrap. Smelting capacity of 90kt E-scrap and 550kt total Cu scrap in Europe

Boliden

Rönnskär smelter specialist E-scrap processor, >120kt capacity. Expansion planned for 2020 +30kt? The Harjavalta smelter also processes a smaller volume

KGHM

Large consumer of refinery grade scrap (>100kt) at Legnica and Glogow I & II. No low-grade or E-scrap processing

Metallo

One of the larger consumers of complex materials (slags, dusts, slimes) but no E-scrap capacity. Metallo's Beerse facility processes up to 350kt/y copper scrap/complex materials

Umicore

Operates the Hoboken works in Belgium, limited copper production (~35kt) with a multi-metal strategy focusing on various complex raw materials

Brixlegg

Secondary smelting/refining operation in Austria, using largely scrap, complex materials and blister from Krompachy in Slovakia

Atlantic copper

Huelva in Spain uses up to 30kt/y Cu scrap including a small volume of E-scrap

Conclusions

1. To meet the growing demand for copper from the low-carbon economy we need both primary copper mining and post-consumer recycling
2. The importance of sustainable recycling grows as we consume more materials and we seek to avoid unnecessary primary production
3. Much of the material we need for the secondary industry is already in the hands of consumers
4. Each region has its own challenges – with Europe well advanced in recycling capacity but short of post-consumer waste and developing countries seeking to create economic, safe and environmentally sustainable recycling industries
5. Consumers, scrap dealers / collector, recyclers and primary producers would benefit from considering the full life cycle of their products by:
 - designing in recyclability
 - sharing best practice
 - developing cost effective recycling technology and
 - regulating to ensure post consumer waste is reprocessed safely



THANK YOU

Rebecca Gordon
Divisional Director, CRU Consulting
rebecca.gordon@crugroup.com

