



# End-of-waste Criteria for Copper and Copper Alloy Scrap: Technical Proposals

Lenka Muchova, Peter Eder and Alejandro Villanueva



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European Commission  
Joint Research Centre  
Institute for Prospective Technological Studies

**Contact information**

Address: Edificio Expo. c/ Inca Garcilaso, 3. E-41092 Seville (Spain)  
E-mail: [jrc-ipts-secretariat@ec.europa.eu](mailto:jrc-ipts-secretariat@ec.europa.eu)  
Tel.: +34 954488318  
Fax: +34 954488300

<http://ipts.jrc.ec.europa.eu>  
<http://www.jrc.ec.europa.eu>

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## **PREFACE**

This report is the JRC-IPTS contribution to the development of the end-of-waste criteria for copper and copper alloy scrap in accordance with Article 6 of Directive 2008/98/EC of the European Parliament and of the Council on waste (the Waste Framework Directive).

The purpose of end-of-waste criteria is to avoid confusion about the waste definition and to clarify when certain waste that has undergone recovery ceases to be waste. Recycling should be supported by creating legal certainty and an equal level playing field and by removing unnecessary administrative burdens. The end-of-waste criteria should provide a high level of environmental protection and an environmental and economic benefit.

The recitals of the Waste Framework Directive identify scrap metals as a possible category of waste for which end-of-waste criteria should be developed. Consequently, the Environment Directorate-General requested from the JRC-IPTS a study with technical proposals on end-of-waste criteria for copper and copper alloy scrap.

This report delivers the results of the study. It includes a possible set of end-of-waste criteria and shows how the proposals were developed based on a comprehensive techno-economic analysis of copper and copper alloy recycling and an analysis of the economic, environmental and legal impacts when copper scrap cease to be wastes.

The report has been produced by the JRC-IPTS based on the contributions of experts from Member States and the stakeholders by means of a TWG. The experts contributed in the form of written inputs and through participation in a workshop organised by the JRC-IPTS in July 2009. The report also used the results of previous research carried out by the JRC-IPTS from 2006 to 2008 and described in the reports 'End-of-waste criteria' and 'Study on the selection of waste streams for end-of-waste assessment'.

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## TABLE OF CONTENTS

<b>Preface</b> .....	<b>1</b>
<b>Table of contents</b> .....	<b>2</b>
<b>List of acronyms</b> .....	<b>3</b>
<b>1 Introduction</b> .....	<b>5</b>
1.1 Background .....	5
1.2 Objective .....	5
1.3 Process .....	5
1.4 Structure of the report .....	6
<b>2 Background information on copper and copper alloy scrap</b> .....	<b>7</b>
2.1 Copper: definition and scope .....	7
2.2 The copper life cycle.....	8
2.3 Economic data.....	26
2.4 Specifications and standards .....	35
2.5 Legislation and regulation.....	37
2.6 Environmental and health aspects.....	41
<b>3 End-of-waste criteria</b> .....	<b>45</b>
3.1 Conditions for end-of-waste criteria .....	45
3.2 Outline of end-of-waste criteria .....	46
3.3 Product quality requirements .....	48
3.4 Requirements on input materials .....	62
3.5 Requirements on treatment processes and techniques .....	64
3.6 Quality assurance .....	66
3.7 Information provided with the product .....	68
<b>4 Description of impacts</b> .....	<b>69</b>
4.1 Environment and health impacts.....	69
4.2 Economy and market impacts .....	71
4.3 Legislation impacts .....	78
4.4 Summary of impacts of EoW on copper scrap .....	87
<b>Acknowledgment</b> .....	<b>89</b>
<b>Glossary</b> .....	<b>91</b>
<b>References</b> .....	<b>95</b>
<b>Annex 1: Scrap categories according to EN 12861:1999</b> .....	<b>99</b>
<b>Annex 2. Copper and copper alloys scrap categories according to ISRI specification.</b> .....	<b>103</b>
<b>Annex 3. Summarised proposal of the criteria</b> .....	<b>105</b>

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## LIST OF ACRONYMS

ASR	Automotive shredder residue
BIR	Bureau of International Recycling
C&D	Construction and demolition waste
CEN	European Committee for Standardization
CFCs	Chlorofluorocarbons
CO	Carbon oxide
CO <sub>2</sub>	Carbon dioxide
ECHA	European Chemical Agency
ECI	European Copper Institute
EEE	Electrical and electronic equipment
ELVs	End-of-life vehicles
EoW	End-of-waste
EU	European Union
Eurometrec	European Metal Trade & Recycling Federation
FER	Federación Española de la Recuperación y el Reciclaje
GHG	Greenhouse gas
ICSG	International Copper Study Group
IEW	Industrial electrical equipment waste
INEW	Industrial non-electrical equipment waste
ISRI	Institute of Scrap Recycling Industries
JRC-IPTS	Joint Research Centre- Institute for Prospective Technological Studies
LME	London Metal Exchange
MSW	Municipal Solid Waste
PBT	Persistent, Bioaccumulative and Toxic chemicals
PCDD/F	Polychlorinated dibenzodioxins/ Polychlorinated dibenzofurans
P-free	Phosphorus-free
PVC	Polyvinyl chloride
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RoHS	Restriction of Hazardous Substances Directive
SDS	Safety Data Sheet
TWG	Technical Working Group
UNECE	United Nations Economic Commission for Europe
VAT	Value added tax
VOC	Volatile organic compounds
vPvB	very Persistent, very Bioaccumulative
WEEE	Waste electrical and electronic equipment
WFD	Waste Framework Directive



# 1 INTRODUCTION

## 1.1 Background

According to Article 6(1) and (2) of the new Waste Framework Directive (WFD) 2008/98/EC, waste of certain types can cease to be waste when it has undergone a recovery operation and complies with specific criteria to be developed in line with certain legal conditions, in particular when there is an existing market or demand for the material and the use is lawful and will not lead to overall negative environmental or human health impacts. Such criteria should be set for specific materials by the Commission in comitology. The end-of-waste criteria mechanism was introduced to further encourage recycling in the EU by creating legal certainty and an equal level playing field and removing unnecessary administrative burdens.

A methodology guideline<sup>1</sup> to develop end-of-waste criteria has been elaborated by the Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS) as part of the 'End-of-Waste Criteria' report. The European Commission is preparing proposals for end-of-waste criteria for specific waste streams according to the legal conditions and following the JRC methodology guideline. As part of this work, the JRC-IPTS has conducted a study with the aim to prepare technical proposals for copper and copper alloy scrap.

## 1.2 Objective

This technical report is the final deliverable from IPTS to DG Environment, and it presents a consolidated version of the background technical information that documents an end-of-waste proposal for copper scrap. It is the objective of this report to provide the technical background for the preparation by DG Environment of a Commission Regulation on end-of-waste criteria for copper and copper alloy scrap.

## 1.3 Process

The proposals by the Commission on end-of-waste criteria need substantial technical preparation. Acknowledging this fact, the JRC-IPTS has produced this report with the help of a technical working group (TWG) composed of experts from the different Member States, belonging to different stakeholder groups such as administration, industry, academia, and NGOs. The study includes all the information needed for a proposal on end-of-waste criteria for copper/copper alloy scrap in conformity with Article 6 of the WFD, and follows the methodology developed by the JRC-IPTS in the 'End-of-Waste Criteria' report.

The technical proposals were developed based on the contributions of experts from Member States and the stakeholders by means of a TWG. The experts were requested to make their contribution in the form of written inputs and through participation in the expert workshops organised by the JRC-IPTS on 23 March and 7 July 2010. Before each workshop, the JRC-IPTS submitted a background paper to the TWG in order to prepare for the work, to collect the necessary information from the experts and to have previously collected information peer-reviewed within the TWG.

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<sup>1</sup> End-of-waste documents from the JRC-IPTS are available at <http://susproc.jrc.ec.europa.eu/activities/waste/>. See in particular the operational procedure guidelines of Figure 5 in the 'End-of-Waste Criteria' report.

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Shortly after the first and second workshop, the JRC-IPTS wrote to the TWG with the request for additional inputs. This final report has been prepared by the JRC-IPTS based on the inputs and comments from the TWG throughout the whole process. At the end of the process, the final document is to be submitted to DG Environment for further use in preparation of the proposal of the Commission Regulation.

#### ***1.4 Structure of the report***

The first part of this report (Chapter 2) provides a comprehensive overview of copper/copper alloy scrap recycling. It analyses scrap sources, describes the scrap metal recycling processes depending on the source of the material, and identifies the main environmental issues of copper recycling. It also includes a description of the industry structure, scrap type specifications used by industry, and related legislation and regulation.

The second part (Chapter 3) describes the proposed end-of-waste criteria as such. It identifies the reasons for developing the end-of-waste criteria for copper/copper alloy scrap, i.e. the advantages these criteria offer compared to the current situation. It then analyses how the basic general conditions for the end-of-waste criteria can be fulfilled and finally it proposes outlines of possible end-of-waste criteria.

The third part (Chapter 4) addresses potential environmental, economic and legal impacts of implementing the end-of-waste criteria.

The summarised proposals of criteria are included at the end of the document.



## 2 BACKGROUND INFORMATION ON COPPER AND COPPER ALLOY SCRAP

### 2.1 Copper: definition and scope

Copper is a malleable and ductile metallic element that is an excellent conductor of heat and electricity as well as being corrosion resistant and antimicrobial (ICSG, 2010b). Copper occurs naturally in the earth's crust in a variety of forms. It can be found in sulphide deposits (as chalcopyrite, bornite, chalcocite, covellite), in carbonate deposits (as azurite and malachite), in silicate deposits (as chrysocolla and diopside) and as pure 'native' copper. As trace element, copper also occurs naturally in humans, animals and plants. An overview of the physico-chemical properties of copper is given in Table 1.

**Table 1: Physico-chemical properties of copper.**

Chemical symbol	Cu
Atomic number	29
Atomic weight	63.54
Density	8960 kg m <sup>-3</sup>
Melting point	1356 K
Specific heat cp (at 293 K)	0.383 kJ kg <sup>-1</sup> K <sup>-1</sup>
Thermal conductivity	394 W m <sup>-1</sup> K <sup>-1</sup>
Coefficient of linear expansion	16.5 x 10 <sup>-6</sup> K <sup>-1</sup>
Young's modulus of elasticity	110 x 10 <sup>9</sup> N m <sup>-2</sup>
Electrical conductivity (% IACS)	1.673 x 10 <sup>-8</sup> ohm m
Crystal Structure	Face-Centered Cubic

*Source: ICSG, 2010b.*

Copper can be alloyed with other metals, such as zinc (to form brass), aluminium or tin (to form bronzes), for use in specialised applications. Bronze is a mix of copper that contains as much as 25% tin. Brass is a mix of copper that contains between 5% and 45% zinc. Small amounts of manganese, aluminium, and other elements may be added to bronzes and brasses to improve machinability, corrosion resistance, or other properties.

Copper and copper alloys are classified according to CEN classification as follows:

- Copper
- Miscellaneous Copper alloys (max. 5% alloy elements)
- Miscellaneous Copper alloys (over 5% alloy elements)
- Copper-aluminium alloys
- Copper-nickel alloys
- Copper-nickel-zinc alloys
- Copper-tin alloys, binary
- Copper-zinc-lead alloys
- Copper-zinc alloys, complex
- Copper material not standardised by CEN/TC 133.

## 2.2 The copper life cycle

### 2.2.1 Copper mining

Virgin copper originates from mining activities. Since the year 1900, when world production was less than 500 thousand tonnes, world copper mining production has steadily grown by around 4% per year to reach nearly 16 million tonnes in 2009. The technology of electrowinning<sup>2</sup>, virtually non-existent before the 1960s, delivered almost 3.3 million tonnes in 2009 (see Figure 1).

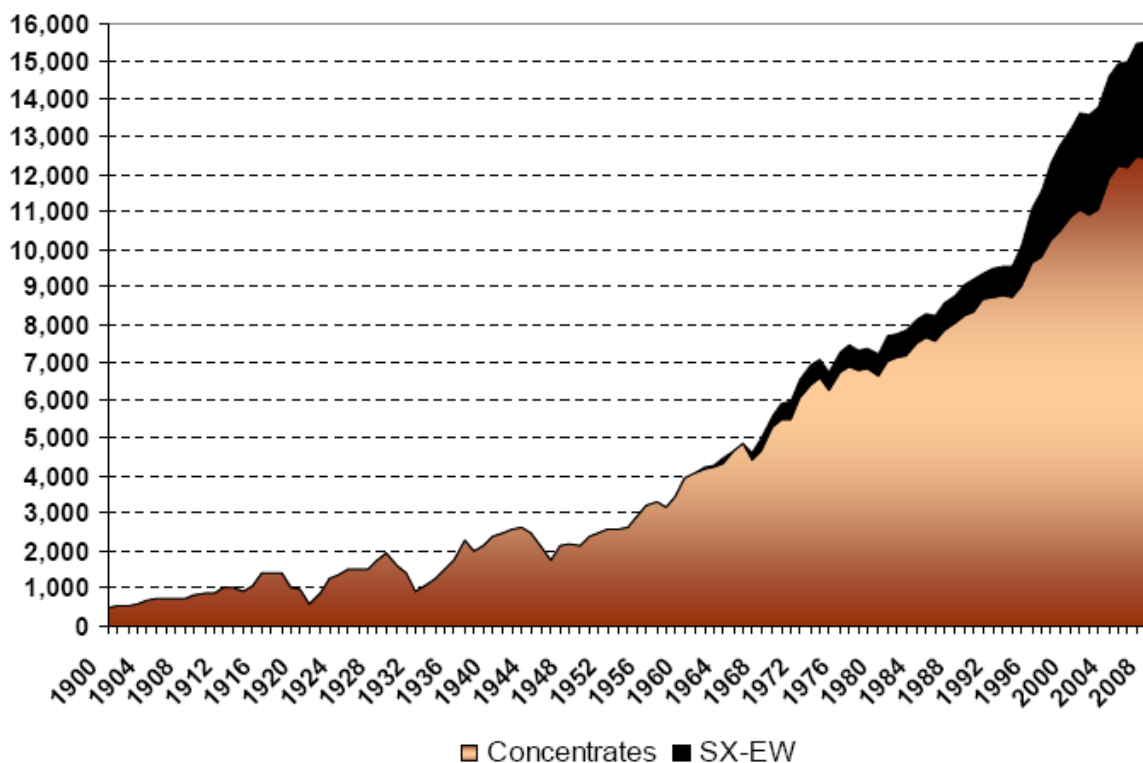


Figure 1: World copper mining production evolution from 1900 to 2009 in thousand metric tonnes, based on hydrometallurgical concentrate production and electrowinning (SX-EW).  
Source: ICSG, 2010b.

In 2009, Chile accounted for over one third of the world copper mining production, with a mining output of nearly 5.4 million tonnes (ICSG, 2010b). Europe, including the Russian federation, produced about 2 million tonnes of mined copper (Figure 2). In the EU-27, Poland delivered the main share of copper mining production with 0.43 million tonnes.

<sup>2</sup> Electrowinning, also called electroextraction, is the recovery of metal from metallic salts by means of electrolysis.

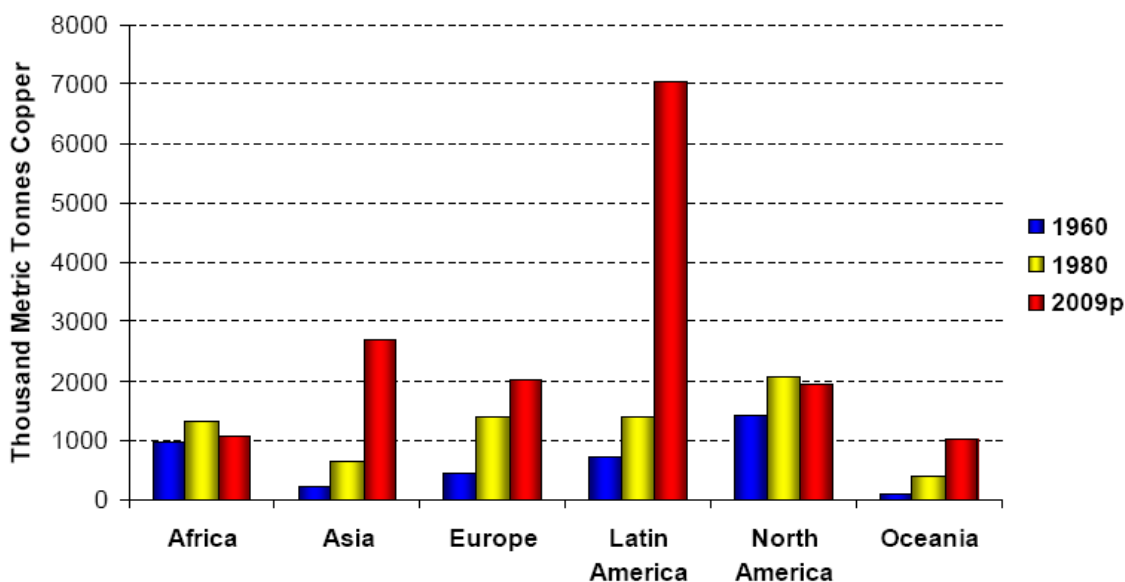


Figure 2: Copper mining production by region for the years 1960, 1980 and 2009 (projected data).  
Source: ICSG, 2010b.

The import of copper ores and concentrates into the EU increased from 2004 until 2008 (see Table 2). The main importing countries in the EU-27 are Germany and Spain the main exporting countries of copper ores and concentrates are Portugal and Bulgaria.

Table 2: EU-27 mine production, export and import of copper ores and concentrates, gross weight and copper content from 2004 to 2008 (in thousand metric tonnes),

		2004	2005	2006	2007	2008
EU-27 mine production		841.7	821.5	805.7	742.3	708.8
EU-27 export	Gross wt	46.6	27.8	40.1	136.8	144.5
	Cu content	14	8.3	12	40.6	43.4
EU-27 import	Gross wt	2435.6	2681	2788.1	3339.5	3419.9
	Cu content	730.7	804.3	836.4	1001.9	1026
Data for export and import from 2004, 2005 and 2006 are only for the EU-25. Data for export and import from 2008 are preliminary (incomplete).						

Source: ICSG, 2009b and 2010c.

### 2.2.2 Copper production

In 2008, 67% of refined copper came from primary production, and 33% from secondary production in the EU-27 (ECI, 2011).

Copper results from two sources:

1. primary production: extraction and processing (refining) of the raw mined material
2. secondary production, originating from:
  - direct melt of 'new scrap' (waste resulting from the manufacturing process)
  - recycling of end-of-life products, using 'old scrap'.

Primary copper production can rely on two processes.

- The first process is based on the extraction of copper-bearing ores. After the ore has been mined, it is crushed and ground followed by a concentration by flotation. The obtained copper concentrates typically contain around 30% copper. In the subsequent smelting process, copper is transformed into a 'matte' containing 50-70% copper. The molten matte is processed in a converter resulting in a blister copper of 98.5-99.5% copper content. In the next step, the blister copper is fire refined in the traditional process route, or, increasingly, re-melted and cast into anodes for electro-refining. The output of electro-refining is refined copper cathodes, assaying over 99.99% of copper.
- Alternatively, in the hydrometallurgical route, copper is extracted from mainly low grade oxide ores and also some sulphide ores, through leaching (solvent extraction) and electrowinning, called the SX-EW process. The output is the same as through the electro-refining route-refined copper cathodes.

The next step in the production chain is the production of **refined** copper. When based on mine production materials (from metallurgical treatment of concentrates or from SX-EW), this process is still part of the '**primary copper production**', since obtainable from a primary raw material source.

Another important source of raw material is copper scrap. This scrap from either metals discarded in semis<sup>3</sup> fabrication, finished product manufacturing processes ('new scrap') or obsolete end-of-life products ('old scrap'). Upon utilisation of scrap, the refining process is referred to as '**secondary copper production**'. Secondary producers use processes similar to those employed for primary production. The ICSG estimates that in 2008, at the producers and manufacturers level, secondary copper refined production reached around 15% of total refined copper production in the world. In 2008, 40 % of all the copper used in the EU-27 came from recycling, compared with 38% in 2007.

World primary refined production in 2008 was 15.5 million tonnes and the secondary refined production was 2.8 million tonnes (ICSG, 2010d). The world copper production by smelters and refiners is shown in Figure 3. The world's major producer is China, accounting for 20% of copper production, followed by Chile with 17% and the European Union with 14%.

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<sup>3</sup> 'Semi' is a term used for intermediate products for the copper industry, i.e. not for final use, for instance ingots or billets by various processes, such as rolling, extruding, drawing, casting and forging.

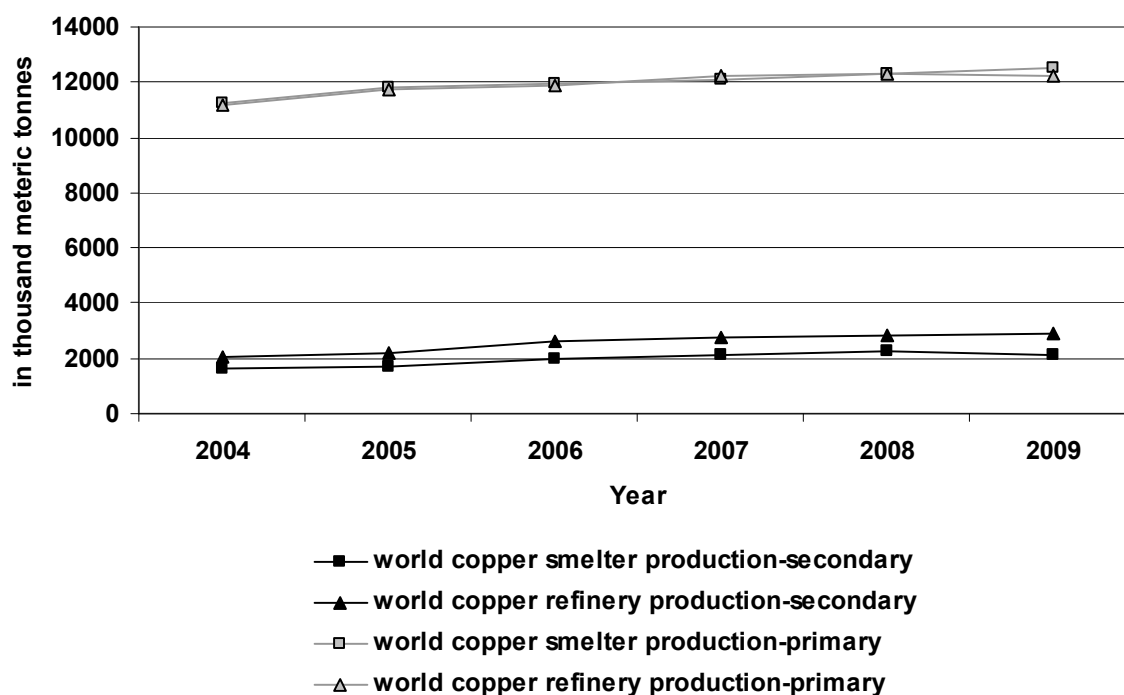


Figure 3: World copper production, primary and secondary by smelters and refiners.  
Source: ICSG, 2010c.

The production of copper in the EU-27 from 2004 until 2009 is summarised in Table 3. The table includes the production by primary and secondary smelters, primary refined copper production and secondary refined production. The scrap that is recycled and enters into production at the next level, at the level of semis producers or 'first users' of refined copper, is designated as direct melt scrap.

Table 3: Total production of copper in the EU-27 (in thousand metric tonnes).  
(\* ) Estimated number by ICSG.

	2004	2005	2006	2007	2008	2009
Refinery Primary	1604	1662	1650	1623	1706	1673
Refinery Secondary	809	771	822	800	857	830
Refinery SX-EW	1	0	1	3	3	8
Smelt Primary	1597	1598.8	1500.1	1450.1	1549	1437
Smelt Secondary	559.8	527	630.4	595.9	663	656
Direct melt scrap*	1353	1228	1271	1242	1150	NA
NA=not available						

Source: ICSG, 2010c.

The production of secondary copper in the EU-27 from 2004 until 2008 was stable (see Table 3) with a slight increase in secondary smelting and a slow decrease in direct melt scrap.

### 2.2.3 Copper use

Copper usage is, after iron and aluminium, third in the world and has grown steadily, in line with the evolution of copper production.

The world refined use in 2008 was 18 million tonnes. Growth in refined copper use has been especially strong in Asia, where demand has expanded more than fivefold in less than 30 years (Figure 4).

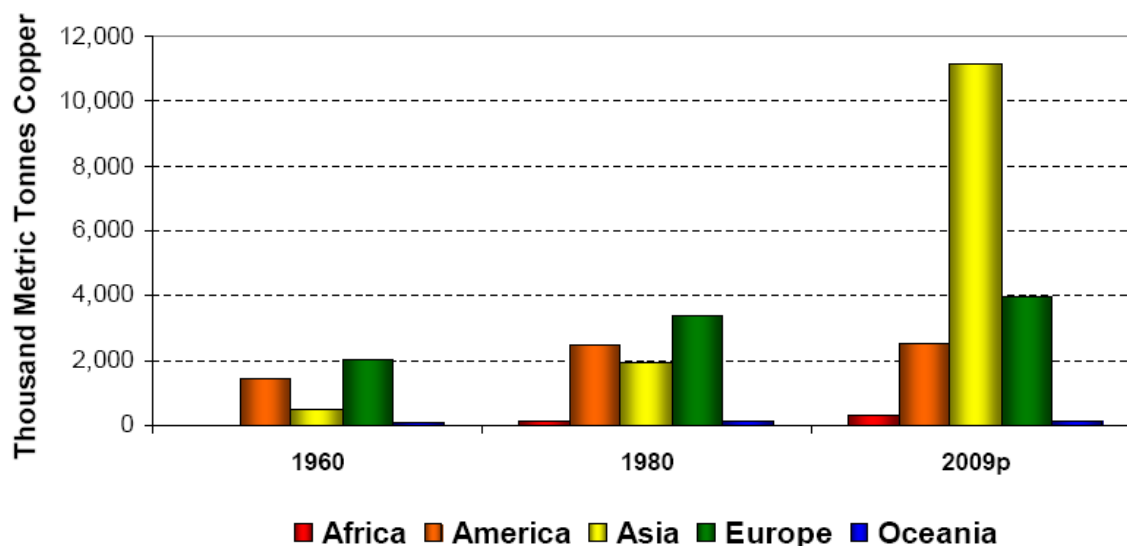


Figure 4: Refined copper use by region (data for 1960, 1980 and (p) projected data for 2009).  
Source: ICSG, 2010b.

Copper is delivered to users mainly as cathode, wire rod, billet, cake (slab) or ingot. Through extrusion, drawing, rolling, forging, melting, electrolysis or atomisation, producers form wire, rod, tube, sheet, plate, strip, castings, powder and other shapes. These copper and copper alloyed products are then shipped for final manufacturing or distribution. Final copper use can be classified into following categories: electrical, electronics and communications, construction, transportation, industrial machinery and equipment and consumer and general products.

#### **Electrical**

Because of its good conductive properties, copper is used in power cables, either insulated or non-insulated, for high, medium and low voltage applications. In addition, copper's strength, ductility and resistance to creeping and corrosion make it a valuable conductor for commercial and residential building wiring. Copper is an essential component of generators, motors and transformers as well.

#### **Electronics and communications**

Copper plays a major role in worldwide information and communications technologies. Copper cables, e.g. telephone lines, can be used for low and high speed data communication. Furthermore, copper and copper alloy products are used in wide and local area networks, mobile phones and personal computers. Copper is also used in other electronic equipment such as copper heat sinks, wires, transformers, connectors and switches.

**Construction**

Copper and brass are extensively used for plumbing, taps, valves and fittings. Furthermore, copper is used for building facades, canopies, window frames, roofing and ornaments.

**Transportation**

Automobiles and trucks contain a substantial amount of copper (around 1.5%). Copper and copper alloys are also used in trains, ships and airplanes.

**Industrial machinery and equipment**

Because of their durability, machinability and ability to high-precision casting, copper alloys are used for the production of gears, bearings and turbine blades. Thanks to copper's good heat transfer properties and strength, heat exchange equipment, pressure vessels and vats are made of the metal. The corrosion resistance of copper and copper alloys makes them suitable for use in marine and other demanding environments.

**Consumer and general products**

Coins of various currencies and denominations contain considerable amounts of copper, e.g. the euro coins. In addition, copper is used in cookware, brassware, locks and keys.

In the EU, the building and construction sector is the largest sector of copper use, absorbing over 30% of the total EU use and therefore represents an important scrap source. The use of refined copper in Europe is shown in Figure 5.

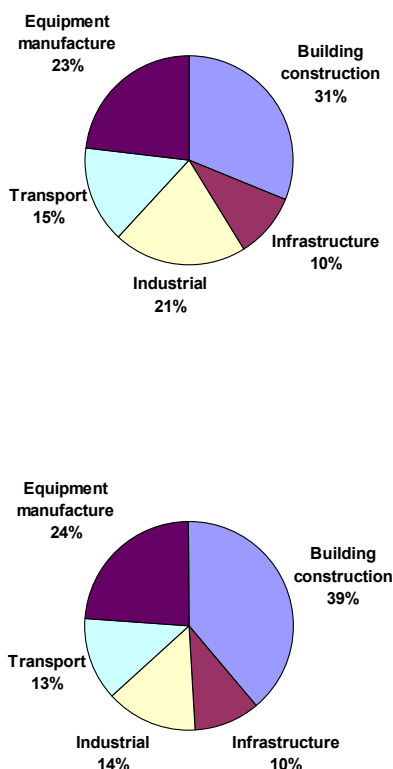


Figure 5: EU main uses of copper in 2008 (left) and 2009 (right). Data based on ECI estimates for Europe, including Western and Eastern Europe, excluding Russia. Source: ECI, 2010.

## **2.2.4 Copper scrap recycling**

Copper scrap or copper alloys scrap is generated during metal product fabrication or when a copper-containing product reaches its end of life.

### **2.2.4.1 Copper scrap origin**

There are two types of copper scrap: new scrap and old scrap. New scrap is generated during the initial manufacturing processes, originating from factories that produce articles from copper or copper alloys. Old scrap is collected after a consumer cycle, either separately or mixed, and it is often contaminated to a certain degree, depending highly on origin and collection systems. The main sources of copper/copper alloy scrap and their characteristics are described below.

#### ***Industrial non-electrical equipment waste (INEW) and industrial electrical equipment waste (IEW)***

IEW refers to all electrical and electronic equipment that is not included in the 'WEEE' category falling under the WEEE Directive. It includes brass mill semis and wire and cable applications for infrastructure such as power lines, telecommunication lines, substations, etc. and industrial equipment such as transformers, electrical motors, etc.

The INEW category is a summary group for all remaining applications such as transport, industrial machinery, ordinance, etc.

#### ***Cables***

According to BIR (BIR, 2010), the predominant way of recovering the metal from cable scrap in developed countries is automated cable chopping. This process usually includes pre-sorting, cable chopping, granulation, screening and density separation. The metal content of residue streams can vary from less than 1% to more than 15%. If a dry electrostatic system or wet separation (e.g. cyclones, tables) is used, the metal content may be reduced to less than 0.1%, which will consequently increase the value of the recovered plastic. In general, the overall metal recovery is around 94-99%.

A less costly and as environmentally sound process for material separation is cable stripping, but it is a process with much lower throughput. Cable stripping machines are also used in most developed countries by utilities, cable manufacturers, cable chopping companies and metal scrap dealers. The advantages of stripping, in contrast to chopping, is the purity of the recovered jacketing and insulation materials. They are completely free of conducting metal and, if the user is careful in segregating the cable scrap before it is processed, the tailings can consist of one type of polymer. This way, the tailings, both metal and polymer, become more easily recyclable.

Another treatment for cable recycling is provided by red melting furnaces (e.g. Kaldor furnace, Isasmelt furnace, etc.), which use the plastics from insulation to supply process heat. Using cable scrap, printed circuit boards and other metal-containing residues as feed materials, these furnaces produce precious and base metal-containing mattes that are further treated for recovery in smelters (Lehner, 2000).

#### ***Construction and demolition (C&D)***

The average metal content of construction and demolition waste (C&D) in Western Europe can be estimated to be around 3.5% (ICSG, 2005) of which copper and copper alloy account for about 0.3%.



Regulation and standards related to construction and demolition have been developed in the past mostly in favour of selective demolition, which has been proven to be most effective for recycling various types of waste streams. For cost reasons, metal scrap is separated whenever possible along the dismantling process and is sold for direct reuse or to traders or treatment plants.

***Waste from electrical or electronic equipment (WEEE)***

The WEEE Directive requires the responsibility of producers in recycling and waste prevention. However, users and local authorities play an essential role in waste collection and separation. The WEEE Directive also requires that hazardous components, such as batteries, printed circuit boards, liquid crystal displays, etc. be removed with proper technologies. This is done at different stages of the treatment process depending on the implementation of the Directive in Member States.

After depollution, WEEE consists chiefly of a mixture of metal, plastics and glass. From here, the treatment of WEEE in general has the following steps, though the process may vary with different combinations of shredding, granulating, magnetic separation, and eddy current separation. There is also the possibility of density separation on the separation table and/or hand separation.

WEEE contains a diverse range of materials such as ferrous metals (~48% on average), non-ferrous metals (~12%), plastics (~20%), glass (~5%) and others (ICSG, 2005). Copper can be found in the form of insulated cables, winding wire, connector strips, etc. According to Taberman (Taberman, 1995) the average copper content of WEEE is estimated to be 7% by weight.

***End-of-life vehicles (ELV)***

The treatment of ELV usually includes depollution, selective dismantling, and size-reduction via shredders. The resulting fractions after shredding are: the steel fraction, the non-ferrous metal fraction and the automobile shredder residue. Copper is recovered from the non-ferrous fraction in media/metal separation plants by using eddy-current separation, sink-float techniques, etc. Based on the outlined average weight and copper/alloy content, the 11.5 million vehicles deregistered in Western Europe would correspond to a gross weight of 15 million tonnes containing 210 000 tonnes of copper and alloys (ICSG, 2005).

An overview of the common types of copper and copper alloys scraps and their sources are shown in Table 4 and Table 5. Table 4 shows different types of copper and copper alloy materials and the typical range of their copper content. Table 5 shows usual scrap types and their typical composition of metals as well as other materials.

**Background information on copper and copper alloy scrap**

**Table 4: Overview of copper secondary starting materials, input materials for the production of secondary copper.**

<b>Type of materials</b>	<b>Cu content (wt-%)</b>	<b>Sources</b>
Mixed copper sludges	2-25	Electroplating
Computer scrap	15-20	Electronics industry
Copper mono-sludges	2-40	Electroplating
Copper-iron material (lumpy or comminuted) from armatures, stators, rotors, etc.	10-20	Electrical industry
Brass dross, ashes and slags that contain copper	10-40	Foundries, semi-finished product plants
Red brass dross, ashes and slags that contain copper	10-40	Foundries, semi-finished product plants
Shredder material	30-80	Shredder plants
Copper-brass radiators	60-65	Cars
Mixed red brass scrap	70-85	Water meters, gear wheels, valves, taps, machine components, bearing boxes, propellers, fittings
Light copper scrap	88-92	Copper sheets, eaves, gutters, water boilers, heaters
Heavy copper scrap	90-98	Sheets, copper punching, slide rails, wires, pipes
Mixed copper scrap	90-95	Light and heavy copper scrap
Copper granules	90-98	Cable comminution
Pure No. 1 scrap	99	Semi-finished products, wire, cuttings, strip

*Source: Rentz 1999.*

**Table 5: Copper and copper alloy scrap types, general range in compositions (in percent metal content).**

Scrap type	Copper		Tin		Lead		Zinc		Aluminium		Nickel/cobalt		Manganese		Other	
	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High
<b>Unalloyed copper scrap</b>																
No 1. copper	99.00	99.90														
No 2. copper, mixed, light	94.50	99.00														
Other	94.00	99.00														
<b>Copper-based alloy scrap</b>																
Red brass	87.00	98.00	0.20	0.35	0.10	3.00	2.00	12.00	0.00	0.01	0.05	1.00			0.03	0.08
Leaded red & semi-red brass	75.00	86.00	2.00	6.00	3.50	7.00	4.00	17.00	0.01		0.30	2.00			0.10	0.40
Yellow, leaded and heavy brass	57.00	75.00	0.70	2.00	0.20	5.00	20.00	41.00	0.01	8.00	0.20	1.00	0.20	0.50	0.01	0.80
Yellow & low brass, and other copper-zinc brasses	65.00	82.43			0.02	0.30	17.50	31.50							0.05	0.10
Copper/nickel/zinc alloys	42.00	73.50	1.50	5.50	0.03	11.00	1.00	25.00	0.00	0.01	4.00	27.00	0.50	2.50	0.15	1.50
Copper/nickel alloys	62.27	97.90			0.01	0.03	0.00	1.00			2.00	33.00	0.05	2.50	0.05	1.20
High leaded tin bronzes	45.50	91.50	1.50	14.00	7.00	34.00	0.00	4.00	0.00	0.01	0.00	1.00			0.00	1.50
Tin brasses	57.00	88.00	0.25	4.00	0.05	2.50	3.75	42.70	0.00	0.10	0.00	0.50	0.00	0.15	0.00	1.00
Tin bronze/phosphor bronze	71.19	93.00	6.00	20.00	0.25	0.50	0.25	5.00	0.01	0.01	0.50	2.00	0.00	0.10	0.00	1.20
High coppers <sup>(1)</sup>	93.88	99.98	0.00	0.10	0.00	0.02	0.00	0.10	0.00	0.15	0.00	3.00			0.02	2.75
Manganese bronze	35.60	68.00	0.50	1.50	0.20	0.40	22.00	42.00	0.50	7.50	0.00	4.00	0.10	5.00	0.40	4.00
Aluminium bronze <sup>(2)</sup>	71.00	88.00			0.00	0.05			6.00	13.50	0.00	5.50	0.00	14.00	0.05	5.00
Silicon bronze & brass	63.00	94.00	0.00	0.25	0.15	1.00	0.25	36.00	0.00	0.80	0.00	0.20	0.00	1.50	0.00	0.20
<b>Common scrap groups</b>																
Water meters	62.00	65.00			0.80	1.50	33.00	36.40	0.00						0.15	0.15
Auto radiators (ocean)	68.00	70.00	3.00	5.00	7.00	12.00	10.00	15.00								
Cocks & faucets <sup>(3)</sup> (Grape)	65.00	77.00	0.00	2.00	2.00	6.00	15.00	33.00			x				x	
Cartridge cases and brass	68.50	71.50			0.07	0.07	28.40	31.40								
Refinery brass <sup>(4)</sup> (drink)	61.30															39.00
Aluminium/copper radiators		45.60				0.02				54.00		0.05				0.20
Copper-bearing material	20.00	60.00													40.00	80.00

(1) Be, Cd, Cr coppers, (2) Al, Fe, Ni alloys, (3) Mixed red and yellow brass plumbing fixtures, including nickel/chrome-plated. Free of zinc die-cast and aluminium parts, (4) Limit 5% iron, including copper, brass and bronze-alloyed metal.

Source: Copper Development Association, ISRI, U.S. Bureau of Mines, 1989.

### **2.2.4.2 Copper scrap processing**

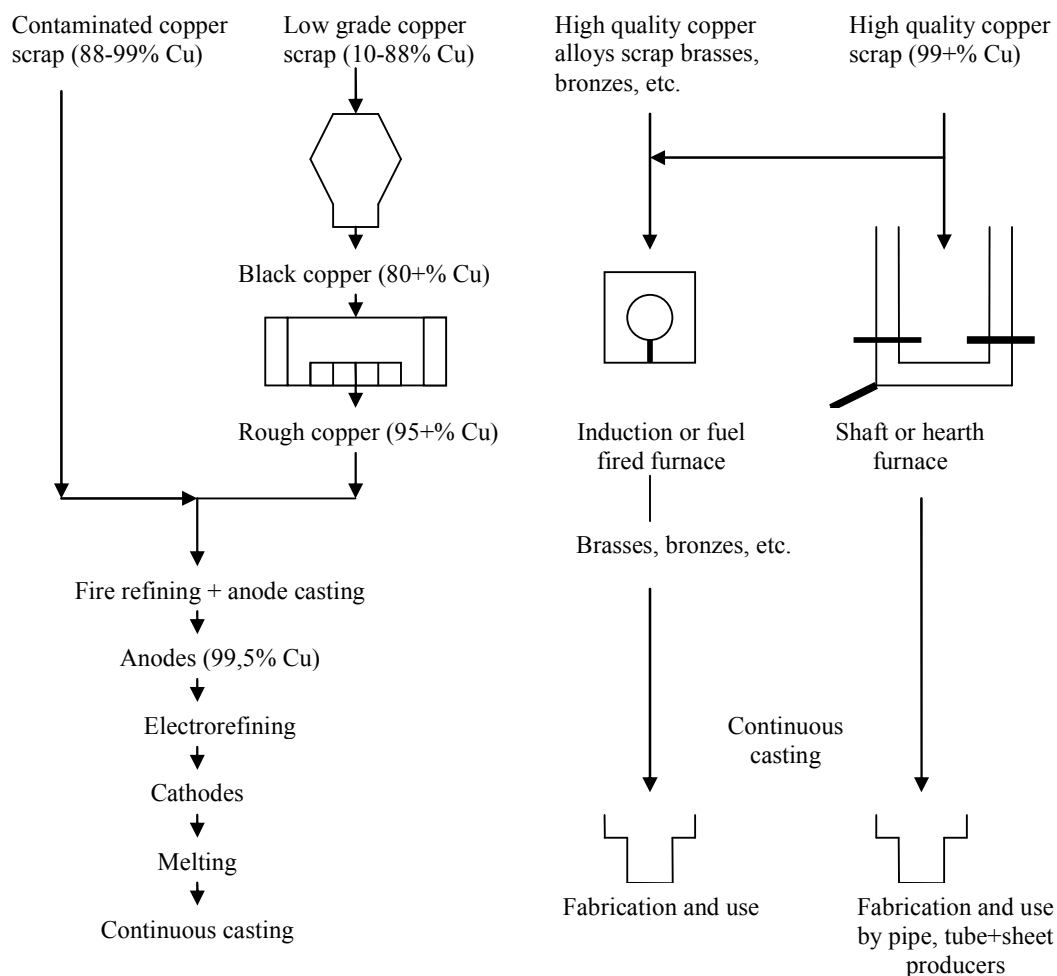
For an effective use of scrap, it needs to be collected and sorted according to different levels of purity. Scrap before use must be prepared and analysed prior to processing to alter its shape and size and/or its purity.

Scrap processing is achieved through manual, mechanical, pyrometallurgical or hydrometallurgical methods.

- Manual and mechanical methods include sorting, shredding and magnetic separation. The scrap can then be pressed into briquettes by a hydraulic press.
- Pyrometallurgical pretreatment includes sweating, burning insulation from copper wire and drying in rotary kilns to volatise oil and other organic compounds.
- Hydrometallurgical pretreatment is mainly related to the low quality of residues and includes floating (if slag contains over 10% copper) and leaching to recover copper from slag.

Copper scrap is used by the primary and secondary smelters, refiners and producers to generate various copper products but it is also used for the production of chemicals in the fertiliser industry.

Copper scrap treatment depends on its purity (Figure 6). The lowest grade scrap is smelted and refined like concentrate in a primary or secondary smelter/refinery. Higher grade scrap is fire refined, then electrorefined. The highest grade scrap is often melted and cast without refining.



**Figure 6: Flow sheet of processes for the recovery of copper and copper alloys from scrap. Low grade scrap is usually smelted in shaft furnaces but also in other furnaces, e.g. electric.**  
 Source: Davenport et al., 2002.

If scrap consists only of one alloy composition, it is easier to remelt into a good quality product, however there may have to be some adjustment of composition on remelting. When scrap is remelted, it is more difficult to adjust the composition within the limits of a chosen specification when the scrap is mixed, contaminated or includes other materials.

When lead or tin are included, it is usually possible to adjust the composition by the addition of more lead or tin to make leaded bronzes. For some scrap contaminated with undesirable impurities, it is sometimes possible to dilute it when melting so that the impurity level comes within an acceptable specification. Where scrap is contaminated beyond acceptable limits it is necessary to re-refine it back to pure copper using conventional secondary metal refining techniques that provide a useful supplement to the supplies of primary copper.

Electrical grade scrap must never be mixed with any of the lower purity grades such as plumbing tube scrap because the latter contains higher amounts of phosphorus, which drastically reduces the electrical conductivity. The lower grades of scrap can be used to make copper alloys or chemicals. Alloy scrap (brass, bronze) is melted and cast as alloy. There is no advantage to smelting/refining it to pure copper.

Brass (for extrusion and hot stamping) is usually made from a basic melt of scrap of similar composition adjusted by the addition of virgin copper or zinc. Brass scrap from machining

operations can be economically remelted but should be substantially free from excess lubricants, especially those including organic compounds. When brass is remelted, there is usually some evolution of the more volatile zinc. Brass to be made into sheet, strip or wire form must be significantly free of harmful impurities in order to retain ductility when cold. It is normal to make it mainly from virgin copper and zinc, together with process scrap arising from processing that has been kept clean, carefully segregated and identified.

Copper alloys such as phosphor bronzes, gunmetal, leaded bronzes and aluminium bronzes are normally made to closely controlled specifications in order to ensure fitness for demanding service. They are normally made from ingots of guaranteed composition together with process scrap of the same composition that has been kept carefully segregated. Where scrap has become mixed, or is of unknown composition, it is first remelted by an ingot maker and analysed so that the composition can be suitably adjusted to bring it within grade for an alloy.

***Secondary smelting***

For the low and medium grade material, the furnaces used include the blast furnaces, mini smelters, top blown rotary furnaces (TBRC), sealed submerged arc electric furnaces, Ausmelt/ISA smelt furnaces (KRS or Kayser recycling system) and reverberatory furnaces. Contimelt systems are used for high grade copper scrap (>99 % Cu) (European IPPC Bureau, 2009). An overview of secondary copper smelting techniques is shown in Table 6.

**Table 6: BAT for secondary copper smelting techniques.**

<b>Technique</b>	<b>Raw materials</b>
Blast furnace	Low grade material
Submerged arc electric furnace	Electronic scrap Some raw material restrictions
Mini Smelter	Irony material
TBRC	Range of material including particulate matter
Ausmelt/ISA Smelt	Mixed primary and secondary
KRS smelter	Mixed secondary material Electronic scrap
Converter	Black copper Copper alloys
Hearth shaft furnace	Higher grade scrap, anode and blister copper
Contimelt process	Higher grade scrap, anode and blister copper
Reverberatory hearth furnace	Higher grade scrap, and blister copper

*Source: European IPPC Bureau, 2009.*

***Converting, fire-refining, electrorefining***

Converting and refining furnaces are for the secondary copper production the same as those used for primary production and the slag treatment systems and electrorefining processes also evolve in the same way. The main difference is that converters used for secondary production treat metal and not matte. Secondary converters also oxidise and slag minor elements like iron and separate other metals like zinc or tin by volatilisation. They produce a converter copper in a quality that suits fire-refining. The heat of the reaction when air is blown into the converter is used to volatilise metallic components and slagging agents are used to remove iron and some lead. Fire-refining furnaces are also used to melt higher grade scrap. There are potential sources of diffuse emissions from secondary converters.

Copper alloys such as bronzes and brasses are used as well as secondary raw materials in a number of processes. If they are impure or are mixed with other alloys, they are processed in the secondary smelting and refining circuits.

The pure alloy is used directly for semis fabrication. Induction furnaces are used to melt the clean material followed by casting into shapes suited for the further fabrication step.

***Wire-rod production***

Wire-rod is manufactured from high purity electrorefined copper cathodes. However, in the case of the southwire process, shaft furnaces are used where the copper cathodes and other pure copper scraps are melted.

***Semi-finished production***

Copper and copper alloy (copper cathode, copper and copper alloys scrap) are melted and cast for the production of shapes suited to the further fabrication steps. The first stage consists of the melting phase where an electric or induction furnace is used. The second stage is the casting where billets and cakes/slabs are produced and processed further. The last stage is the fabrication of tubes, sections and rods.

***Production of ingots***

Copper or copper alloys ingots are produced for the foundry industry using a fixed mould casting process. The production of ingots requires an accurate alloy composition. Copper or copper alloys can be melted in batches in rotary furnaces (used for dirtier scrap) or induction furnaces.

**2.2.4.3 Copper scrap use**

In 2007, 8.2 million tonnes of copper recyclables were used globally by the copper industry. In Europe about 2.5 million tonnes of copper recyclables were used (Table 7).

**Table 7: Global copper recyclables use from 2004 until 2007 in thousand metric tonnes.**

	2004	2005	2006	2007
Europe	2595	2455	2650	2546
EU-27*	2162	1999	2093	2042
Americas	1252	1339	1419	1427
Asia	3398	3541	4011	4179
Africa & Oceania	51	55	48	60
World total	7301	7399	8133	8220
*Calculated as direct melt plus secondary refinery production in the EU-27				
<i>Source: ICSG, 2009 and 2010c.</i>				

## Background information on copper and copper alloy scrap

The quantities and qualities of scrap used by different EU producers of copper/copper alloys are summarised in Table 8 (ECI, 2010). The table uses estimated data based on the total purchase of ECI members which are lower than data for the EU-27 because many producers and ingots makers' scrap purchases were not surveyed. The total scrap use in the EU-27 is based on ICSG data (ICSG, 2009 and 2010b). Refined copper production attributable to recycled scrap feed is classified as 'total scrap use'<sup>4</sup>.

It should be noted that Table 8 uses other standards (EN standard) than Table 5 (ISRI) for classification. EN standards are detailed, but only concern high quality scrap, whereas ISRI specifications cover all types of copper scrap, but are only detailed on some grades. The different specifications and standards are discussed in a dedicated section below in the document.

Based on the data presented in Table 8, it could be assumed that more than 50% of the scrap used by ECI members (refiners and semiproducers) in Europe is of high quality with a metal content of >98%. Refiners use about 17% of copper/copper alloy scrap with <2% of foreign materials, the main consumers of copper/copper alloy scrap with <2% foreign materials are semiproducers. More than 76% of the scrap used by semiproducers is high quality scrap with <2% foreign materials.

**Table 8: Scrap grades used by different producers, as estimated by ECI.**

Grade	Primary user	End-product	EN 12861: 1999 standard	Foreign materials (%)	A Refiners/Smelting (I and II) (t/year)	B Semi producers (pure and alloys) (t/year)	A+B Total purchase ECI Members (t/year)	Total scrap use EU27 (t/year)
High	Semi producers	Semi-finished products (rod, tube, wire, strip)	S-CU-1 to S-Cu-7 and S-Cu-10	< 2	90 000	380 000	470 000	660 000
Medium	Primary refiners	Cathodes	S-Cu-8 and S-Cu-9	8 < > 2	470 000	0	470 000	560 000
High (alloy)	Semi producers (alloy)	Semi-finished alloys	S-CuZn-1 to S-CuZn-4, Annex D and E	< 2	20 000	390 000	410 000	540 000
Medium (alloy)	Ingot makers and semi producers	Ingots and semi-finished products	S-CuZn-5 to S-CuZn-7	9 < > 2	40 000	240 000	280 000	480 000
				TOTAL	620 000	1 010 000	1 630 000	2 240 000

*Source: ECI, 2010.*

Figure 7 shows a simplified copper flow model based on available information about copper production, fabrication, copper scrap use, imports and exports. Currently, much of the information about copper flow in the EU-27 is not complete particularly with regard to the quality and amount of scrap used by different producers of copper/copper alloys. The information presented in

<sup>4</sup> Copper use represents refined copper used by semiproducers, i. e., at wire-rod mills, brass mills, foundries, chemical plants and other miscellaneous manufacturers. Estimated apparent use is calculated by using the following formula: *Refined copper production+refined imports-refined exports+refined beginning stocks-ending stocks* (ICSG, 2010c).



Figure 7 is only indicative, referring to the data from 2007, which were obtained from several sources by the ICSG and the ECI.

All numbers in

Figure 7 under the production part refer to the primary or secondary production of copper in thousand metric tonnes. The direct melt of 1242 thousand tonnes under the fabrication part refers to the copper amount which was directly melted in 2007. The data for the quality of copper scrap presented in Table 8, which underwent a different production process (smelter, refinery, producers) are based on estimations by different stakeholders and experts from the copper businesses. The estimated numbers presented in

Figure 7 refer to the copper recyclable use that was calculated as direct melt plus secondary refinery production, which was estimated at 2042 thousand metric tonnes in 2007 (Table 7). The copper/copper alloy scrap imported and exported is stated as gross weight of scrap. The numbers in red refer to the copper content of the scrap imported/exported. These numbers were estimated based on the information about the scrap quality (Table 9). The number referring to the copper availability was estimated based on the previous assumptions and is 2192 thousand tonnes (Table 10).



Some data in the flow model are not included such as what amount from the different scrap categories is used by different copper/copper alloys producers. The major unalloyed scrap categories following the ISRI specifications are No1 copper (with common names such as Barley, Berry, Candy and Clove), which is high quality scrap and often is simply remelted, and No 2 (with common names Birch, Cliff and Cobra) which usually must be refined. Examples of scrap types with different foreign material content are shown in Figure 8 and Figure 9. In the US during 2007, No 1 copper scrap (43%), yellow and low brass (31%) were used predominantly and No 2 copper scrap (5%) only accounted for a minor share. The remaining scrap sources used were automobile radiators, red brass, cartridge brass, and low-grade ashes and residues. According to the flow chart in the US the No 2 scrap was used for 70% by primary/secondary smelters and for 30% by brass and tube mill casting and copper refineries.

For Europe, it could be concluded that the majority of copper scrap No 1 is used predominantly by remelters and category No 2 scrap by smelters and refiners. In Europe, scrap from category No 2 is generally used more, but the amount is difficult to estimate. Based on the information from the ECI (Table 8) it could be in the range of approximately 40% (in the last column,  $(560\ 000+480\ 000)/2\ 240\ 000$ ).



**Figure 8: Examples of No 2 copper scrap with foreign material content between 5 to 10 %.**  
*Source: Aurubis, 2010.*

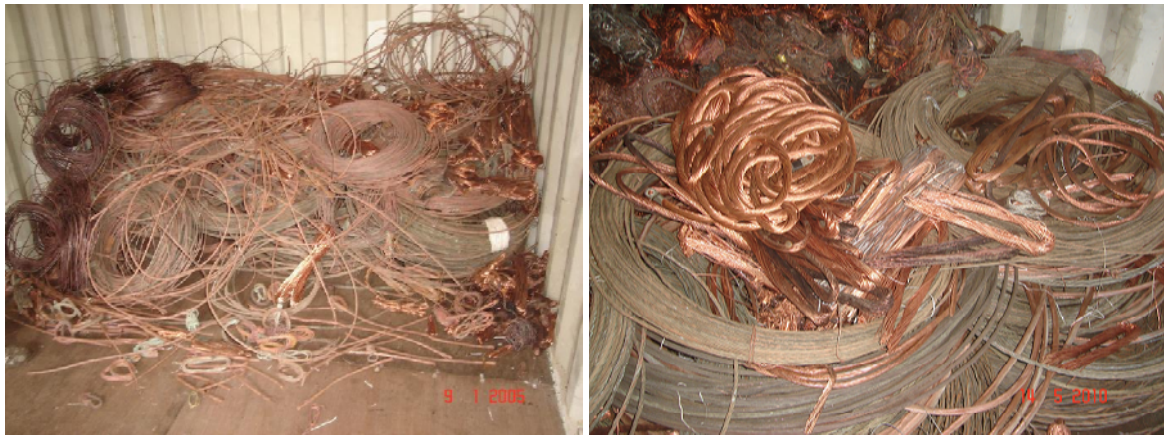


Figure 9: Examples of No 1 copper scrap with foreign material content <2%. Source: Eurometrec, 2011.

## 2.3 Economic data

### 2.3.1 Industry structure

The copper scrap recycling industry consists of scrap collection and sorting, distribution, treatment and processing (Figure 10). Along this recycling chain, scrap is cleaned to become secondary material for final metal production.

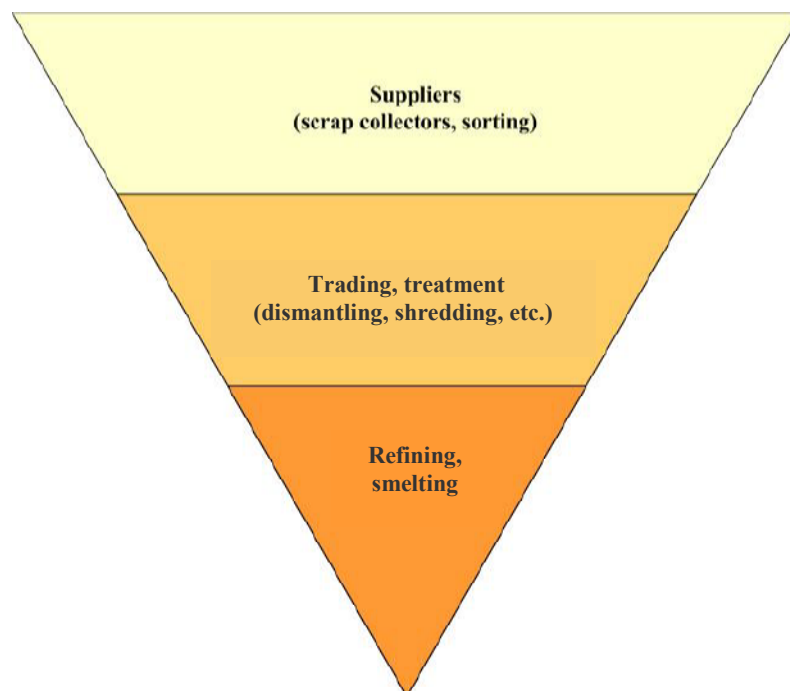


Figure 10: The inverted pyramid structure of the recycling sector.

Collection and sorting of old scrap is organised mainly by individuals rather than companies collecting the copper waste and selling it to small scrap traders. They in turn supply it to medium and large scrap buyers. Large buyers then supply the collected quantities to copper producers. New scrap is usually completely recycled either on site or is sent directly to a remelter/refiner.

There are potentially many scrap collectors, sorters and processors in the EU-27 (over 60,000 enterprises in the ferrous and non-ferrous metals recovery and recycling sectors in the EU-25, employing 500 000 persons).

The structure of the European copper smelting and refining industry (primary and secondary) is as follows (ECI, 2008):

- Atlantic Copper S.A. in Huelva, Spain, capacity 350 000 t/y of new anodes and 250 000 t/year of cathodes
- New Boliden AB with sites in Harjavalta and Pori, Finland and Rönnskär, Sweden, capacity of the Harjavalta copper smelter 165 000 t/year, Pori refinery 125 000 t/year
- Aurubis AG with sites in Hamburg, Germany; Lünen, Germany; Pirdop, Bulgaria and Olen, Belgium
- KGHM Polska Międz S.A. with sites in Głogów (1 and 2) and Legnica, Poland, production of electrolytic copper, anode copper was 1 211 000 t in 2006
- Metallo-Chimique N.V. in Beerse, Belgium with its daughter company Elmet S.L. in Berango, Spain, production of copper anodes, copper-nickel anodes and copper cathodes in 2006 was 138 000 t
- Montanwerke Brixlegg AG, Austria with its daughter company Krompachy, Slovakia, production of copper anodes, cathodes and billets in 2006 was 233 000 t
- Umicore S.A. in Hoboken, Belgium, cathodic copper production in 2006 17 800t.

Note: Metallo-Chimique, Montanwerke Brixlegg and Umicore are pure secondary smelters. Atlantic, Boliden, Aurubis and KGHM are considered primary smelters with some secondary smelting capacities (ECI, 2011).

Regarding the main producers, at the refinery level, the largest plants in the EU (by capacity) that use scrap as an input include Aurubis' Hamburg Refinery in Germany, Aurubis' Olen refinery in Belgium, and Boliden's Rönnskär refinery in Sweden.

Semis producers are considered to be the 'first users' of refined copper and include ingot makers, master alloy plants, wire rod plants, brass mills, alloy wire mills, foundries and foil mills. The largest copper fabricating plants in the EU-27 (in 2008) were (ICSG, 2009):

- Wieland Werke, Vöhringen, Germany with a capacity of 360 000 tonnes (brass mill)
- SCCC, Chauny, France with a capacity of 300 000 tonnes (wire rod plant)
- Trafilerie Carlo Gnutti, Chiari, Brescia Italy with a capacity of 300 000 tonnes (brass mill)
- Aurubis, Olen Belgium with a capacity of 280 000 tonnes (wire rod plant)
- Aurubis, Hamburg Germany with a capacity of 275 000 tonnes (wire rod plant)
- Deutsche Giessdraht (Aurubis and Codelco) in Emmerich Germany with a capacity of 250 000 tonnes (wire rod plant) and MKM Mansferder Kupfer & Messing (Kazakhmys) in Hettstedt Germany, with a capacity of 250 000 tonnes (brass mill) and Diehl, Germany with a total capacity of 90 000 to 180 000 (brass mill), (ECI, 2011)
- KME (around. 10 plants in Italy, France and Germany) with a total capacity of 520 000 to 1 110 000 (brass mill, wire rod, etc.), (ECI, 2011).

2.3.2 Imports and exports of scrap

Copper scrap imports into the EU-27 in the last ten years varied between 200 000 – 400 000 tonnes per year with an increase by 26% between 2004 and 2008. The EU-27 evolved from being a small net importer (around 300 000 tonnes in 2009) of copper scrap to a large net exporter (around 1 200 000 tonnes in 2009).

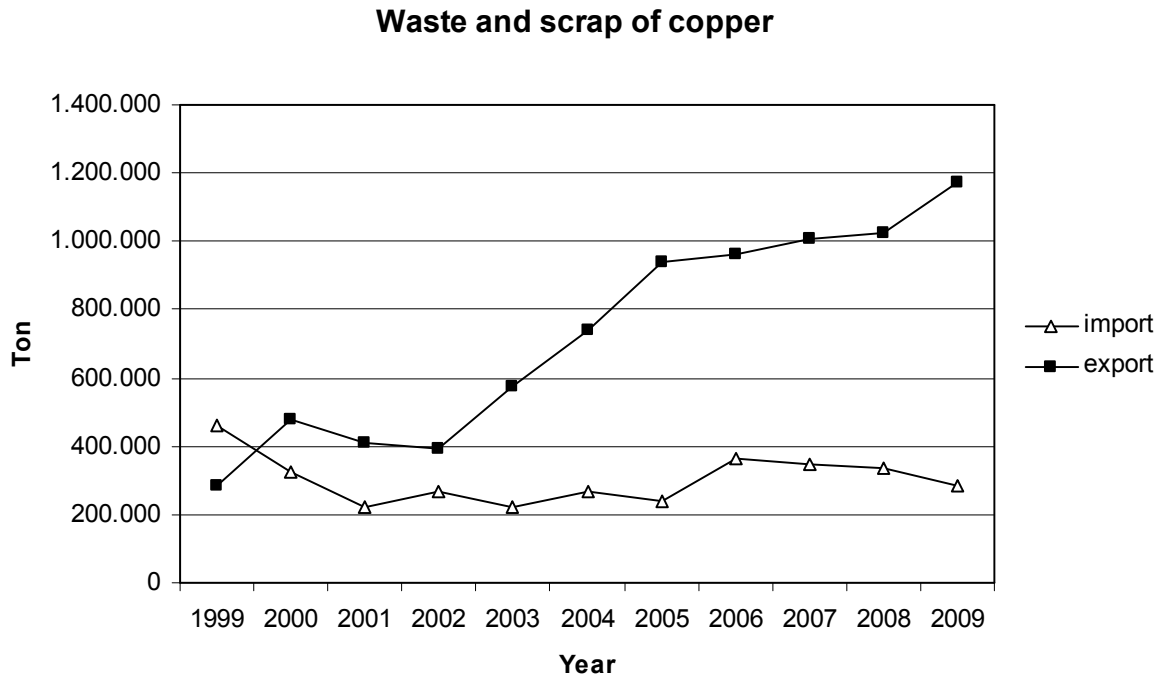


Figure 11: EU-27 copper scrap trade from 1999-2009 (in tonnes) . Source: Eurostat, 2010.

More detailed data about import and export from/to the EU are shown in Figure 12 to Figure 17, based on information from Eurostat.

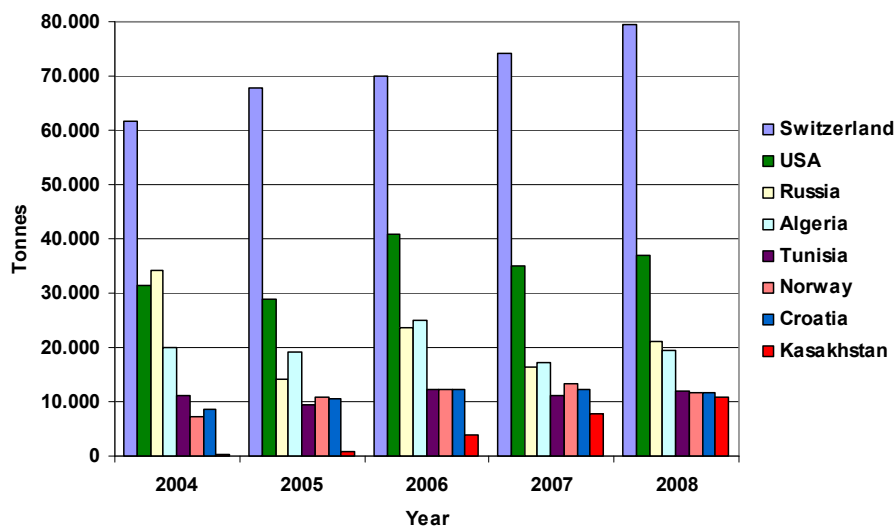


Figure 12: EU-27 copper waste and scrap imports from 2004-2008 by origin. Source: Eurostat, 2010.

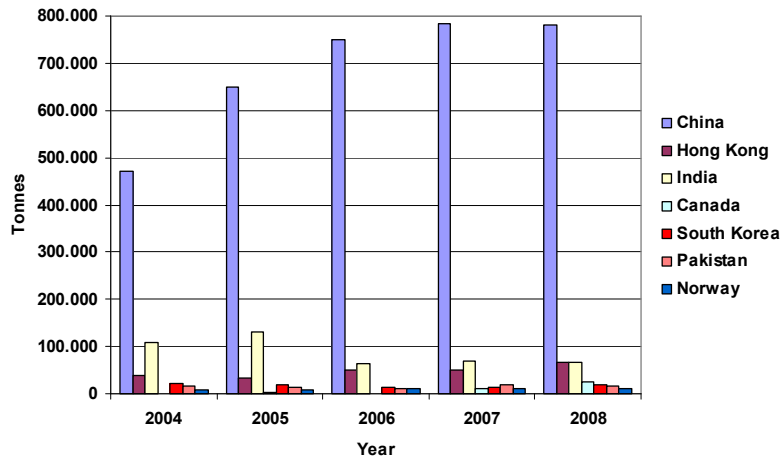


Figure 13: EU-27 copper waste and scrap exports from 2004-2008, destination in volume. Source: Eurostat, 2010.

The main copper/copper alloys scrap exporting and importing countries from/to the EU-27 are shown in Figure 14 and Figure 15. The main recipients of EU scrap are China, Hong-Kong and India which receive 90% of the total EU exports.

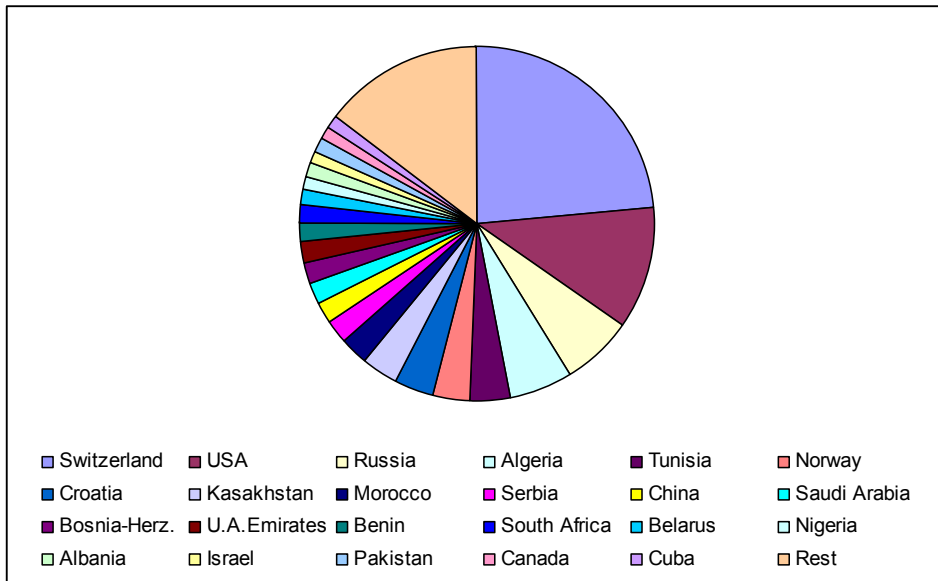


Figure 14: Origins of the imports to the EU-27 in 2008 . Source: Eurostat, 2010.

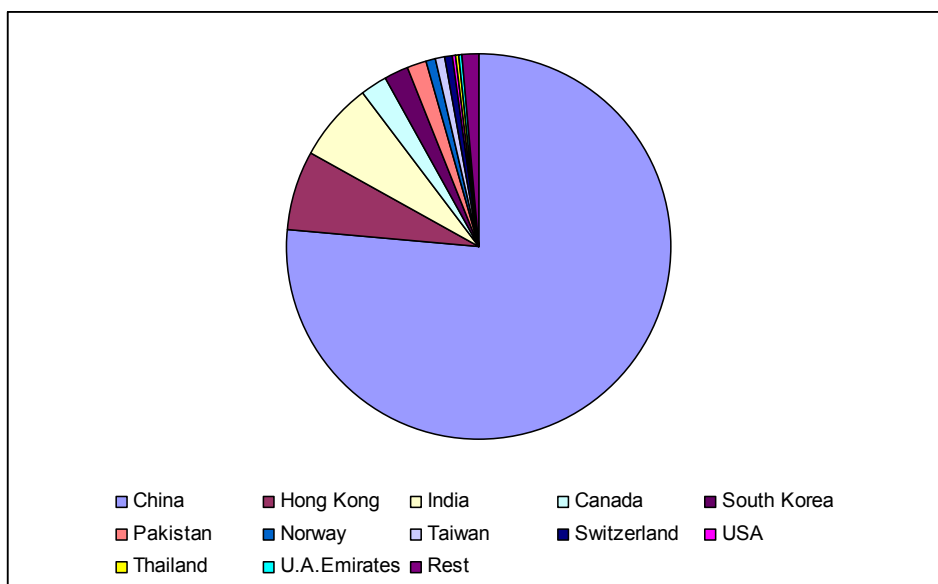


Figure 15: Destinations of exports from the EU-27 in 2008. Source: Eurostat, 2010.

The copper scrap data from Eurostat on imports/exports are divided into three categories (Figure 16 and Figure 17) according to their customs codes. These customs codes are for waste and scrap together, the codes do not differentiate between 'waste' and 'end-of-waste' or 'products'. These three scrap categories do not include any information about the quality of scrap, metal content, copper content, etc.

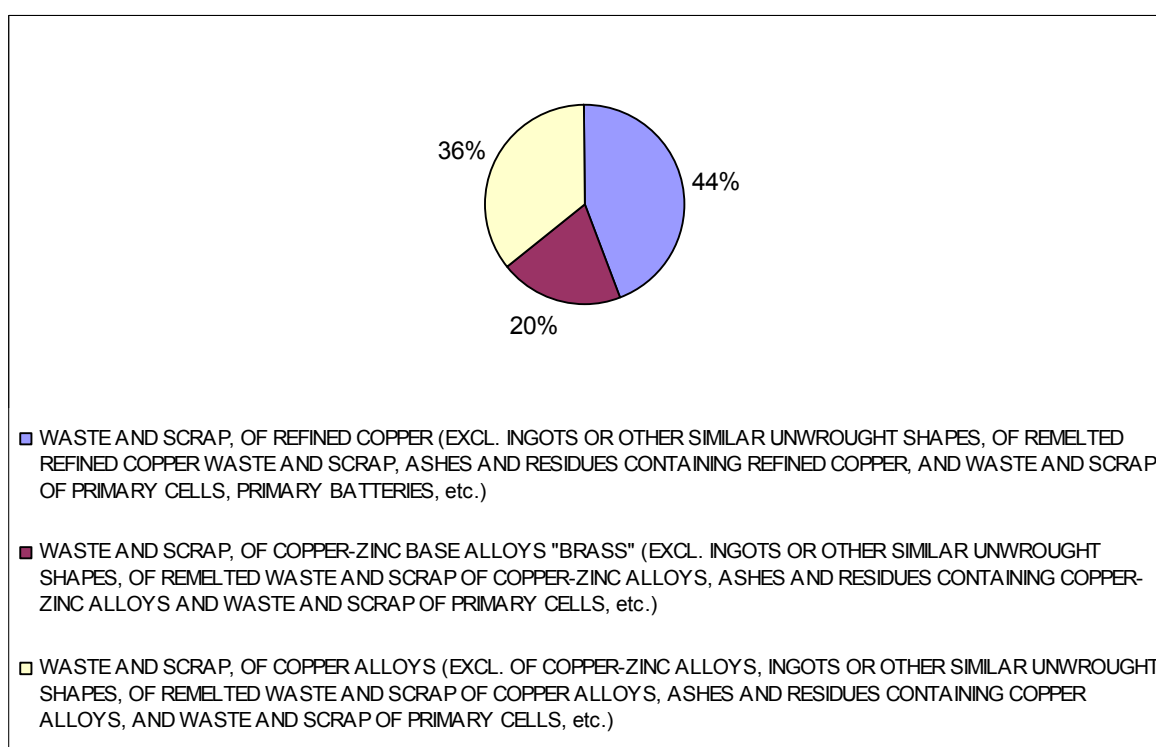


Figure 16: Categories (grades) of copper scrap imported by the EU-27 in 2008. Source: Eurostat, 2010.



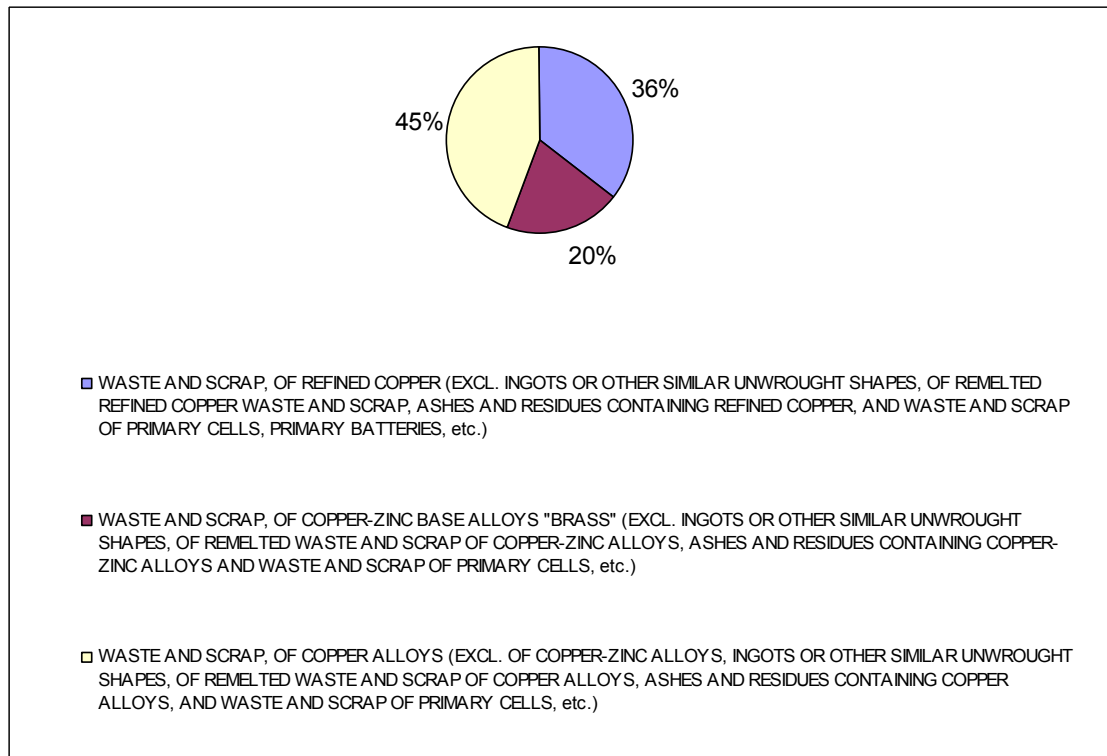


Figure 17: Categories (grades) of copper scrap exported from the EU-27 in 2008. Source: Eurostat, 2010.

In order to determine the average copper content in the scrap exported/imported from/to the EU-27, a calculation was made based on the data series from Eurostat (the amount of scrap exported and imported and the total price of the scrap exported/imported) and based on the average yearly copper prices obtained from the London Metal Exchange. The result of this estimation is shown in Table 9.

Table 9: Estimation of copper content in the copper/copper alloy scrap exported/imported from/to the EU-27.

	Export Cu content (on average from 2004 -2008)	Import Cu content (on average from 2004-2008)
Waste and scrap of refined copper	39%	77%
Waste and scrap of copper-zinc base alloys 'brass'	52%	52%
Waste and scrap of copper alloys other than copper-zinc	36%	59%

Based on estimated average values shown in Table 9, it appears that the imported scrap may have a higher copper content than the copper scrap exported. According to ICSG (ICSG, 2011); China's imported scrap quality from the EU was estimated as 35.4% of copper in the copper/copper alloy scrap. This result also corresponds to an explanation presented by ICSG (ICSG, 2010d) which described that in general, exports from countries with large flows to China present relatively low copper content. The copper content estimated in European exports in 2008 was estimated by the ICSG Secretariat as 51% from Germany, 53% from the scrap leaving Europe via the Netherlands ports, 44% from France exports, 43% from Austria, 32% from the exports leaving the United Kingdom. However it should be noted that the data about scrap amount and quality have certain limitations mainly because of difficulties of

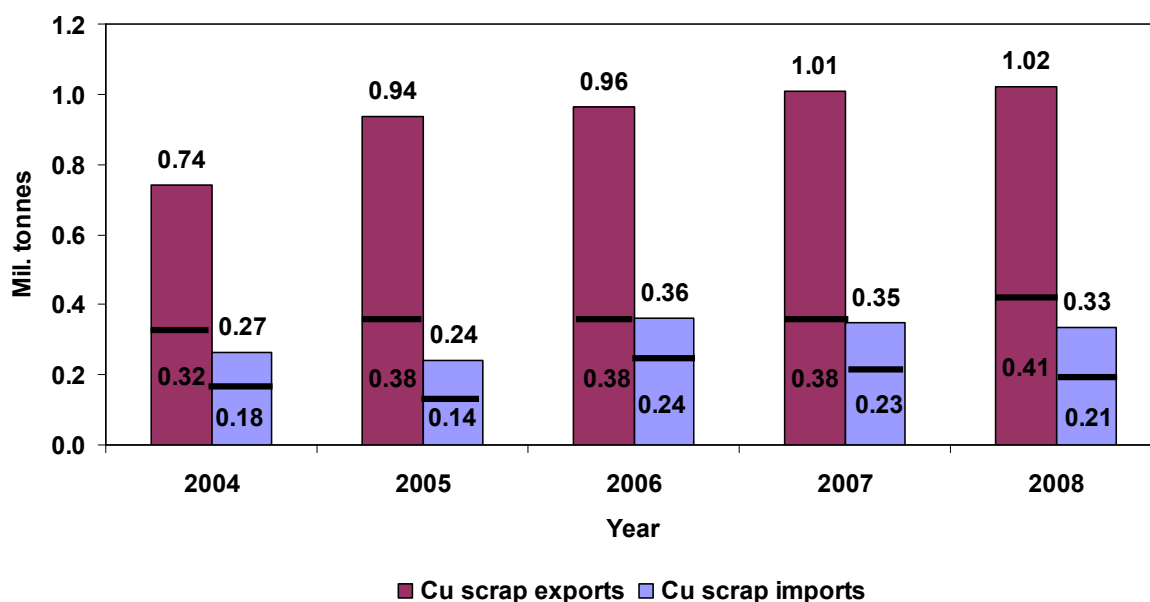
monitoring, and public availability of information on the copper content in reported exports and imports.

The amount of scrap which was exported/imported (Figure 11) does not reflect the actual amount of copper which was exported/imported, because as shown in Table 9 the copper content in copper scrap vary between 36-77% . Thus, in Table 10 the actual copper export/import from/to the EU is estimated. Table 10 also shows the apparent amount that became available for recycling of Cu from scrap that originated in the EU.

**Table 10: Use of copper from copper/copper alloy scrap in the EU-27 in tonnes (own estimation based on ICSG data and LME), and estimated import and export of copper and availability of copper.**

	2004	2005	2006	2007	2008
Copper recyclables use in the EU-27	2 162 000	1 999 000	2 093 000	2 042 000	2 007 000
Import (copper)*	-179 507	-143 398	-242 417	-232 141	-213 603
Export (copper)*	+318 978	+381 488	+375 230	+381 797	+407 794
Availability for recycling	2 301 471	2 237 091	2 225 813	2 191 656	2 201 191
* Value estimated based on the estimated average copper content in the scrap.					

In 2007 it can be estimated that the amount of copper which was exported from the EU-27 was about 19% (381 797 divided by 2 042 000), whereas for the copper imported to the EU this was 11.4% (232 141 divided by 2 042 000) from the total copper recyclable use. For a better illustration of the copper scrap export/import and the actual amount of copper exported/imported in the scrap is shown in Figure 18.



**Figure 18: Copper/copper alloy scrap export/import in total and the amount of copper in copper scrap exported/imported (written in the column under the line).**

According to Eurometrec (Eurometrec, 2010) the following copper scrap categories, according to ISRI specification, are commonly traded both intra and extra EU (Table 11).

**Table 11: The most traded copper/copper alloys scrap categories (intra and extra EU).**

Birch, No 2 copper wire (including Cliff as one grade)	20-40%
Honey, yellow brass scrap	30-40%
Night, yellow brass rod turnings	5-22%
Ocean, mixed unsweated auto radiators	15%
Barley, No 1 copper wire	10%
Berry, No 1 copper wire	10%
Druid, insulated copper wire scrap	10%
Candy, No 1 heavy copper	10%
Drove, copper-bearing scrap	5%
Nomad, yellow brass turnings	5%
Clove, No 1 copper wire nodules	5%
Lake, brass small arms and rifle shells, clean fired	5%
Cocoa, copper wire nodules	5%
Dream, light copper	5%
Label, new brass clippings	5%
Ebony, composition or red brass	1-6%

*Source: Eurometrec, 2010.*

The percentage for each scrap category is only indicative and therefore the above categories do not sum up to exactly 100%.

### **2.3.3 Copper market and prices**

Copper is traded on three commodity exchanges: The London Metal Exchange (LME), the Commodities Exchange Division of the New York Mercantile Exchange (COMEX/NYMEX), and the Shanghai Metal Exchange (SHME).

Over the last 50 years, the copper price went through several price cycles. When recalculating copper prices to a constant dollar value (base=2005), it is seen that prices peaked in the mid-sixties and seventies, but generally declined towards the end of the 20th century (Figure 19).

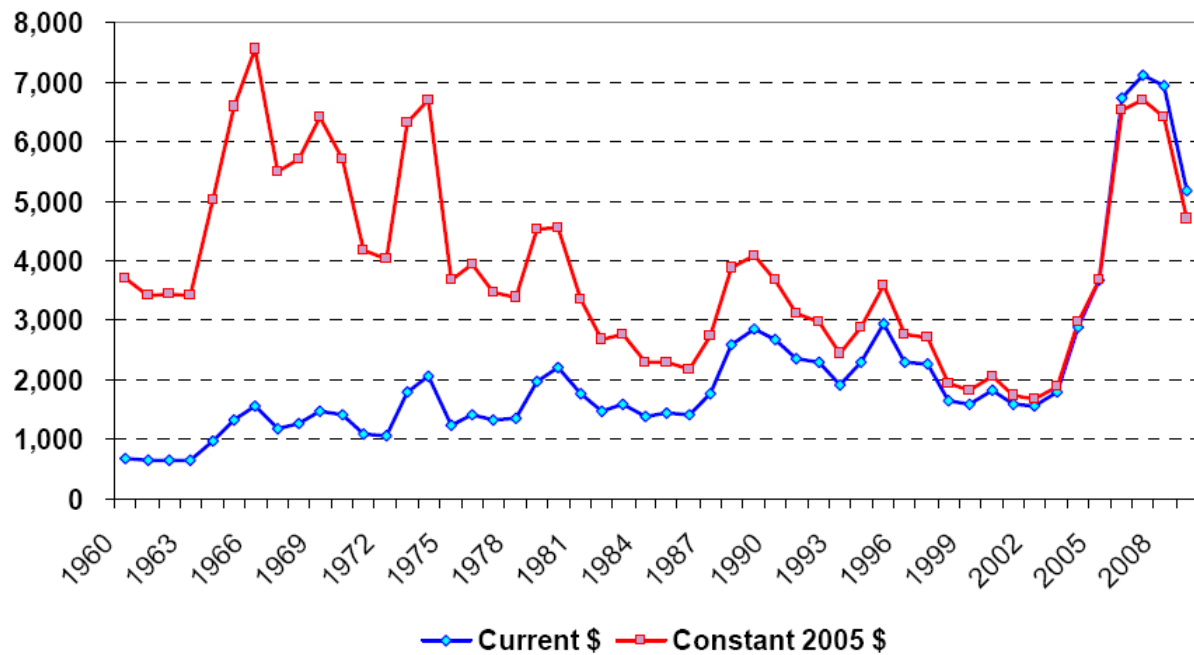


Figure 19: Average annual copper prices from 1960-2009 in USD per tonne. *Source: ICSG, 2010b.*

During the last decade, the copper prices (LME and COMEX) have been increasing from 2003 until 2008 (Figure 20). In the second half of 2008, with the onset of the global financial and economic crisis, falling output among many metal processing companies has resulted in low levels of demand for copper and scrap so that copper and scrap prices fell sharply. However at the beginning of 2009, the copper prices were still comparable to prices in 2004. Prices recuperated during 2009. This shows that copper/copper alloy scrap is valuable material and the high value of scrap and its increasing demand make it an interesting object for trade.

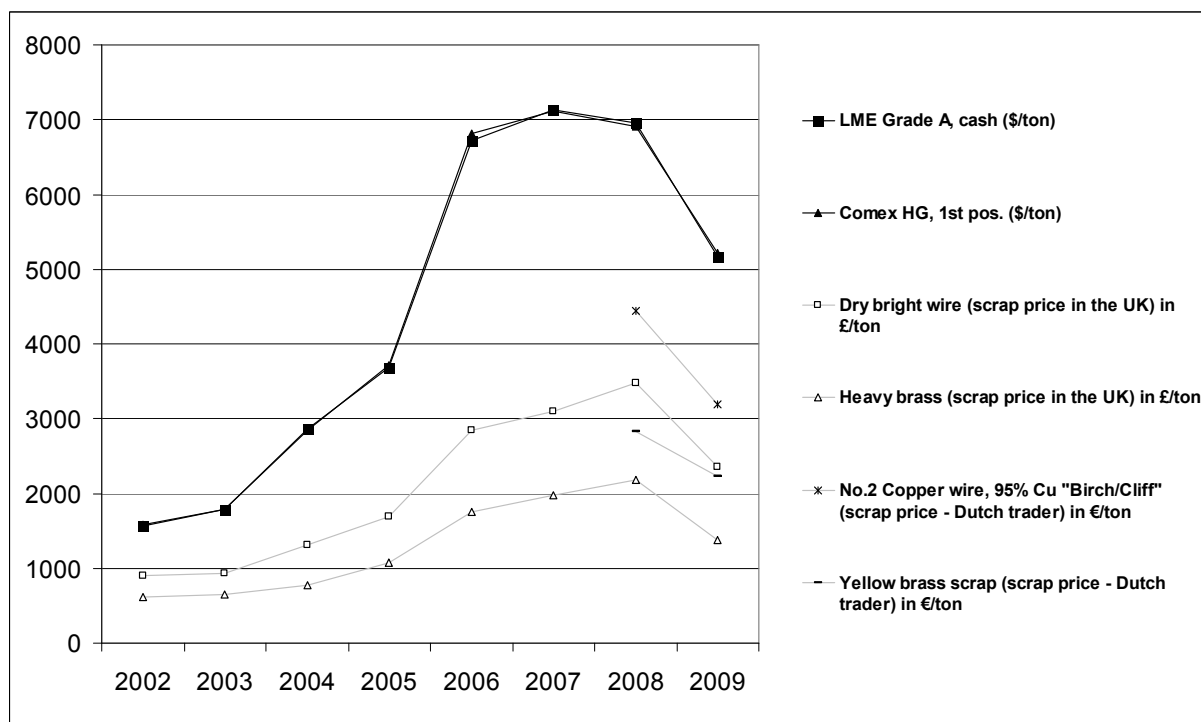


Figure 20: Price graph for copper and copper/copper alloy scrap from 2002 until 2009.  
Sources: LME, Comex, Letsrecycle, 2010.

## 2.4 Specifications and standards

Currently, specifications and standard classifications for copper and copper alloy scrap exist at all levels: international, European, national, as well as between individual parties. For marketing and trading reasons, standards and specifications are needed not only to set the price but are also used as a reference for classification and quality control. In many cases, based on the production need, scrap is processed according to the bilateral specifications agreed upon between the scrap processor and smelters and refiners.

### *European Standard EN 12861: Copper and copper alloys-scrap*

The EN standard describes in detail the specifications of several copper and copper alloys scrap for use in direct melting, i.e. of high quality. The scrap grades covered by the standard are summarised in Annex 1.

### *ISRI specifications*

Developed by the US trade association 'Institute of Scrap Recycling Industries (ISRI)', this American specification classifies several materials, including non-ferrous scrap, ferrous scrap, glass cullet, paper stock, plastic scrap, electronics scrap, and tyre scrap. It is widely used in international trade. The ISRI specifications for copper scrap are summarised in Annex 2.

### *National association specifications*

Many national trade associations in the EU Member States have developed their own specifications for copper scrap over many years. Generally these national specifications have been agreed between scrap processors and the copper refiners and remelters in their respective Member States.

***Bilateral contract/specification***

As already mentioned, frequently there are also specifications as part of the commercial agreements or contracts between two parties. Such specifications are usually based on a standard classification, with additional requirements to fit the host production process or product. In such cases, specifications may be continuously reviewed and if necessary modified.

***Radioactivity monitoring***

The monitoring of copper scrap with respect to radioactivity can be carried out in accordance with the UNECE Recommendations on Monitoring and Response Procedures for Radioactive Metal Scrap<sup>5</sup> or according to national rules or other international recommendations. For example Spain has its own system and the International Atomic Energy Agency has been developing safety standards for 'Orphan Sources and Other Radioactive Material in the Metal Recycling and Production Industries'.

More information on the UNECE recommendations:

The recommendations (or 'Protocol') were agreed upon after the second meeting of the group of experts on the Monitoring of Radioactive Scrap Metal held in June 2006 under the auspices of the UNECE.

The recommendations are 'intended to assist Governments, industry and all concerned parties to counter the problem of radioactively contaminated scrap metal, activated scrap metal and scrap metal with radioactive source(s) or substances contained within it (termed 'radioactive scrap metal' [...]) by seeking to prevent its occurrence, by effectively monitoring metal shipments and facilities, and by intercepting and managing any radioactive scrap metal that is detected.' The recommendations set out 'the responsibilities of all concerned parties and the actions required of them to fulfil the objectives'.

The producer of the material that applies the end-of-waste criteria should arrange for radiation monitoring to be performed on the scrap metal (each load or consignment) and to provide a certificate indicating the results of that monitoring. (An example of a certificate of shipment monitoring is attached as Annex 1 to the UNECE recommendations.) The owner/seller should ensure appropriate training of involved staff.

The recommendations contain also specific recommendations regarding radiation monitoring at scrap yards, processing facilities and melting plants, including that the owners of major scrap yards, processing facilities and melting plants should follow the specifications below:

- Ensure that incoming and outgoing shipments are checked by administrative and visual means.
- Provide radiation monitors at the entrance/exit to the premises and, as appropriate, on conveyors and grapples. All entrances and exits should be monitored.
- Ensure the effectiveness of the radiation monitors by appropriate quality assurance procedures to verify the ability to detect changes in radiation intensity.
- Arrange for periodic calibration and testing of the detectors (at least annually) to ensure optimum performance.
- Provide appropriate training in radiation monitoring and initial response procedures for personnel likely to be involved in the monitoring of scrap metal shipments.

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<sup>5</sup> [http://www.unece.org/trans/radiation/docs/recommendations\\_e.pdf](http://www.unece.org/trans/radiation/docs/recommendations_e.pdf)

- Establish a response plan for action in the event of radioactive material being discovered.
- Make a formal arrangement with the national organisation with experience in radiation monitoring and radiation protection to provide:
  - training of personnel on radiation detection and response procedures, and
  - assistance in the event of a radiation incident involving the detection of radioactive scrap metal.
- Require that contracts for the supply of scrap metal include the condition that any cost associated with radioactive material discovered in shipments will be accepted by the seller unless the original owner of the radioactive source or material can be found.

Instruments for detecting radioactive material can be divided into three categories and any of them could be used for measuring the radioactivity.

- Pocket-type instruments are small, lightweight instruments used to detect the presence of radioactive material and to inform the user about radiation levels.
- Hand-held instruments usually have greater sensitivity and can be used to detect, locate or (for some types of instrument) identify radioactive material. Such instruments may also be useful for making more accurate dose rate measurements in order to determine radiation safety requirements.
- Fixed, installed, automatic instruments are designed to be used at checkpoints. Such instruments can provide high sensitivity monitoring of a continuous flow of vehicles whilst minimising interference with the flow of traffic.

## ***2.5 Legislation and regulation***

In the EU the management of waste scrap metal is currently under the waste regulations, e.g. the Waste Framework Directive and EU Waste Shipment Regulation.

Scrap treatment plants (e.g. shredders, dismantlers, media separation plants) as well as scrap collectors and sorting plants are operated under a permit for waste treatment, although the details of their permits vary among Member States.

The secondary copper production and the associated treatment of scrap metal on site are subject to the IPPC Directive.

Certain metal-containing waste streams are regulated under specific directives, such as the WEEE, ELV and Packaging Directives. In these directives, the elements listed below regarding the treatment and processing of the types of waste are described and they ensure proper handling of the waste stream.

- The WEEE Directive includes compliance with minimum standards for recycling and treatment.

*According to Directive 2002/96/EN on WEEE, Article 6 (Treatment)*

*Member States shall ensure that producers or third parties acting on their behalf, in accordance with Community legislation, set up systems to provide for the treatment of WEEE using best available treatment, recovery and recycling techniques. The systems may be set up*

*by producers individually and/or collectively. To ensure compliance with Article 4 of Directive 75/442/EEC, the treatment shall, as a minimum, include the removal of all fluids and a selective treatment in accordance with Annex II to this Directive. Other treatment technologies ensuring at least the same level of protection for human health and the environment may be introduced in Annex II under the procedure referred to in Article 14(2). For the purposes of environmental protection, Member States may set up minimum quality standards for the treatment of collected WEEE. Member States which opt for such quality standards shall inform the Commission thereof, which shall publish these standards.*

*According to ANNEX II:*

1. *As a minimum the following substances, preparations and components have to be removed from any separately collected WEEE (examples):*
  - polychlorinated biphenyls (PCB) containing capacitors in accordance with Council Directive 96/59/EC of 16 September 1996 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls (PCB/PCT) (1)
  - batteries
  - printed circuit boards of mobile phones generally, and of other devices if the surface of the printed circuit board is greater than 10 square centimetres
  - plastic-containing brominated flame retardants
  - asbestos waste and components which contain asbestos
  - chlorofluorocarbons (CFC), hydrochlorofluorocarbons (HCFC) or hydrofluorocarbons (HFC), hydrocarbons (HC)
  - gas discharge lamps
  - components containing radioactive substances with the exception of components that are below the exemption thresholds set in Article 3 of and Annex I to Council Directive 96/29/Euratom of 13 May 1996 laying down basic
  - safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation (3)
  - electrolyte capacitors containing substances of concern (height > 25 mm, diameter > 25
  - etc.
  
2. *The following components of WEEE that are separately collected have to be treated as indicated:*
  - *cathode ray tubes: the fluorescent coating has to be removed,*
  - *equipment containing gases that are ozone depleting or have a global warming potential (GWP) above 15, such as those contained in foams and refrigeration circuits: the gases must be properly extracted and properly treated. Ozone-depleting gases must be treated in accordance with Regulation (EC) No 2037/2000 of the European Parliament and of the Council of 29 June 2000 on substances that deplete the ozone layer (4).*
  - *gas discharge lamps: the mercury shall be removed.*
  - *ELVs includes minimum technical requirements for the treatment*

*According to Directive 2000/53/EC - the "ELV Directive" Article 6 (Treatment)*



3. *Member States shall take the necessary measures to ensure that any establishment or undertaking carrying out **treatment operations fulfils at least the following obligations in accordance with Annex I:***
- a. *end-of-life vehicles shall be stripped before further treatment or other equivalent arrangements are made in order to reduce any adverse impact on the environment. Components or materials labelled or otherwise made identifiable in accordance with Article 4(2) shall be stripped before further treatment;*
  - b. *hazardous materials and components shall be removed and segregated in a selective way so as not to contaminate subsequent shredder waste from end-of life vehicles;*
  - c. *stripping operations and storage shall be carried out in such a way as to ensure the suitability of vehicle components for reuse and recovery, and in particular for recycling. Treatment operations for depollution of end-of life vehicles as referred to in Annex I(3) shall be carried out as soon as possible.*

*According to ANNEX I: An example of minimum technical requirements for treatment in accordance with Article 6.*

*Treatment operations for depollution of end-of-life vehicles:*

- removal of batteries and liquified gas tanks,
- removal or neutralisation of potential explosive components, (e.g. air bags),
- removal and separate collection and storage of fuel, motor oil, transmission oil, gearbox oil, hydraulic oil, cooling liquids, antifreeze, brake fluids, air-conditioning system fluids and any other fluid contained in the end-of-life vehicle, unless they are necessary for the reuse of the parts concerned,
- removal, as far as feasible, of all components identified as containing mercury.

*Treatment operations in order to promote recycling:*

- removal of catalysts,
- removal of metal components containing copper, aluminium and magnesium if these metals are not segregated in the shredding process,
- removal of tyres and large plastic components (bumpers, dashboard, fluid containers, etc), if these materials are not segregated in the shredding process in such a way that they can be effectively recycled as materials,
- removal of glass.

#### Waste shipment

On 12 July 2007, the new Regulation EC 1013/2006 on Waste Shipment came into force. Accordingly, most metal scrap is under List B of Part 1 of Annex V (also referred to as the 'green list').

Export of waste under the 'green list' within the OECD countries is not subject to the notification and consent procedure and is done under normal commercial transactions; however, the new Waste Regulation does require the completion of an Annex VII form.

For 'green list' exports to non OECD countries, the Regulations require the Commission to obtain a new declaration from the receiving country as to whether it will accept each kind of waste; it may also require pre-notification.

In List B, the possibly affected ones are some metal scraps under B1010 (copper scrap) GC010 (electronic assemblies consisting of only metals or alloys) and GC020 (Electronic Scrap e.g. printed circuit boards, electronic components, wire, etc.) and reclaimed electronic components suitable for base and precious metal recovery). However, some of the non-OECD countries failed to respond and where no reply is received, those countries are to be regarded as having chosen a procedure of prior written notification and consent. Default controls of prior written notification and consent are applied.

When scrap is traded under the procedure of prior notification and consent, exporters of scrap metals to non-OECD countries are required to pre-notify, which requires administration and payment of a fee as well as the establishment of a financial guarantee<sup>6</sup>.

In any case, the Waste Shipment Regulation allows exports from the Community only if the facility that receives the waste (i.e. the secondary metal production plant) is operated in accordance with human health and environmental standards that are broadly equivalent to standards established in Community legislation (IPPC).

The end-of-waste may affect metal scrap that has fulfilled the criteria and become product in the way that the trading will not be under waste shipment regime. The impact on waste shipment is described in Chapter 3.

### By-products

If a certain metal scrap generated, for example by the metal processing industry, were regarded as being a by-product, and not being waste, in the sense of Article 5 of the WFD, then the case end-of-waste criteria would not apply unless the by-product were to become waste later.

Article 5 of the WFD on by-product reads as follows:

1. *A substance or object, resulting from a production process, the primary aim of which is not the production of that item, may be regarded as not being waste referred to in point (1) of Article 3 but as being a by product only if the following conditions are met:*
  - a. *further use of the substance or object is certain;*
  - b. *the substance or object can be used directly without any further processing other than normal industrial practice;*
  - c. *the substance or object is produced as an integral part of a production process; and*
  - d. *further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts.*
2. *On the basis of the conditions laid down in paragraph 1, measures may be adopted to determine the criteria to be met for specific substances or objects to be regarded as a by-product and not as waste referred to in point (1) of Article 3. Those measures, designed to amend non-essential elements of this Directive by supplementing it, shall be adopted in accordance with the regulatory procedure with scrutiny referred to in Article 39(2).'*

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<sup>6</sup> A financial guarantee is not required in cases of shipment of green listed waste to EU-Member States with transitional provisions to control such waste under the Amber control procedure.

It is notable that Article 5 of the WFD says '*...may be regarded...*', which appears to leave a certain freedom of choice even if the four conditions of Article 5 are met, at least as long as measures under Article 5.2 have not been adopted.

### REACH

When metal scrap ceases to be waste, it becomes subject to the provisions of the REACH Regulation and other legislation (e.g. RoHS, etc.). The implications of this are discussed in detail in the chapter entitled the Description of Impacts.

## **2.6 Environmental and health aspects**

### **Energy use and GHG emissions**

The energy requirement for secondary copper production is between 35-85% of primary production (BIR, 2008) and this would lead to an estimated 7.3 MJ/kg in energy savings.

The benchmark energy requirements for the production of cathode copper metal from primary copper ore concentrate by pyrometallurgy, by hydrometallurgy and for secondary cathode copper metal from scrap and secondary sources are shown in Table 12.

**Table 12: Benchmark energy requirements from copper production.**

<b>Copper recovery method</b>	<b>Energy requirement (MJ/kg Cu)</b>	<b>Carbon footprint (t CO<sub>2</sub>/t Cu)</b>
Secondary production from scrap	6.3	0.44
Pyrometallurgy from ore concentrate	16.9	1.25
Hydrometallurgy from oxide ores	25.5	1.57

*Source: BIR, 2008.*

### **Emissions during the process of copper/copper alloy production from the scrap**

#### **Emissions to air**

Dust and air emissions during secondary copper production in a furnace need to be captured. Emissions of metals are strongly dependent on the composition of the dust produced by the processes. The composition is influenced by the process (e.g. type of furnace, temperature) and by the materials that are being processed, both metallic and non-metallic, as the more non-metallic material, the larger the emissions. Many emissions can however be mitigated by the use of appropriate technology. The flue gases are normally cleaned in fabric filters to reduce the emissions of dust and many metal compounds such as lead, zinc, arsenic, cadmium, etc. attached to particles.

Many pollutants are only generated if the scrap has a high non-metallic content. In cases of presence and poor combustion of organic material (oil, plastics) in the scrap, gases such as CO, VOC, PCDD/F are formed. Sulphur dioxide is formed due to the sulphur content in the raw material. NO<sub>x</sub> is dependent on the combustion conditions, i.e. the type of furnace and how it is operated, and so are dust and metal fumes (European IPPC Bureau, 2009). If major amounts of electronic scrap with brominated flame retardants are used as feedstock, this may result in the formation of mixed halogenated dioxins. In the case of copper remelting/refining, the conditions may exist for the formation of PCDD/F, in particular when using scrap material and chips contaminated with chlorine from cuttings fluids (European IPPC Bureau, 2009).

Careful plant design and process operation is needed to capture process gases. Most of the emissions above can be abated with the use of BAT. The control of emissions to air and discharges to water from the production of copper wire rod and copper and copper alloy semis is well developed. The control of the emissions of carbon monoxide from shaft furnaces especially those operating under reducing conditions is achieved by burner optimisation. In the EU, such emissions are controlled according to permits under the IPPC Directive (European IPPC Bureau, 2001).

### **Emissions to water**

During copper production, significant quantities of cooling water are used in direct contact with copper, and suspended solids, metal compounds and oils are transferred to water and require treatment.

### **Generation of solid residues (wastes)**

Copper scrap processing generates solid residues such as slag, dust, and sludge. Because of the high content of metals, they are often used as raw materials for the production of other metals, within the copper production processes or outside copper production. More slag, dust and sludge are generated when the foreign materials content in the scrap increases. The exact amount of slag and the composition of slag will depend on process conditions during the copper production.

However, the mentioned processes and emissions would not be different for a given scrap being classified as end-of-waste material or waste material. It is also important to note that slag, sludge, filter ash and other residues from scrap treatment are classified as waste, regardless of the classification of the scrap input as waste or non-waste.

### **Risks related to scrap transportation and storage**

Scrap metal in itself does not pose any risk to the environment, i.e. there are no environmental risks in transportation and storage of metal itself. However, if metals are contaminated with oil or mixed with other waste, this may create hazards during transportation or storage. For example, oil or any other liquid attached to scrap metal, when exposed to rain, may cause contamination to the surrounding environment.

### **Coatings and paints**

Coatings can be divided into organic coatings (powders, pastes, liquids, film or sheeting), inorganic coatings (manufactured from ceramics and cement mortar) and metallic coatings.

The most common coatings of copper scrap are tin-coated scrap, nickel-coated scrap, silver-coated scrap, plastic-coated scrap, etc.

Plastic coatings of tubes can be removed by shredder processes. Colour adhesions basically are removed by the melting process and detected by the exhaust air purification system.

For copper or copper alloys scrap containing organic materials like coatings, or that are oily in nature, there are installations which use de-coating and de-oiling methods or a special design of the furnace and the abatement system to control released emissions. For copper wire-rod and semis production, VOCs are emitted if oily material is used as feed (Brixlegg, 2007).

Some processes have a specific de-coating step. Residual paint/coatings are removed in the furnace as part of the process, either contributing to slag generation or air emissions. PVC and other halogenated coatings may contribute to the generation of dioxins and furans.

In the case of copper scrap, the main plastic coatings are mostly from the cables and wires. All cables with plastics must be treated to remove the plastics by chopping or stripping (as proposed under criteria for processes and techniques).

### **Radioactive metal scrap**

Scrap metal can contain sources of radiation with the associated environmental and health risks. Radioactive scrap metal can occur in a number of different ways. Some of the main origins are the demolition or the decommissioning of industrial facilities processing raw materials containing naturally occurring radionuclides, the decommissioning of nuclear installations (such as nuclear power plants and other nuclear fuel cycle facilities) and other facilities, the loss of sources (sealed radioactive sources are sometimes lost or mislaid and they may be collected as scrap metal), the demolition of facilities in which radioactive sources have been used, the incorporation of old radioactive devices into scrap (items such as timepieces and compasses covered with radioluminous paint, lightning rods, thoriated lenses, etc. may be collected as scrap). Naturally-occurring radioactive materials related to the demolition of off-shore industries have also been mentioned.

In order to minimise the risks, radioactivity needs to be measured systematically. The United Nations Economic Commission for Europe (UNECE) has released recommendations to monitor and reduce the risks involving radioactivity in scrap metal, defining the requirements for the control of radioactive material and while these recommendations are not legally binding, they provide guidance based on existing best practice to all interested parties (scrap yards, metal smelters, customs, regulatory authorities and transporters, amongst others).

The International Atomic Energy Agency is also preparing the safety standard 'Orphan Sources and Other Radioactive Material in the Metal Recycling and Production Industries' in order to provide guidance in regard to safety requirements on the presence of radioactive material in scrap metal.



### 3 END-OF-WASTE CRITERIA

The end-of-waste criteria should be such that the material has waste status if regulatory controls under waste legislation are needed to protect the environment and human health; otherwise the material could have end-of-waste status to facilitate recycling and recovery. The criteria should be developed in compliance with the legal conditions, be operational, and should not create new disproportionate burdens and should consider that copper scrap recycling is a well-functioning industrial practice today.

The following main types of benefits can be expected when EU-wide end-of-waste criteria for copper scrap are introduced:

- Improved functioning of the internal market (harmonised rules across countries).
- Clearer differentiation between high quality scrap and low quality scrap. Only high quality scrap will cease to be waste.
- Reduction of administrative burdens especially related to shipment and transport.

#### 3.1 *Conditions for end-of-waste criteria*

According to the Waste Framework Directive, Article 6, *'certain specified waste shall cease to be waste within the meaning of point (1) of Article 3 when it has undergone a recovery, including recycling, operation and complies with specific criteria to be developed in accordance with the following conditions:*

- a. The substance or object is commonly used for a specific purpose;*
- b. A market or demand exists for such a substance or object;*
- c. The substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products (e.g. REACH); and*
- d. The use of the substance or object will not lead to overall adverse environmental or human health impacts.'*

Regarding the first two conditions, there is evidence in the case of copper and copper alloy scrap that specific uses and a structured market exist, e.g. scrap of this metal is traded internationally in large amounts, and standards and classifications of scrap metal grades have been developed and are used as a reference for trade. Copper and copper alloy scrap is commonly used as a feedstock in the metal-producing industry, in different qualities according to the needs of the different segments of the copper refining chain (smelting and refining uses the lowest quality grades to produce refined copper, direct melters use high quality scrap and refined copper to produce semis, the copper manufacture industry uses semis to produce copper products). The value of scrap complying with standards or specifications (the prices of most traded scrap grades have fluctuated in the last decade in the €700-4000 per tonne range) is such that there is always a demand for copper scrap as feedstock to copper manufacture, and any other use or disposal is highly unlikely and unintended. This is also true in the case of exports outside the EU, including to non-OECD countries.

The third condition implies that end-of-waste criteria need to ensure that, at the point of ceasing to be waste, any technical requirement related to the use be fulfilled and the recycled material comply with applicable legislation and standards as product. In the case of copper

scrap, this means that at the moment of end-of-waste, the scrap should fulfil standards/specifications that the copper and copper alloys industries use for the scrap they buy.

From a life cycle point of view, copper scrap metal recycling has overall environment benefits compared to production from ores, mainly based on a large reduction of the energy required.

If scrap has reached end-of-waste status, it can be transported by ordinary goods transport means, and not only those that are permitted to transport waste. It is important to note that only scrap without hazardous properties can cease to be waste.

Regarding waste shipment, it is important to highlight that only scrap for which it is highly likely that it will actually be used as feedstock can be exported and imported outside the waste regulatory controls of the Waste Shipment Regulation. End-of-waste scrap should not have any waste-related properties that would lead to overall adverse environmental or health impacts if used outside the EU.

### ***3.2 Outline of end-of-waste criteria***

End-of-waste criteria for a material should be such that the recycled material has waste status if—and only if— regulatory controls under waste legislation are needed to protect environment and human health.

Criteria have to be developed in compliance with the legal conditions, be operational, not lead to new disproportionate burdens and undesirable side-effects, and consider that copper scrap collection and recycling is a well-functioning industrial practice today. Criteria should provide the end-of-waste benefits to as many copper scrap flows as possible, and address with priority the main and largest flows in the EU.

It has been reported that the current waste status of copper scrap (and other recyclable waste materials) creates in some cases a variety of administrative and economic burdens, especially related to storage, shipment and transport, and creates legal uncertainty by keeping under waste legislation a material that in practice is perceived and treated as a product.

The following main benefits can be expected when EU-wide end-of-waste criteria for copper scrap are introduced:

- Clearer differentiation of the high-quality copper scrap, and recognisable distinction to lower-quality copper scrap. Certainty that only high-quality (quality assured) copper scrap will cease to be waste. This confirms additionally the waste status for low-quality copper scrap, and the reasons for keeping it.
- Improved functioning of the internal and external markets of the EU (harmonised rules across countries, increased legal certainty, increased transparency and reliability on quality assured shipments).
- Reduction of administrative burdens related to shipment, transport and trade that are redundant for environmentally safe materials.



End-of-waste criteria have to be clear, concise and enforceable. They have to be robust and controllable through spot checks, and minimise non-compliance that may undermine the credibility of end-of-waste criteria.

The definition of the criteria needs to be guided by the principles of simplicity and proportionality. Criteria should be proposed in the least intrusive form possible, yet ensuring fulfilment of the conditions of Art. 6 of the WFD. In the appraisal of the need to set a criterion, one may be introduced only where it is judged that the magnitude of the risks of unintended consequences or of impact to health and the environment requires it.

Following the findings of the JRC methodology guidelines for EoW<sup>7</sup>, the ultimate aim of end-of-waste criteria is **product quality**. Thus, end-of-waste criteria will normally include as key elements direct product quality requirements. In addition, a set of end-of-waste criteria may include other elements that help indirectly to ensure product quality, in particular requirements on input material, requirements on processes and techniques, and on quality assurance procedures. The criteria are a package, linked to each other. This means that, e.g. stricter quality criteria may make redundant the inclusion of one or more of the input or process criteria.

Following these considerations, it can be summarised that copper scrap should cease to be waste when:

- copper scrap complies with industry standards or specifications for a copper scrap grade for which there is a market and demand;
- copper scrap includes information about the scrap type and fulfils the requirements for maximum content of foreign materials, oil, oily emulsions, grease or lubricants limitations, radioactivity and PVC limitation;
- copper scrap does not have hazardous properties;
- copper scrap has completed all required treatments to be suitable for direct use;
- the producer of copper scrap provides documentation of the fulfilment of all conditions above.

Furthermore, the end-of-waste criteria for copper scrap should not disrupt the existing recycling system. They should simply identify where copper scrap has attained a quality that is sufficient to ensure that no environmental risks occur when it is transported, further processed or traded without being controlled as waste.

This approach to define a set of end-of-waste criteria combining several levers of action corresponds well to current good industrial practice of ensuring the product quality of copper scrap. Accordingly, copper scrap ceases to be waste when it is placed on a market where it has a demand because it fulfils certain product quality requirements, requirements on input materials and processes and techniques. Compliance with all these requirements has to be ensured by applying the industrial practice of quality control.

Direct product quality requirements were regarded by the experts from the technical working group as especially relevant in connection to spot checks of traded material, as easily measurable requirements would facilitate effective inspection and the identification of cases of non-compliance. Direct product requirements should also address direct hazards for the environment and human health such as related to radioactivity and oil content. In addition,

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<sup>7</sup> Can be downloaded from: <http://susproc.jrc.ec.europa.eu/activities/waste/>.

strong support has been widely given to the introduction of a quantitative criterion limiting the content of foreign materials, which would serve as a check for the completeness of treatment, and that the metal is sufficiently clean for safe use.

Quality assurance was another element of the end-of-waste criteria that the technical working group considered especially important and useful because it is needed to establish wide confidence in the end-of-waste status.

The discussions with the TWG experts led to the proposal that the requirements on input materials and treatment processes should mainly address and be stringent on materials that pose a specific hazard if not treated adequately.

The different possible elements of the end-of-waste criteria, the outcome of the discussions with the TWG experts, and the resulting proposals are presented in the following sections, and are summarised in Annex 3.

### ***3.3 Product quality requirements***

Product quality criteria are needed to check for direct environmental and health risks and if the product is suitable as a direct feedstock in metal production. They also should allow for deciding if the metal in the scrap is sufficiently pure and clean and has been separated effectively from other types of materials. The criteria will additionally require scrap to be characterised according to a standard or a controllable customer specification.

In order to fulfil this, the product quality requirements shall include limitations on at least:

- content of foreign materials<sup>8</sup>
- oil, oily emulsions, grease and lubricants
- radioactivity
- hazardous properties
- coatings, paints, plastics.

Another requirement which should be included is grading according to a standard or specification for the use in metal production.

#### **Grading according to a standard or specification**

Grading according to a standard or specification shall be used to demonstrate that the scrap fulfils the technical requirements for a specific purpose and it also indicates that there will be a market and a demand.

Following the discussions with the TWG, it is considered useful and proportionate to demand that the scrap be graded according to a specification or standard. No prescription shall be made on the specification or standard, as long as it can be proved that it is actually used to characterise the quality of the scrap. For each consignment of copper scrap, the producer should assign a grade or category according to an authentic user specification or standard. The identification of the specification should be sufficiently clear so that it will be possible for the

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<sup>8</sup> For materials different from copper or copper alloys, see further details in the next pages.

competent authorities, in the case of an inspection, to verify through their investigation that the specification corresponds to authentic user requirements.

The relevant standards, customer or industry specifications are those for direct input to one of the final uses (the production of metal substance or objects by remelters/smelters/refiners). The standards or specifications used may be of an agreed nature across an industry sector (e.g. EN 12861, ISRI) or be defined by one or more individual final use companies.

One of the most widely used standards in Europe is Standard EN 12861: 1999. This standard specifies the characteristics of copper and copper alloy scrap *for direct melting*. Compared to other standards, it defines in very detailed terms the condition, moisture, composition, metal content, metal yield and test procedures of scrap (see Annex 1 for a summarised overview of its content). However, it only refers to material suitable to direct melting, i.e. the top end of the quality scale of scrap types.

Compliance with the requirements of EN 12861 ensures that the material has a market and a demand. The requirements of the standard (in particular regarding metal content/yield and chemical composition) also define how effective any pretreatment has to be, and limit the possibilities of diluting the scrap with other waste material.

Another internationally relevant quality reference is the ISRI specification (see Annex 2 for a list of scrap types). This specification covers all copper scrap types, including the lower quality grades for smelting and refining which are not covered in EN 12861. However, these specifications are not as detailed as EN 12861 as regards impurity content limits and test procedures.

In addition to the mentioned specifications, customer specifications may exist, based on the specific needs of the buyer, such as maximum size or baling. In case only customer specifications exist, identification of the requirements should be sufficiently clear, transparent, and available, so that control authorities can effectively check that the specifications correspond to authentic user requirements.

**The legal formulation of the requirement could be as follows:**

***The scrap shall be graded according to an industry specification, a standard for direct use or a customer specification in the production of metal substances or objects by smelters, refiners, re-melters or other metals producers.***

**Limit on foreign materials**

The experts of the TWG have supported that the end-of-waste criteria include a quantitative maximum limit to the content of non-copper materials, except the alloying elements which are part of copper/copper alloy scrap. This limit is proposed as a means to check that the separate collection and/or treatment of waste has been effective in producing a scrap which is sufficiently pure to be used in metal production without generating avoidable waste-related emissions or solid residues. A limit value on foreign materials also restricts the possibilities of having other wastes mixed with the scrap.

**Foreign materials** are defined based on the concept of foreign substance in EN 12861:1999, namely *material other than copper and copper alloys, 'whether metallic or non-metallic including free iron'*. In this sense foreign materials include, inter alia:

- metals other than copper and copper alloys
- non-metallic materials such as earth, dust, insulation and glass
- combustible non-metallic materials such as rubber, plastic, fabric, wood and other chemical or organic substances
- slag, dross, skimmings, baghouse dust, grinder dust, sludge.

In a previous version of the working document, two additional requirements were suggested by some experts of the TWG to be part of foreign materials:

- larger pieces (brick-size) which are non-conductors of electricity such as tyres, pipes filled with cement, wood or concrete
- residues arising from the melting of copper and copper alloys, heating, surface conditioning (including scarfing), grinding, sawing, welding and torch cutting operations such as slag, dross, skimmings, baghouse dust, grinder dust, sludge.

However, most of the substances and materials mentioned in these two items have been found to be only of concern for the definition of end-of-waste criteria on other metal scrap such as ferrous scrap, but are not as relevant for copper scrap. Exceptions are slag, dross, skimmings, baghouse dust, grinder dust, sludge, which have been kept in the proposal.

Copper scrap is essentially composed of copper and copper scrap alloys, and has additionally varying amounts of other metals, the most frequent being zinc and tin, but also lead, aluminium, nickel, cobalt, and manganese. As specified above, the foreign material content should not comprise these alloy metals.

Together with the requirements regarding oil, oily emulsions, grease and lubricants and the exclusion of hazardous properties and of coatings, paints, plastics, the limit value on foreign materials serves to check that the scrap is sufficiently clean of foreign materials. Thus, the risk of not using it as feedstock without generating emissions and solid residues that are waste specific or waste treatment related is sufficiently low.

An alternative to define how clean scrap is is the concept of **metal content**: 'net mass of the inspection lot after deduction of all foreign substances including moisture'. Foreign materials are thus 100% minus the percentage of 'metal content'. Another term used to define cleanliness/purity is **metal yield**: 'direct useful metal in the inspection lot after drying, removal of free iron and proper remelting. The metal in the slag is not included in the net mass'. The choice of a term in EoW defining the purity of scrap was discussed with the TWG, and the general opinion was that the term **foreign material** was the most appropriate.

In practice, foreign material content is measured by taking a dry, representative sample of the scrap, removing the foreign materials by hand, a magnet, or based on the density of materials. Density separation consists of submersion of the sample in a liquid in order for the different materials to separate by density differences. Floating materials can then be skimmed out. The weight before and after, both in dry condition, is then compared. Should separation by hand not be possible because of the size distribution or shape of the scrap pieces, this operation can be repeated after shredding or other mechanical dismantling. If the scrap has a very fine grain size distribution and density separation is ineffective, it is possible to use chemical methods to dissolve the non-metal content, e.g. with nitric acid (EN 12861).

Measurement can take place at the reprocessor of the end-of-waste scrap, at the buyer upon receipt, or/and in spot checks by the control authorities. More details on sampling frequency are provided in the section on quality assurance.

A single limit value for use in all scrap categories is proposed, as this favours simplicity for producers, buyers, and control authorities. This does not exclude that for purposes different than EoW classification as stricter requirements can be added in business-to-business specifications or commercial agreements.

There are diverging opinions among the TWG on what the maximum limit value for the content of foreign materials shall be. Experts from the reprocessing step of the copper chain (scrap collectors, processors and traders) defend the higher end of this range (foreign materials limit 5-8%), whereas the experts from the subsequent steps of the copper chain (users of scrap such as copper and copper alloy producers) defend a value close to 2%.

Based on the existing knowledge of environmental and health impacts that result from the different techniques, a foreign material content higher than 5% is not acceptable for end-of-waste. In the following, the analysis focuses thus on scrap with foreign material contents in the range of 2 to 5%.

#### Mid-range (2-5% foreign material content) quality scrap in EN 12861 specifications

The EN 12861:1999 standard is an important reference example of limit values of foreign materials. This standard addresses the high end of the quality scale of copper/copper alloy scrap, and specifies the requirements for scrap used in direct melting. The standard defines scrap for direct melting as 'a metallic product with levels of impurity elements which would not prohibit its use for direct melting, with or without preliminary mechanical treatment (e.g. baling, fragmenting, crushing)'. However some scrap categories (e.g. S-Cu-8 and S-Cu-9) are used in the production of semis only after some pretreatment such as fire-refinement (ECI, 2011).

The EN standard characterises 19 main grades of copper scrap and copper alloy scrap (see Table 13). Copper scrap has the codes S-Cu-1 until S-Cu-10, while copper alloy scrap has the codes S-CuZn-1 until S-CuZn-10. Grade S-CuZn-5 refers to turnings, a grade which is excluded from EoW because of the frequent content of oil, grease, emulsions, etc.

According to the information summarised by the European Copper Institute (ECI, 2010) on EN scrap categories, of the 19 main grades defined in the EN 12861, 14 grades have foreign materials below 2%. These are high purity scrap grades. Besides these, four scrap grades (S-Cu-8, S-Cu-9 and S-CuZn-6, S-CuZn-7, shaded in Table 13) exceed the 2% limit. Depending on the specific technical conditions of the furnace (direct melter) using this scrap, additional pretreatment may be needed to improve the quality of the scrap, despite the original definition in EN12861 that no treatment is needed for the grades described in it.

According to the European Copper Institute (ECI, 2010), scrap which contains >2% of foreign materials cannot be used by direct melters without upgrading their quality by additional treatments. This consideration is relevant, as end-of-waste shall in principle require that the consignment not need further treatment before use. However, this consideration only concerns direct melters, which are the most downstream element of the scrap reprocessing chain and have the highest quality requirements for its input. Copper scrap with foreign

## **End-of-waste criteria**

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materials of >5% is used abundantly by other upstream steps in the copper chain such as smelters and refiners, usually without any additional treatment.

**Table 13: Quality of copper/copper alloy scrap, following EN 12861 grading.**

ID	Type	Source	Cu content according to EN 12861	Metal content according to EN 12861	Foreign materials according to the ECI (% (m/m))	
					Total	Thereof humidity (moisture, oil, emulsion, etc)
B.1	S-Cu-1	Production scrap from P-free electrolytic copper	99.9	-	max. 0.25	max. 0.2
B.2	S-Cu-2	Old scrap from P-free pure electrolytic copper	99.9	-	max. 0.25	max. 0.2
B.3	S-Cu-3	Lacquered wire, P-free	99.9	-	lacquer + humidity	max. 0.2
B.4	S-Cu-4	Production scrap from tubes, sheets, coils, etc., pure copper, P-containing	99.9	-	max. 0.25	max. 0.2
B.5	S-Cu-5	Old scrap from tubes, sheets, coils etc., pure copper, P-containing	99.9	-	max. 0.25	max. 0.2
B.6	S-Cu-6	Old scrap from fire-stripped coated wires, pure copper	99.7	>98.5	max. 1.5 <sup>1</sup>	max. 0.2
B.7	S-Cu-7	Old scrap from varying copper products	99.5	>98	max. 2.0 <sup>1</sup>	max. 0.2
B.8	S-Cu-8	Old scrap from varying copper products, no radiators or vessels	98	>96	max. 4.0 <sup>1</sup>	max. 0.2
B.9	S-Cu-9	Old scrap, which does not fit into categories B.1 to B.8 due to enhanced impurities	96	>92	max. 8.0 <sup>1</sup>	max. 0.2
B.10	S-Cu-10	Chopped copper wire, coated and uncoated	min. 97.5 (S-Cu-10D) to min. 99.90 (S-Cu-10A)	-	max. 0.4	max. 0.2
C.1	S-CuZn-1	Production scrap from copper-zinc alloy (CuZn5 to CuZn40), lead-free	63.5	-	max. 0.25	max. 0.2
C.2	S-CuZn-2	Copper-zinc alloy scrap from shells	69	-	max. 0.25	max. 0.2

## End-of-waste criteria

ID	Type	Source	Cu content according to EN 12861	Metal content according to EN 12861	Foreign materials according to the ECI (% (m/m))	
					Total	Thereof humidity (moisture, oil, emulsion, etc)
C.3	S-CuZn-3	Copper-zinc alloy scrap from cartridges	69	-	max. 0.25	max. 0.2
C.4	S-CuZn-4	Copper-zinc-lead alloy scrap	57	-	max. 0.25	max. 0.2
C.5	S-CuZn-5	Turnings from copper-zinc-lead alloys	57 and min 91%metal yield	-	max. 9 <sup>1</sup>	max. 7
C.6	S-CuZn-6	Valves and taps from copper-zinc alloys	57	>97	max. 3 <sup>1</sup>	max. 0.2
C.7	S-CuZn-7	Scrap from copper-zinc alloys, varying sources	57	>95	max. 5 <sup>1</sup>	max. 0.2
D		Scrap from condenser tubes, different alloys	-	>98	max. 2 <sup>1</sup>	max. 0.2
E		Production scrap, different sources and alloys	-	-	max. 0.25	max. 0.2

<sup>1</sup> calculated.  
**Source: ECI, 2010.**

Table 8 in Chapter 2 presents the data on flows of scrap for different uses in Europe, with estimations by the European Copper Institute (ECI, 2010). It presents the grades of scrap used as input by different categories of copper/copper alloy producers, as well as their amounts. The last column includes all uses, while the remaining columns refer to different types of producers, therefore the difference in the totals. It can be seen that different grades of scrap are normally used by different types of producers: while producers of semis use high quality input, with <2% foreign material content, primary refiners and smelters use EN 12861 grades with a foreign material content of up to 9%. Table 8 indicates that about 60% of the total flow of copper and copper alloy scrap is used by semis producers, the remaining being used by refiners, and likely also smelters (the latter not included in the first columns, but included in the last column).

The high quality scrap (<2% foreign materials) represents about a half of the total scrap flow used by the industry. This high quality scrap is mainly used by semis producers (approximately 80% of it), and only about 20% of scrap of that quality is used by refiners/smelters.

The intermediate quality scrap, with foreign materials between 2 and 5 %, is usually bought by refiners and smelters, but the data confirm that copper alloys in this purity range are also



used for direct melting by semis producers. However according to the ECI, this quality of scrap can be used by direct melters only after some pretreatment (fire-refinement).

#### Mid-range (2-5% foreign material content) quality scrap in the ISRI specifications

In international trade it is common to use the grading system of ISRI, instead of the EN 12861. The main traded unalloyed scrap categories internationally according to ISRI are the 'No 1 copper' category which have common trade names such as **Barley, Berry, Candy and Clove**, (see Figure 9) with minimal foreign material content and which often are used for direct melting without any further treatment. Also frequently traded is No 2 copper, with common names such as **Birch, Cliff and Cobra** (see Figure 8), which usually need further refining before melting.

These denominations have their similarities to the EN standard grading: No 1 scrap refers to the scrap grades which usually have a foreign materials content of <2%, while No 2 scrap usually refers to a quality of foreign materials of > 2%. Following this similarity, it could be estimated that the majority of copper scrap No 1 is used for direct melting, and category No 2 scrap is predominantly used by smelters and refiners.

Eurometrec (2010) estimates that the most traded copper/copper alloy scrap grades following the ISRI categories are also No 1 scrap (about 30-40% of the amounts traded) and No 2 scrap (20-40%), see Table 11. Eurometrec estimates that copper scrap category No 1 is not going to be very affected by the limit of foreign material content, as it is of the highest quality, it fulfils all conditions, and its trade will remain as it is. Possibly, the most affected category in terms of uncertainty of fulfilment of the criteria would be category No 2 Birch/Cliff. If the end-of-waste requirements on foreign materials were to be set at 2%, then likely little or no Birch/Cliff would qualify as end-of-waste. If the limit were to be set at 5%, probably the majority of Birch/Cliff would cease to be waste. Being in or out of end-of-waste criteria may have consequences in the amounts traded within and outside of the EU. In the case of the categories Honey, Barley, Nomad, Berry, and Candy, if the foreign material limit is 5%, most of these categories would likely meet the requirement. Other categories like Ocean may not meet end-of-waste criteria due to the frequent content of iron attachments and solder, and Druid will probably also not meet the criteria due to the high content of insulation material.

A possible consequence for the industry of a strict limit on foreign material content is that more high quality scrap would be generated, e.g. more scrap No 1 from better separation of scrap No 2. An example of this is the reprocessing of wire and cables by scrap chopping. If the scrap upgrading activity takes place domestically in the EU, this may support activity of the related EU reprocessing industry. This argument is also valid for a 5% limit, as more scrap with a higher foreign content than this threshold would be processed to a higher quality, under 5%.

Besides the mentioned improvement in the quality of the exported material, limited information is available regarding the potential environmental consequences of different foreign material content thresholds. A 2% limit would have benefits as well as limitations. On the plus side, it may result in shifting the composition of the traded copper scrap towards cleaner scrap, ensuring that the upgrade takes place within the EU and using EU environmental standards for the further treatment of the rejects. Conversely, a 5% limit would allow an overall larger flow of scrap to benefit from EoW. Copper with impurities in the 2-5% range is currently a valuable material for producers, especially smelters and refiners, often with no pretreatment needed. If this scrap was exported out of the EU, there could be a

concern that the rejects are not treated under the same environmental conditions as within the EU. If traded internally in the EU, the recycling conditions would be better ensured, and in addition the economic activity of reprocessing a larger flow of scrap would be kept domestically. At this stage, it is not possible to predict the strength of demand of scrap in the 2 to 5% foreign material content range, which would determine whether this collection and recovery activity is kept domestically in the EU or not. This depends on other factors such as labour costs, environmental compliance costs, or processing technology.

How the threshold is set may also have effects on the availability and price of scrap, although it is estimated that other factors different from EoW such as trade policy have a much larger influence on scrap availability.

### Conclusion: 2 or 5%?

Given the split views of the technical working group and based on the available information, this report does not arrive at a clear-cut conclusion on the right limit value for the foreign material content as part of the end-of-waste criteria. However it is possible to summarise the main arguments for consideration in a political decision:

The main argument for a limit value close to 2 % is the lower possibility of environmental impacts from the foreign material content when the scrap is used. None of the experts see foreign material contents of up to 2 % as problematic for the end-of-waste status.

The <2% limit value can be used without pretreatment in the majority of cases by industry, either by direct melters/refiners/smelters.

A limit value close to 2% implies that more than half of the copper and copper alloy scrap currently traded as waste would not benefit from the reduction of administrative burdens associated with EoW. The 2% limit would probably increase the generation of high quality scrap.

A limit value close to 5 % implies that most of the scrap would benefit from reduced administrative burdens. This would be directly beneficial for the trading of scrap, which again may lead to more collection of scrap and would improve the overall economics of recovering copper from waste. Within the European industry, the sectors involved upstream in the recycling are likely to benefit in economic terms more from this than the downstream sectors.

The main concern related to a 5 % limit is whether the scrap, which contains more foreign materials, would be treated and refined outside the EU with the same environmental protection techniques as within the EU.

### Other considerations related to the foreign material content

Some experts of the TWG have proposed to not count any non-hazardous metals as foreign materials. It was argued that such other metals, for example iron, may be a desired component in the scrap used for certain secondary copper production processes. It was also suggested to allow copper-aluminium radiators or copper-steel rotors for end-of-waste status. It was argued that these scraps were commonly used by copper smelters or aluminium smelters, and that excluding them may not be economically preferable. However, since these mixed materials usually require smelting/refining and their use may potentially increase the level of emissions and residues, it remains doubtful whether the quality of these scrap types would qualify for end-of-waste status.

In addition and as a complement to the limit value on foreign materials, the scrap shall not contain excessive oxide in any form, except for typical amounts arising from the outside storage of prepared scrap under normal atmospheric conditions. The TWG experts did not express a uniform opinion on the inclusion of requirements on oxide content. However, it is clear that including a limitation on the presence of excessive oxides limits the environmental risks. This requirement has thus been proposed.

The scrap should be investigated by visual inspection for the presence of foreign materials and oxides; a typical amount of oxide arising from outside storage of prepared scrap under normal atmospheric conditions is acceptable. The appropriate frequencies of monitoring shall be established by consideration of the following factors:

- the expected pattern of variability (for example as shown by historical results)
- the inherent risk of variability in raw material input quality and any subsequent processing
- the inherent precision of the monitoring method
- the proximity of actual results to the limit of compliance with the relevant end-of-waste condition.

The process of determining monitoring frequencies should be documented as part of the overall quality assurance scheme and as such should be available for auditing.

***The legal formulation could be as follows:***

***The total amount of foreign materials shall be x % by weight (the final number shall be within the range from 2% to 5 %);***

***Foreign materials include, inter alia:***

1. ***metals other than copper and copper alloys;***
2. ***non-metallic materials such as earth, dust, insulation and glass;***
3. ***combustible non-metallic materials such as rubber, plastic, fabric, wood and other chemical or organic substances;***
4. ***slags, dross, skimmings, baghouse dust, grinder dust, sludge.***

***The scrap shall not contain excessive metal oxide in any form, except for typical amounts arising from outside storage of prepared scrap under normal atmospheric conditions.***

***Monitoring:***

***Qualified staff shall carry out visual inspection of each consignment. At appropriate intervals representative samples of each grade of copper/copper alloy scrap shall be analysed to measure the total amount of foreign materials. The total amount of foreign materials shall be measured by weighing after manual separating copper/copper alloy metallic particles and objects from particles and objects consisting foreign materials by hand sorting or other means of separation (e.g. by magnet or based on the density).***

*The appropriate frequencies of analysing representative samples shall be established taking into account the following factors:*

- 1. the expected pattern of variability (for example as shown by historical results);*
- 2. the inherent risk of variability in the quality of waste used as input for the recovery operation and in the performance of the treatment processes;*
- 3. the inherent precision of the monitoring method; and*
- 4. the proximity of results to the limit values for the total amount of foreign materials.*

#### **Oil, oily emulsions, grease or lubricants**

Oil, oily emulsions, grease or lubricants are often used in products made of copper and for the working of these materials. If they are present in scrap, except in negligible amounts, they present a direct environmental risk to water and soil, especially if not handled with protective measures during transport and storage. They are also undesired in the copper or copper alloys production process and can lead to higher levels of emissions of certain pollutants.

The discussion of the TWG during the workshops in March and July 2010 in Seville led to the conclusion that a qualitative requirement was sufficient in the sense that the copper/copper alloy scrap should be free of visible oil. This means that oil, oily emulsions, grease, or lubricants should not be visible in any part of the scrap load. Each load/consignment of scrap should be inspected visually regarding this requirement, especially in those parts of the load where oil is most likely to accumulate, i.e. the bottom.

Small stains of oil on limited parts of large objects (oily shine) could be tolerated only if they are negligible in terms of mass and extension in the consignment. Under no circumstances can oil be tolerated that may lead to dripping.

A concern voiced by several members of the TWG was that oil in filings and turnings may make up several percentage points of the mass of the material, also if the material has been centrifuged and pressed, and to some extent even after heat treatment. Filings and turnings that contain oil should therefore be excluded as input material for end-of-waste scrap (see the section on input materials below).

Eurometrec (2010) estimates that the ISRI category Night will in no case meet the end-of-waste criteria due to the presence of oil and grease.

#### **The legal formulation could be as follows:**

*The scrap shall be free of visible oil, oily emulsions, lubricants or grease except negligible amounts that will not lead to any dripping.*

*Qualified staff shall carry out a visual inspection of each consignment, paying particular attention to those parts where oil is most likely to drip.*

#### **Radioactivity**

The end-of-waste criteria need to address radioactivity because of the direct environmental and health risks of incidents involving radioactive scrap. In addition, the financial consequences of such incidents for the metal processing industry are always very serious, and the incidents can lead to a loss of trust in the recycled metal industry and the associated products since consumers do not wish to have unnecessary radiation emanating from their purchases.

The radiation of each load of metal scrap shall have been monitored and should be demonstrated by the producer of the scrap metal who declares compliance with the end-of-waste criteria, for example by providing a Radioactivity Test Certificate in accordance with the UNECE recommendations or any other national or international rules on monitoring and response procedures for radioactive scrap metal.

Some members of the TWG expressed doubts that a requirement on radioactivity monitoring was required in the case of copper and copper alloy scrap because incidents were less frequent than for aluminium, iron and steel scrap and input monitoring before scrap use may be sufficient and more economical. Others insisted on the need for a monitoring requirement also in the case of copper and copper alloy scrap. Reports from several sources on the increasing number of radioactivity incidents in the case of copper scrap support that there is a need to check for radioactivity.

The common practice in the EU-27 is to check the radioactivity with installed automatic instruments (used usually by large or medium-sized companies) or hand-held and pocket-type instruments (used usually by small companies) which by a sound signal (alarm) indicates the possible presence of a radioactive source. If the alarm sounds, then, for example, the procedure according to the UNECE recommendation or according to the safety standards made by the International Atomic Energy Agency for 'Orphan Sources and Other Radioactive Material in the Metal Recycling and Production Industries' should take place and common procedures should be followed.

In the proposals for aluminium scrap and iron and steel scrap a formulation referring to the **ambient level of radioactivity** had been used: 'The following must be excluded: material presenting radioactivity in excess of the ambient level of radioactivity; and radioactive material in sealed containers, even if no significant exterior radioactivity is detectable due to shielding or due to the position of the sealed source in the scrap delivery.'

However, reference to the concept of ambient level is not recommended for a legal text as it is an imprecise, variable reference. Reference to the term '**response action**' is proposed instead.

***The legal formulation could be as follows:***

***There is no need for response action according to national or international rules on monitoring and response procedures for radioactive scrap metal.***

***This requirement is without prejudice to the legislation on the health protection of workers and members of the public adopted in Chapter III of the Euratom Treaty, in particular Council Directive 96/29/Euratom.***

***Measuring:***

***Qualified staff shall monitor the radioactivity of each consignment. Each consignment of scrap shall be accompanied by a certificate established in accordance with national or international rules on monitoring and response procedures for radioactive scrap metal. The certificate may be included in other documentation accompanying the consignment.***

**Hazardous properties**

Condition (d) of Article 6.1 of the WFD demands that end-of-waste criteria ensure that the use (understood here as also including transport, handling, trade) of scrap shall not lead to overall adverse environmental or human health impacts.

This implies that copper and copper alloy scrap should not be given end-of-waste status if it has any of the hazardous properties included in Annex III of Directive 2008/98/EC on waste (properties of waste which render it hazardous). This concerns for example materials such as asbestos, which shall not be present in end-of-waste scrap.

The reason is that in this case, general waste regulatory controls as well as the specific provisions of the WFD on hazardous waste (in particular Articles 17-19 regarding control, ban on the mixing and labelling of hazardous waste) are needed to protect the environment and human health.

The product quality requirement should therefore include a clause that clearly establishes that scrap with hazardous properties does not cease to be waste. Concentration limit values of the relevant EU legislation should apply, including those regarding persistent organic pollutants and for any metals contained in the scrap (including As, Be, Se, Cd, Pb, Ni, Hg) with the exception that the end-of-waste criteria should not limit the content of alloying elements that are part of the alloy.

Comprehensive monitoring of the product with respect to all of the possible hazardous properties by specific tests is, however, not a feasible approach. The systematic chemical analysis of the composition, determination of moisture or oil for every truckload or loose material box would require additional costs and may defeat the purpose of the whole end-of-waste concept.

For example, the in-depth inspection of every consignment of material will require the following estimated costs (ECI, 2010):

- € 20-30 for a visual inspection
- € 40-50 for direct spectrometric analyses
- € 70-90 for analyses that need prior melting of the sample.

These costs exclude the investment costs of equipment, e.g. a melting furnace (approximately €40 000-50 000), a spectrometer (approximately €50 000-60 000), an analyser for lubrication/moisture content (approximately € 3 000-5 000).

Currently, the processors and traders do not typically analyse the chemical composition of their scrap, the analysis is done on the metals producers side. In Europe there are thousands of small scrap collectors for which additional analyses such as spectrometric or melting for every batch would cause their businesses to close.

The best approach to exclude hazardous properties of the product is to rely on a combination of proportionate direct product monitoring with requirements on input materials, treatment processes and techniques, and quality assurance.

This approach is deemed sufficient to control scrap quality. Some members of the TWG suggested that it should be made clear that whenever there are indications for possible hazardous properties (e.g. in suspected cases of contamination) further appropriate monitoring measures have to be taken, including, if appropriate, sampling and testing.

**The legal formulation could be as follows:**

*The scrap shall not display any of the hazardous properties listed in Annex III to Directive 2008/98/EC. The scrap shall comply with the concentration limits laid down in Commission Decision 2000/532/EC and not exceed the concentration limits laid down in Annex IV of Regulation 850/2004/EC.*

*Properties of alloy metals included in copper alloys are not relevant for this requirement.*

**Measuring:**

*Qualified staff shall investigate each consignment by visual inspection. Where visual inspection raises any suspicion of possible hazardous properties, further appropriate monitoring measures shall be taken, such as sampling and testing where appropriate. The staff shall be trained on potential hazardous properties that may be associated with copper/copper alloys scrap and on material components or features that allow recognising the hazardous properties. The procedure of recognizing hazardous materials shall be documented under the quality management system.*

**Other undesirable materials/objects**

Particular aspects to be addressed are pressurised, closed or insufficiently open containers of all origins. Such containers represent a specific hazard because they could cause explosions in the metal work furnace. This hazard is not addressed explicitly by Annex III of the WFD. A specific clause would therefore have to be included in the end-of-waste criteria.

While some experts of the TWG said that the criterion on pressurised containers was not needed, others wanted to keep the formulation or additionally add that the scrap shall not contain liquid or solid items containing encased liquids (e.g. copper compressors containing oil) or that closed containers with non-metallic or unknown contents have to be avoided too.

It should be noted, however, that it is proposed to include as a process requirement that barrels and containers shall have been emptied and cleaned.

It seems therefore reasonable to maintain the requirement on pressurised, closed or insufficiently open containers.

**The legal formulation could be as follows:**

*The scrap does not contain any pressurised, closed or insufficiently open containers that could cause explosions in a metal work furnace.*

**Measuring:**

*Qualified staff shall investigate each consignment by visual inspection.*

**Coatings, paints, plastics**

Only limited amounts of coatings and other organic substances such as paints can be tolerated for secondary copper production. Generally, plastics are covered under the definition of foreign materials. Under normal conditions, considerable amounts of coatings, paints and plastics are removed during treatment (e.g. shredding).

Coatings and paints will combust during melting, resulting in emissions, and therefore provide no benefit for scrap customers. Emissions from these materials are controlled and regulated in the EU under IPPC permits. However, there is particular concern over the

presence of PVC and other halogenated substances in them, which may lead to additional emissions of dioxins and other toxic substances from the furnaces, and require special air emissions equipment. The TWG has thus supported the inclusion of an additional limitation on PVC, in order to minimise the potential environmental impact of the inappropriate combustion of coatings and paints.

Other important potential sources of halogens are special types of emulsions or oils. The combustion-related risk from these are addressed in the end-of-waste criteria in specific requirements on the limitation of oil, emulsions and grease.

**The legal formulation could be as follows:**

***The scrap shall not contain PVC in form of coatings, paints, or residual plastics.***

***Measuring:***

***Qualified staff shall carry out a visual inspection of each consignment.***

**Considerations not leading to proposals of separate product quality requirements**

Requirements on chemical composition

The TWGs on iron and steel scrap and aluminium scrap were not in favour of including requirements on the chemical composition of scrap alloys, i.e. other ferrous or non-ferrous metals such as steel, copper, molybdenum, or zinc. This was deemed a matter for commercial agreements rather than for regulation because no particular environmental or market risks would be addressed.

As the situation for copper and copper alloys scrap is totally parallel, a similar approach has been used.

Size of materials

The size of the particles or pieces of scrap is related to technical limitations of the processes in the customer's furnace, therefore it does not have a direct effect on environmental or health issues. Prescriptions on size need not be included as part of the criteria, and are considered a matter of specifications and commercial agreements between the seller and the customer in the copper chain.

### ***3.4 Requirements on input materials***

The purpose of criteria on input materials is to check product quality indirectly. The end-of-waste criteria should allow as input only waste types for which it is practical and safe to obtain copper scrap or copper alloy scrap in compliance with the product quality requirements. This implies that a waste can only be allowed if it contains copper or copper alloy that can be recovered for the production of new copper or copper alloys products and, after appropriate treatment, can be used without overall adverse environmental or human health impacts.

The discussions in the TWG confirmed that the criteria on input materials should not be unnecessarily restrictive and that, in principle, all types of waste that contain recoverable metal scrap and for which treatments exist to obtain scrap metal with the required product quality should be allowed as input. The criteria on input materials and treatment processes



should be explicit for those wastes that pose relevant hazards and that the criteria can be more general for other types of wastes.

Regarding non-hazardous waste, it would be sufficient to include a general requirement that they must contain recoverable copper or copper alloys. If the original copper slag is hazardous, further considerations need to be taken into account which are described below:

Hazardous wastes pose substantial risks to the environment and human health. Waste law includes specific regulatory controls to deal with these risks. Hazardous waste can only cease to be waste if confidence is established that it has been treated in a way that reliably removes all hazardous properties.

The monitoring and testing of product quality alone is not a workable approach to ensure that the resulting product does not have any hazardous properties, sufficient confidence can only be obtained through this approach with disproportionate testing efforts. Instead, it is generally more feasible to ensure that whenever a hazardous waste is used as an input, it has undergone a suitable treatment. Which type of treatment is suitable depends on the type of hazardous waste used as input.

As part of end-of-waste criteria the choice of a suitable treatment to deal with hazardous waste cannot be left open to case-by-case industry decisions but must follow clearly defined and legitimated treatment requirements for the specific type of hazardous waste. In the EU such treatment requirements have been established in the ELV Directive and the WEEE Directive. Hazardous wastes that are covered by the provisions of one of these directives could therefore be allowed as input materials.

For instance, if discarded equipment containing chlorofluorocarbons is considered a hazardous waste only due to the content of chlorofluorocarbons, it can be rendered non-hazardous by removing these substances in a controlled process. This is a clearly defined process that can be included in the process requirements. This type of hazardous waste may therefore also be allowed as input material.

Other types of hazardous waste could be used as input under the condition that proof is provided and approved by the authorities (for example as part of the permit for the waste treatment facility) that suitable treatment is applied to remove all hazardous properties.

Barrels and containers containing oil or paint should not be accepted due to the higher environmental risk. The main reason is that it is known that some paints, oils and solvents can not be fully cleaned except with disproportionate efforts. However, containers treated in accordance with the End-of-life Vehicles Directive (see also requirements on treatment processes below) should be able to cease to be waste.

#### Filings and turnings

Experts from the TWG have expressed concerns that copper and copper alloy turnings usually contain substantial amounts of oil even when such a material is treated by centrifuging or pressing. Oil contents result in organic emissions when entering the furnace, with environmental and health impacts when such scrap is used. It would thus not be justified to release filings and turnings that contain such fluids from waste regulatory control. Accordingly, fillings and turnings that contain cutting fluids or oils should not be allowed as input material for end-of-waste scrap.

***The legal formulation could be as follows:***

***Only waste that contained recoverable copper or copper alloys may be used as input.***

***Hazardous waste shall not be used as an input except where proof is provided that the processes and techniques specified under ' criteria on treatment and techniques' to remove all hazardous properties have been applied.***

***The following wastes shall not be used as an input:***

- ***filings and turnings that contain fluids such as oil or oily emulsions and***
- ***barrels and containers, except equipment from end-of-life vehicles, which contain or have contained oil or paints.***

***Monitoring:***

***Acceptance control of all waste received (by visual inspection) and of the accompanying documentation shall be carried out by qualified staff which is trained on how to recognise waste that does not fulfil the criteria set out in this section.***

### ***3.5 Requirements on treatment processes and techniques***

The legal conditions require that end-of-waste criteria ensure that there is a demand for the substance or object that ceases to be waste and that its use will not lead to overall adverse environmental or human health impacts.

This implies that the material must have gone through all necessary treatment processes that make it directly useful and allow for transporting, handling, trading and using the scrap without increased environmental and health impact (or risks) compared to a situation where the waste status is maintained.

The purpose of criteria on treatment processes is to check product quality indirectly.

The criteria on processes and techniques can include:

- basic general process requirements that apply in all cases (for all types of waste);
- specific process requirements for specific types of waste (including all allowed hazardous waste types).

For non-hazardous waste, generic requirements that do not prescribe a specific technology are preferable. The reason is that industry should not be prevented from adapting to the specific circumstances and from innovation. Specific process requirements are however needed for the treatment of hazardous wastes and certain complex waste and possibly also for certain special cases of input materials (such as cables) for which the direct product requirements are not considered stringent enough.

The general process requirements should clarify the minimum treatment required and where in the treatment chain the point of end-of-waste is reached. The principle is that scrap should have completed all required treatments that make it suitable for direct use in the production of new metal. Exempt from this are pretreatments that normally take place directly at the metal works. Some scrap may be obtained in pure form by segregating it from other waste at source

or during collection. Any other wastes (that at the origin contain copper scrap and other material) must have been treated to separate the non-metal and if needed also other metals off.

**The legal formulation could be as follows:**

***The copper and copper alloys scrap shall have been segregated at source or while collecting and shall have been kept separate or the input wastes shall have been treated to separate the copper and copper alloys scrap from the non-metal and non-copper metal components.***

***All mechanical treatments (like cutting, shearing, shredding or granulating; sorting, separation, cleaning, de-polluting, emptying) needed to prepare the metal scrap for direct input into final use shall have been completed.***

ELVs and WEEE are complex wastes for which treatment requirements have been established by European directives. The wastes covered by these directives, whether hazardous or non-hazardous, cannot cease to be waste unless they have fulfilled the provisions of the directives.

Specific treatment requirements are also needed for discarded equipment containing chlorofluorocarbons because they are hazardous waste and are not in all cases covered by the requirements of the ELV or WEEE Directives.

Special treatment requirements are also needed for cables and containers, including stripping, chopping, the removal of organics, emptying and cleaning containers. Guidelines on Best Available Techniques for these operations exist internationally, e.g. UNEP 2003 on BAT for the smouldering of copper cables.

A majority of experts from the TWG have suggested that there should be no requirements on baling or compacting. Baling has the advantage of easier handling and transport, but it can also be used to hide lower quality material inside the bale. For EoW criteria, this issue is a necessary requirement as long as control of the quality of a consignment is not hindered; cf. section below on quality assurance. It is understood that it is also in the interest of the buyer of scrap that the material quality be in conformity with the commercial contract, and that the quality be able to be controlled.

**The legal formulation for the specific process requirements could be as follows:**

***For waste containing hazardous components the following specific requirements shall apply:***

1. *Input materials that originate from waste electrical or electronic equipment or from end-of-life vehicles shall have undergone all treatments required by Article 6 of Directive 2002/96/EC of the European Parliament and of the Council and by Article 6 of Directive 2000/53/EC of the European Parliament and of the Council;*
2. *Chlorofluorocarbons in discarded equipment shall have been captured in a process approved by the competent authorities;*
3. *Cables shall have been chopped or stripped. If a cable contains organic coatings (plastics), the organic coatings shall have been removed in accordance with best available techniques;*
4. *Barrels and containers shall have been emptied and cleaned;*
5. *Hazardous substances in waste not mentioned in point (1) shall have been efficiently removed in a process which is approved by the competent authority.*

### 3.6 *Quality assurance*

The TWG has expressed strong support for making quality assurance requirements part of the end-of-waste criteria. Quality assurance is needed to create confidence in the end-of-waste status. The owner of the material applying for the end-of-waste status will have to rely on a quality assurance system to be able to demonstrate compliance with all the end-of-waste criteria for the material to cease to be waste.

A quality management system must be in place and cover the key areas of operation where compliance with end-of-waste criteria will have to be demonstrated.

Whilst the implementation of an internationally recognised quality management system such as ISO 9001 would be suitable, it is not considered appropriate for end-of-waste criteria to specify a particular quality management system which must be implemented.

It is considered appropriate and proportional for end-of-waste criteria to require that a quality management system be implemented and externally verified. Such verification should assess if the quality management system is suitable for the purpose of demonstrating compliance with the end-of-waste criteria applicable to the case in question.

A suitable quality management system for scrap metal is expected to include:

- procedures to determine the acceptance of input materials;
- monitoring of processes to ensure they are effective at all times;
- procedures for monitoring product quality (including sampling and analysis) that are adjusted to the process and product specifics according to good practice;
- procedures that ensure the effectiveness of radiation monitoring and the ability of radiation monitors to detect changes in radiation intensity;
- actively soliciting feedback from customers in order to confirm compliance with product documentation;
- record-keeping of main quality control parameters;
- measures for the review and improvement of the quality management system;
- training of staff.

The quality assurance system must be verified by an independent expert (e.g. an environmental verifier as defined in Regulation (EC) No 1221/2009 or a conformity assessment body as defined in Regulation (EC) No 765/2008). The independent expert shall verify that the quality management system complies with the requirements and that the competent authorities have access to the quality management system when needed.

**The legal proposal on quality assurance system could be as follows:**

1. ***The producer shall implement a quality management system suitable to demonstrate compliance with the criteria.***
2. ***The quality management system shall include a set of documented procedures concerning each of the following aspects:***
  - a. ***acceptance control of waste used as input for the recovery operation;***
  - b. ***monitoring of the treatment processes and techniques (described under section treatment processes and techniques);***
  - c. ***monitoring of the quality of scrap metal resulting from the recovery operation (including sampling and analysis);***
  - d. ***effectiveness of the radiation monitoring (described under section of radiation and monitoring);***
  - e. ***feedback from customers concerning the product quality;***
  - f. ***record keeping of the results of monitoring conducted under points (a) to (d);***
  - g. ***review and improvement of the quality management system;***
  - h. ***training of staff.***
3. ***The quality management system shall also prescribe the specific monitoring requirements set out for each criterion.***
4. ***Where any of the treatments referred to in the section on specific process requirements for waste containing hazardous components<sup>9</sup> is carried out by a prior holder, the producer shall ensure that the supplier implements a quality management system which complies with the requirements.***
5. ***The importer shall require his suppliers to implement a quality management system which complies with the requirements of points 1 to 4 and has been verified by an independent external verifier.***

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<sup>9</sup> For waste containing hazardous components the following specific requirements shall apply:

- (1) Input materials that originate from waste electrical or electronic equipment or from end-of-life vehicles shall have undergone all treatments required by Article 6 of Directive 2002/96/EC of the European Parliament and of the Council and by Article 6 of Directive 2000/53/EC of the European Parliament and of the Council;
- (2) Chlorofluorocarbons in discarded equipment shall have been captured in a process approved by the competent authorities;
- (3) Cables shall have been chopped or stripped. If a cable contains organic coatings (plastics), the organic coatings shall have been removed in accordance with best available techniques;
- (4) Barrels and containers shall have been emptied and cleaned;
- (5) Hazardous substances in waste not mentioned in point (1) shall have been efficiently removed in a process which is approved by the competent authority.

6. *A conformity assessment body as defined in Regulation (EC) No 765/2008, which has obtained accreditation in accordance with that Regulation, or any other environmental verifier as defined in Art 2(20) (b) of Regulation (EC) No 1221/2009 shall verify that the quality management system complies with the requirements of this Article. The verification should be carried out every three years.*
7. *The producer shall give competent authorities access to the quality management system upon request.*

### 3.7 Information provided with the product

*The producer or the importer shall issue, for each consignment of scrap metal, a statement of conformity conforming to the model set out below.*

	<i>Producer/importer of scrap metal:</i>
	<i>Name:</i>
	<i>Address:</i>
1.	<i>Contact person:</i>
	<i>Tel.:</i>
	<i>Fax:</i>
	<i>E-mail:</i>
2.	<i>a. Name or code of the scrap metal category, in accordance with an industry specification or standard:</i>
	<i>b. b) Where relevant, main technical provisions of a customer specification, such as composition, size, type and properties:</i>
3.	<i>The scrap metal consignment complies with the industry specification or standard referred to in point 2(a) or with the customer specification to in point 2(b).</i>
4.	<i>Quantity of the consignment in kg<sup>10</sup>:</i>
5.	<i>A radioactivity test certificate has been established in accordance with national or international rules on monitoring and response procedures for radioactive scrap metal</i>
6.	<i>The producer of scrap metal applies a quality management system complying with Article 6 of Regulation (EU) No....[will be inserted once this Regulation adopted], which has been verified by an accredited verifier or, where scrap metal which has ceased to be waste is imported into the customs territory of the Union, by an independent verifier.</i>
7.	<i>The scrap metal consignment meets the criteria referred to above.</i>
8.	<i>Declaration of the producer/importer of scrap metal : I certify that the above information is complete and correct to the best of my knowledge:</i>
	<i>Name:</i>
	<i>Date:</i>
	<i>Signature:</i>

*The statement of conformity may be issued in an electronic format.*

<sup>10</sup> By using kg instead of tonne, one uses a unit which is part of the International System of Units (SI), and avoids any possible confusion in international transport between the SI accepted unit tonne (1000kg), also called metric tonne, and the units of the Imperial UK and US customary units "ton" (long tonne = 1.016 tonnes, short ton = 0.9072 tonnes).

## 4 DESCRIPTION OF IMPACTS

The introduction of end-of-waste criteria is expected to support recycling markets by creating legal certainty and a level playing field, as well as removing unnecessary administrative burdens. This section outlines key impacts on the environment, on markets, and on existing legislation, of the implementation of end-of-waste criteria.

### 4.1 *Environment and health impacts*

#### Air emissions, odours, dust, noise, fire risks and health impacts

The treatment of copper scrap prior to achieving end-of-waste status will remain under waste regulation, as for any facility that handles waste input. Thus, the specific emissions, dust or noise generated during the treatment of waste containing copper will not be changed by the implementation of end-of-waste criteria. The environmental and health impacts of copper production, including from scrap, are described under IPPC permits. The generation of non-copper materials from reprocessing may change slightly, e.g. in case more upgrading from N<sup>o</sup>2 to N<sup>o</sup>1 scrap takes place, but this is highly uncertain. Should this happen, it would improve health and safety down the copper scrap chain, and may slightly affect both the permits of reprocessors and copper manufacturers.

EoW supports the development of recycling, which is known to reduce the energy requirements of copper production, compared to production from mineral ores. Associated with energy savings, a number of related environmental impacts are also reduced, including most air emissions. The energy savings for secondary production were estimated at around 7 MJ/kg compared to primary production (BIR, 2008). Additionally, all emissions from ore extraction and processing are also avoided.

EoW will thus contribute to the aforementioned environmental impact reductions to the extent, difficult to measure, that it may contribute to an overall increase of the amount of copper scrap recycled.

#### Risks related to transport and storage

Storage and transport of end-of-waste copper scrap will no longer be covered by waste regulatory controls. Theoretically, this could imply an increased risk of impact to the environment if copper scrap were to have properties needing control only provided by waste regulation. However, normal good practice of transport and storage seems to be appropriate to control the type of risks of scrap storage, namely those of dust, noise and moisture. Scrap containing leachable material is not fit for ceasing to be waste. The aforementioned impacts are currently controlled in many reprocessing plants by measures such as separation screens and walls or covers, and regular cleaning. In practice it can be expected that end-of-waste scrap will, as a product, be stored in most cases under the same conditions as when it was considered waste.

In the proposed EoW criteria, no special provisions for health and environmental protection are introduced except the exclusion of a number of input materials (prohibited materials such as hazardous materials, PVC, containers, oil). The criteria proposed are considered sufficient to reduce the health and environment risks from cross-contamination to a minimum, and thereby the risk of disamenities like odours, vermin attraction, or leaching, as if they were under waste law. Among other effects, this will have an impact on some scrap grades that

have an origin of very mixed materials, and are therefore more exposed to cross-contamination. If these copper scrap grades do not meet the criteria, then it is understood that they cannot fulfil in all conditions of use of the copper scrap as a product.

### Risks related to scrap use

Scrap quality has a great impact on energy consumption and direct emissions of secondary copper furnaces. It is common in impact assessment studies to assume that the emissions from scrap processing are characterised by linear relationships between the content of the substances in the emissions, and the origin of these, in most cases as substances present in the foreign materials content. It can therefore be assumed that the production of secondary copper from low quality scrap is more energy and emission intensive than that of high quality scrap (Ecofys, 2009).

Higher foreign material content in the scrap will in all likelihood generate more emissions such as CO<sub>2</sub>, VOC, PCDD/F, slag, ashes, or sludge. It is also known that there are additional factors which may influence the quantity and quality of emissions during the copper production process, such as combustion conditions, type of furnace, and abatement technologies.

The dependence of emissions on the specific foreign materials composition and the processing conditions makes it impossible to specify a direct relationship between foreign materials content and emissions, and estimate exactly the nature of the difference between a 2% or 5% foreign material content. It can just be assessed that overall, greater emissions can be expected the greater the content of foreign materials.

An additional aspect of concern is that emissions to air, water, and soil from copper production outside the EU may be larger than in the EU where best available techniques are generally being applied. This is of relevance especially for scrap containing high percentages of foreign materials treated in smelters and refineries. Most of the copper scrap is currently exported to China, where a recent LCA study indicates that the emissions from copper scrap treatment technology in China, although greater than in Europe, are in general of a high standard, higher than in most non-OECD countries, but similar to North America (Streicher-Porte and Althaus, 2010). It is unclear how effective the current waste status of scrap in the EU is in preventing scrap exports from treating scrap in facilities that do not have environmental protection standards equivalent to those in the EU.

A positive effect of end-of-waste may be that by more systematically controlling sorting and cleaning to meet EoW material quality criteria within the EU, there would be a reduced export of foreign materials in copper scrap, and these will be managed within the EU following EU legislation. This would imply a reduction in the disposal of the non-copper fraction in the destination country under unknown conditions. Marginal energy savings may also result by not unnecessarily transporting the unusable materials in scrap across long distances.

### Radioactive metal scrap

The end-of-waste criteria include requirements on radioactivity monitoring which are introduced to control the risk related to any non-detected radioactive metal scrap.



## 4.2 Economy and market impacts

The following potential economic and market impacts may be expected:

- avoidance of costs related to the shipment of waste
- avoidance of the costs of handling the waste scrap in terms of permits and licenses
- long-term availability and strategy of the European copper industry
- price adjustments.

### Direct costs

End-of-waste regulation will lead to an overall reduction of administrative costs, which will make copper recycling more competitive compared to primary production. Especially the trade for the recycling of clean and pretreated scrap, including high grade old scrap, would become more economical.

In certain cases, traders and possibly also users of end-of-waste scrap will encounter lower administrative burdens. This will be relevant if they use only high grade scrap as a secondary raw material because the end-of-waste status of scrap will spare waste treatment licensing or permitting (see Box 1). For scrap traders and users that will continue in parallel to treat waste scrap, the cost savings will be more limited.

#### **Box 1: Example of paperwork under a waste treatment authorisation**

Under a waste treatment authorisation a company may have to complete the administration paperwork given below every year.

- An annual report (company-specific reporting of all transactions and EWC code-specific reporting of all transactions). This usually requires administration time of 5 person months/year).
- Monthly reports of incoming and outgoing materials.
- Record books.
- Special activity licence.
- Environmental impacts assessment of the activity if handling over 5 tonnes/day.
- Environmental responsibility insurance.
- Waste transport authorisation.

End-of-waste status will also lead to cost savings for scrap exporters. The waste status of metal scrap affects its exportability by increasing the administrative burdens, and has a higher risk of disagreement between control authorities, resulting in higher costs to the recycling sector. The factors given below influencing the costs of international shipment have been identified.

- Requirement to obtain certain information from overseas (non-EU) re-processors to satisfy 'broad equivalence' obligations set out in the Packaging Directive, the WEEE Directive and the Waste Shipments Regulation. With 'end-of-waste' status, it would be possible to produce the necessary evidence based on the end-of-waste criteria concept.
- Notification and insurance costs on financial guarantees for waste shipments sent to countries where pre-notification is required (including certain 'green list' shipments) under the Waste Shipments Regulation. Each notification requires a financial guarantee, except to countries under treaty of accession arrangements. This is 'financed' by the bank at certain costs and also means a lower liquidity for the companies. Because of this there is a limit to the number of notifications a company can handle/absorb. In other words there is an artificial (trade) barrier and companies cannot sell to all potential customers after their financial limit has been reached.
- The shipment of Green-listed waste to EU Member States in a transitional period does not require a financial guarantee (insurance). However administrative fees for notification might be high and vary from country to country. End-of-waste would facilitate the free trade of scrap that meets the set end-of-waste criteria in Latvia up to 31 December 2010; Poland up to 31 December 2012; Slovakia up to 31 December 2011; Bulgaria up to 31 December 2014; and Romania up to 31 December 2015.
- Administration costs for maintaining the Annex VII of the Waste Shipments Regulation tracking forms and domestic waste movement forms. In addition to the direct administration costs associated with form filling, there is an issue of having to supply commercially-sensitive data. Customers outside EU jurisdiction are not willing to have their commercial transactions recorded and made available to public authorities. Therefore they turn to non-EU suppliers.
- Loss of business where customers fail to provide appropriate information.

Shipment costs depend on distance. In general, the costs between neighbouring countries in Europe (100-1000km) are between €15-20 per tonne, in the case of longer distances (+3000 km) the cost could reach €70 per tonne. Exports from the UK to China currently cost on average €65 per tonne (BMRA/ HOE, 2010). These costs remain the same whether the scrap ceases to be waste or not.

The costs of documentation and quality assurance related to the shipment of end-of-waste scrap could be estimated at €4-6 per tonne within Europe, and about €11 per tonne for shipment to Asia (BMRA/ HOE, 2010).

The British Metals Recycling Association summarised the trans-frontier shipment notification costs for several countries. This information is given in Table 14.

**Table 14: Examples of financial guarantee and notification charges for exports from some European countries/regions.**

Country	Financial guarantee (non-haz) (in EUR)	Financial guarantee (haz) (in EUR)	Notification charge – single (in EUR)
Belgium			
Flanders	€2 per tonne (min. €1200)	€8 per tonne (min. €4800)	€250
Wallonia	Variable depending on waste type, distance and treatment influence cost		€250
France	No standard method however the government is willing to define a methodology		€0
Germany	€50 (base) + €1 per tonne >25t	€50 (base) + €1.5 per tonne >25t	€0
Hungary	No formula for the calculation. The calculation is based on many factors, therefore the financial guarantee is very variable: according to calculations submitted by companies, the lowest amount has been approx. 3000 €/truck and the highest 13000 €/truck		Approximately €680
Ireland	Variable: cost of shipment, cost of disposal/recovery + 50% contingency		€250 or 500 (annual fee) + €0.60 or 2.50 per tonne (up to 1000 tonnes + €0.30 per tonne >1000t <sup>[11]</sup> )
Italy	Variable depending on waste type, mode of transport, number of containers per shipment		€130
Netherlands	€450 per tonne, although discounts available (typical discount: €150-200 per tonne)		€0
Spain	No method: local authorities set charges		€0
UK	Variable depending on cost of shipment, cost of disposal/recovery + administrative fee (550€)		€1400 (~€1500€)

*Source: BMRA/HOE, 2010.*

An estimation of costs savings when the end-of-waste status is in force is very difficult to calculate and predict, due to the variety of costs and differences by Member States, as presented in Table 14 above.

#### Quality control costs

The quality of the copper/copper alloy scrap which ceases to be waste must be guaranteed by the quality assurance by direct product monitoring on input materials, treatment processes and product quality.

The criteria have been formulated so as to avoid to the extent possible unnecessary costs. Monitoring will follow current practice and rely mainly on visual inspection and regular analyses of the content of foreign materials. Frequency will depend on how far the average foreign material content is from the threshold, so very pure material will require very little sampling effort, while material typically close to the threshold will have a higher sampling demand.

The current common practice will therefore remain the same for the reprocessors and traders, with adaptation to the foreign material threshold. Chemical analyses of scrap composition are also current practice, and no analyses are required in EoW criteria that are not current

<sup>11</sup> Variable notification charges dependant on whether ‘green list’ or ‘amber list’.

practice. The exception may be the independent procedure to be followed for consignments with the likely presence of hazardous materials, as this requires further measuring and cleaning.

Producers of end-of-waste scrap, typically waste collectors and processors, will incur additional costs of compliance with the end-of-waste criteria, but they will sell a product the trading and use of which will be regulated by product law, and which is quality-assured. It is therefore likely that this will have some influence on price, although only the adjustment of offer-demand equilibria will reveal this.

### Trade

This section analyses the evolution of the copper and copper alloy scrap trade and prices, the factors influencing the development of these parameters and what role end-of-waste may play.

#### *Copper ores and concentrates*

Mining has remained relatively stable in the last decade. The export of copper ores and concentrates in the EU-27 increased from 46.6 thousand metric tonnes in 2004 to 144.5 thousand metric tonnes in 2008. However, during the same period, the import increased from 2436 thousand tonnes to 3420 thousand tonnes respectively (Table 2).

#### *Scrap*

In the period 2004-2007, the yearly use of copper scrap in the EU-27 remained relatively stable at about 2.5 million tonnes (Table 7). During the last decade (2000-2010) the EU-27 moved from a small net importing position to a large net exporting position of copper scrap. In the period from 2004 until 2008, exports from the EU to China increased by 66%, while the import of copper scrap remained quite stable. end

Remarkably, it is not the high quality scrap that is exported to Asia: the main copper scrap categories affected by export in the last decade have been of medium quality (e.g. scrap No 2, containing 2 to 8% foreign material). This category is used in Europe mainly by smelters and refiners.

Worldwide demand for smelting and refining is shifting to world areas with lower operational costs, which may be explained by lower environmental standards, lower labour costs, or lower energy costs. This shift has been witnessed in the US in the past, particularly acute in times of low copper prices.

The ICSG (ICSG, 2010d) sees evidence that Chinese copper scrap imports are probably composed mainly of old scraps with a low copper content. In recent years (2006-2009) copper and copper alloy scrap imports in China have been increasingly correlated with shortages of low copper content scrap in the Chinese markets. The ICSG analysis revealed that Chinese imports of copper scrap are reacting very quickly in recent years to situations of low scrap availability in the domestic market.

During the last decade, the production of copper by direct melting decreased in the EU-27, while the production of secondary smelters and refineries slightly increased (Table 3). In principle, this implies that the generation and the use of lower quality scrap increased both in Europe and overseas, whilst the direct use of higher quality scrap decreased in Europe.

An end-of-waste scenario will probably not affect this distribution of exports, although the future scenario is difficult to predict. On the one hand, more No 1 scrap could be produced at the expense of No 2 scrap, making less scrap available for smelters and refiners, and thus increasing its price. This may be accentuated if a strict foreign material limit is chosen (e.g. 2%). A less strict value may increase reprocessing to achieve No 2 quality to EoW requirements (e.g. 5%), making this scrap type more readily available.

#### *Prices*

ICSG (2010d) reports very high correlations between scrap price indices and copper price indices. It also found a clear increase in price volatility both in copper scrap and refined copper prices after 2003.

Using data from 2002-2008, the ICSG observes that in the short term the behaviour of refined copper prices affects strongly both the secondary refined production of copper cathodes and the use of copper scrap for direct melt by producers. Nevertheless, globally, the secondary refined production is more sensitive to changes in refined copper prices than directly melted copper. Copper in direct melt of producers is also price sensitive, but the reaction is more moderate when compared to cathodes from copper scrap and looks to be driven by scrap availability more than by prices.

The ICSG observes that the global flow of copper scrap exports shows a strong and positive correlation with the prices of copper scrap in China. The global export supply of copper scrap with lower copper contents is more susceptible to changes in the global demand when compared to the global export supply of copper scrap with a higher copper content. Based on this empirical observation, the ICSG concludes that exports of new scrap (scraps with high copper content recovered from downstream manufacturers) are less sensitive to changes in global demand for imports than the export supply of old scrap (copper scrap recycled from end-of-life products such as industrial waste, old cars, old electronic and electric equipment as old household appliances).

It is expected that with EoW criteria, the supply of high quality scrap would be stimulated. This may lead to an increase in recycling rates and an image improvement, both of them stimulating collection and recycling. Whether availability and larger supply are reflected in prices depends then on many factors, including the economies of scale of the increased reprocessing activity.

One of the potential side effects of this in the medium and long term could be marginally higher prices of scrap that has ceased to be waste, compared to waste scrap. The possible effect on prices is seen differently by downstream manufacturers than by reprocessors. Reprocessors could have prospects of higher prices if they are able to deliver consignments with the added value of being quality checked as part of a quality management that includes periodical quantitative sampling. Conversely, copper manufacturers indicate that they are cautious in their willingness to pay more for qualitatively checked material, as it is yet to be seen if increased quality and price match.

#### *Profitability of recycling*

According to the ICSG, copper scrap recycling is profitable when there is a sustained and reasonable spread in price between refined copper price and that of copper scrap. However, the profitability of recycling copper scrap of different grades is not only related to refined copper prices but also to the price of other metals in the alloys and also to environmental

regulations, taxes, subsidies and requirements of each country, and also with the specific availability of copper scrap and refined copper in every country.

### *Barriers to trade*

Some countries such as China, Russia and Ukraine apply export quotas on copper and copper alloy scrap. China applies a 15 % export tariff on copper scrap exports. There is also a new VAT policy on the recovery and utilisation of renewable resources from December 2008 where the VAT for scrap which is exported from China is 17% (from January 2009).

When Russia introduced very high taxes (50 %) on copper scrap export in 1998, this let the Russian copper scrap export market collapse and the Russian copper scrap markets remained out of reach of international trade during the following decade.

In the past, the European Community also imposed export quotas on copper and copper-alloy scrap exports. These quotas were set by the European Community in 1971 during a copper and copper-alloy scrap shortage. With the help of these export quotas and other restrictions, scrap users within the European Community were able to purchase scrap at relatively lower prices. International trade partners complained and in 1989 the European Community decided not to renew its export quotas on copper and copper-alloy scrap.

The following relationships described below between end-of-waste and scrap trade have been identified.

1. The global trade of scrap is strongly influenced by global development in manufacturing, supply and demand of copper and price developments and arbitrage at the main metal exchanges (ICSG, 2010d).
2. Current Asian demand from the EU is mostly composed of old scraps with low copper content, which will not cease to be waste.
3. Export costs related to the waste status appear very small compared to trade measures of other countries. The export costs vary from €15-70 per tonne of scrap, however only a relatively small part of these costs depend on the waste status. The associated costs such as documentation costs and costs of quality assurance related to the shipment of waste scrap could be estimated as €4-6 per tonne of scrap within Europe and about €11 per tonne of scrap for the shipment from the EU to China. It is also noticeable that the associated costs are below 1% of the copper scrap price (€2000-4000per tonne) and far lower than copper scrap price fluctuations in the past decade (yearly changes of more than €700 per tonne were observed).
4. The costs associated with waste status are very small compared to export taxes (15-50% of the copper scrap price, i.e. several hundreds of euro) applied by certain trade partners.
5. End-of-waste status will concern medium and high grade scrap, with minimal foreign material content, mostly fit for direct melting or for secondary refinery. Due to the absence of reliable statistics, it is difficult to evaluate the amount of scrap which may cease to be waste.
6. Low grade scrap will not cease to be waste, meaning that a part of scrap used by secondary smelters and partly by refiners will be not affected, and for another part it may become profitable to reprocess scrap into higher quality suitable for EoW.

In the above presented context, waste status and the waste shipment regulation seems to play a minor role. EoW will make transactions more effective and transparent. It will reduce

unnecessary administrative burdens. It will make trade within the EU swifter. But the major players of trends in overseas trade seem to be less related to waste policy, and seem to mostly be dominated by Asian development and demand, and tariff imbalance.

#### *Coexistence and share of markets*

The entering into force of an EoW criteria Regulation will likely result in a new option within the market of scrap, both within the EU and outside the EU. Waste status will likely remain for large amounts of scrap. EoW copper scrap, because of its demonstrated quality, will in its own right acquire the benefits of a product in terms of trade and image. Waste scrap that remains waste will continue to be a valuable material for copper production (and for other uses), with the necessary reprocessing. Both market options will find an equilibrium point and coexist. The exact point of equilibrium and uptake of the new option cannot be predicted. Decisions will have to be made by individual reprocessors and furnaces, weighting the advantages and disadvantages for them of both options.

Coexistence will also be observed on trade. On the one hand, scrap that has ceased to be waste will be easier to export, within and outside of the EU. As seen above, the contribution seems to be very low compared to other trade elements such as tariffs. On the other hand, the EU demand of scrap that has ceased to be waste will also be higher, as higher quality material is more demanded in the area where the environmental costs for production are higher, which is the case of the EU compared to, e.g. Asia.

It is difficult to forecast the share of EoW material in the domestic market and in exports outside the EU when equilibrium is reached.

#### *Availability of scrap to the copper industry*

Compared to other world regions, Europe has a large stock of copper and copper alloy in the form of long-life products such as piping, wiring, or parts of machinery and appliances. This results in the continuous generation of scrap. Concerns have been raised that the availability of this scrap could be reduced by overseas demand with lower production costs, which could cause higher prices. Recent reports (ICSG, 2010d; Jolly, 2009) document the uninterruptedly increasing demand of the Asian smelting and refining industry, in particular from China, which in the past years has contributed as a key factor to the closure of many smelters and refiners in the United States, the United Kingdom, and more recently in continental Europe, including Germany, Italy and Eastern Europe.

Additional reasons for closure have been periods of low price (e.g. around the turn of the century), and the larger and more efficient activity of transformation of low quality to high quality scrap (e.g. No 2 to No 1). European processors of scrap may also be expecting an increase in quality upgrading activity in order to fulfil the products quality requirements proposed under end-of-waste criteria.

TWG experts have highlighted that the increasing export of scrap is not only of scrap as such, but of embedded savings in energy use and emissions compared to using primary sources. So far, a considerable part of the copper scrap exported from the EU to China and other countries is manufactured into goods, and returns to the EU in the form of the different copper parts of commodities. While the exported scrap is readily available for recycling, copper in goods requires the additional effort of dismantling and reprocessing to get copper back into the recycling loop. With the current collection and reprocessing systems in place in the EU, only a part of this copper can be collected again and made available for the industry. The current

balance may change as reprocessing technology of, e.g. EOL vehicles and WEEE develops further.

At a point, the development of domestic consumption and collection and reprocessing systems in China should decrease this country's current reliance on copper scrap imports to maintain the expected growth, as has happened in other developed economies. This may reduce the imports of scrap to China, and it is to be seen if it would also reduce the export of copper within goods.

It seems highly improbable that copper would become a scarce resource, as long as technology can continue to develop to better extract copper from end-of-life commodities.

From an EU perspective in the current situation, the international market for scrap needs to function well, there must be sufficient demand for copper scrap, inside or outside the EU, and scrap prices must remain reasonable and without excessive volatility. It should be recalled that one of the reasons for the closing of the US reprocessing and secondary copper industry was low prices, not high prices and high demand. A high demand from overseas markets for copper scrap are currently effectively used to grow by the reprocessing industry and have resulted in more effective collection systems in Europe, and higher copper recycling rates.

However, these conditions may change if the Asian markets -especially China- gradually become more self-sufficient in copper and no other country takes over the international demand pull. Scenarios of, e.g. price decrease shall not be excluded, with detrimental effects to the EU's scrap reprocessing industry.

With the data available, and comparing the magnitude of the price of copper scrap and the cost of compliance with EoW, it does not seem plausible that releasing certain scrap from the waste regime would lead to additional exports at a scale which could threaten the availability of this secondary raw material in the EU markets. On the other hand, it will remove disproportionate waste legislation control, and will facilitate further the competition of a quality controlled material reclaimed from waste for recycling, instead of using primary raw materials.

### ***4.3 Legislation impacts***

#### REACH

Article 2.2 of the REACH Regulation<sup>12</sup> specifies that waste is not a substance, mixture or article within the meaning of Article 3 of this Regulation. As long as copper scrap has the status of waste it is therefore not a substance, mixture or article for REACH and most obligations under the REACH Regulation do not apply.

When copper scrap ceases to be waste according to Article 6 of the WFD, the exemption under Article 2.2 of the REACH Regulation no longer applied. A benefit of EU-wide end-of-waste criteria will therefore be to clarify when copper scrap has to be considered a substance, mixture or article under REACH and when not.

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<sup>12</sup> EC 1907/2006



However, based on the previous experience from the iron and steel scrap and aluminium scrap criteria development, concerns have been raised that the end-of-waste criteria may lead to disproportionate regulatory burden under REACH, especially for the companies that produce copper scrap with end-of-waste status. The main potential burdens are related to the registration of the substances in end-of-waste scrap and to the obligations to provide safety information to downstream users.

On 14 October 2009 the Commission organised a meeting in Brussels to discuss end-of-waste criteria for iron and steel scrap and aluminium scrap and REACH. The meeting brought together experts from European and national industry associations of all the affected sectors (metal producers, processors and recyclers, as well as the waste management sector) and staff of DG Environment, DG Enterprise and the Joint Research Centre (JRC). The aim of the meeting was to clarify the link between end-of-waste and REACH. The paragraph below explains the rules for end-of-waste metals based on the information received during the workshop. Although the meeting with experts mainly focused on iron and steel scrap and aluminium scrap, it can be assumed that in the case of copper scrap, most of the requirements will be similar to the aluminium scrap case.

### **Mixtures, substances and impurities**

Currently, the main reference regarding waste and recovered substances is the Commission document CA/24/2008 rev.3, which was produced as a follow up to the 5th Meeting of the Competent Authorities for the implementation of Regulation (EC) 1907/2006 (REACH). The CA/24/2008 rev.3 document states the following regarding recovered metals:

*'Under REACH, pure metal (even if containing a certain amount of impurities) is considered as a substance. Recovered pure metal (even if containing a certain amount of impurities) is also a substance. Registration requirements for the substance will depend on whether the substance has been registered before and the relevant safety information is available (see Article 2 (7)(d)) of REACH.'*

*Alloys are considered as (special) preparations<sup>13</sup> and the substances in those preparations are subject to registration. Recovered metal made from mixed alloy metal scrap will normally be a preparation but it could in certain cases also be a substance with impurities (e.g. when the purpose of recovery is only to reclaim one main metal and all other constituents can be seen as impurities). In general, all components which have been intentionally selected for recovery and which have a main function in the recovered material should be seen as separate substances (e.g. steel will next to iron normally always contain manganese; the recycled steel is therefore a preparation). Constituents which only occasionally occur in parts of the waste from which the recovered metal originates or which do not have a particular function in the recovered material can be seen as impurities (e.g. molybdenum may occur in certain types of steel but not in others).'*

The CA/24/2008 rev.3 document states the following on impurities (in general terms on waste and recovered substances):

*'The guidance on substance identification defines an impurity as "an unintended constituent present in a substance as produced. It may originate from the starting materials or be the result of secondary or incomplete reactions during the production process. While it is present in the final substance it was not intentionally added.'*

<sup>13</sup> The term 'preparation' has since been superseded by the term 'mixture'.

*Recovered substances may contain impurities which may distinguish them from corresponding materials not deriving from recovery processes. This is in particular the case when recovered materials contain unintended constituents which have no function for the recovered material and the only reason for their presence in the recovered material is that they were part of the input waste for the recovery process. The content and nature of such unintended constituents may vary significantly from batch to batch (e.g. in time and location). Full knowledge of the exact composition in each such case may require substantial analytical efforts. While such constituents may have originally been intentionally added as substances to form a preparation, their presence in the recovered material may be unintended (depending on whether these constituents have a specific function or not) and therefore, they can be considered as impurities, which do not require separate registration.*

*Constituents present in quantities above 20% (w/w) should, however, in general not be considered as impurities but as separate substances in a preparation. However, in the case that recovered material is intentionally selected for the presence of certain constituent(s), those constituents should also be considered to be separate substances, even if they are present in smaller quantities than 20% (w/w) (e.g. if PVC is selected for the presence of softeners, it may be necessary to register these softeners, unless they have been registered before).*

*During the mechanical separation of mixed waste it is often impossible to reach 100% purity free of alien elements. These alien elements often are either extraneous to the waste stream per se (for example, and depending on the waste stream, stones, plastics, pieces of rubber, sand, etc.) or extraneous to the material object of the recovery but part of the final product that became waste (for example, paints, coatings, etc.), of which the composition and total amount are difficult to precise. After appropriate sorting and separation, these fractions should be present in the recovered material only in very small fractions. In this case, such elements can be considered as impurities that do not need to be registered.*

*Even if impurities do not have to be registered separately, they may be relevant for the hazard profile as well as the classification and labelling of the substance or mixture in which they occur. Relevant risk management measures may need to be recommended in SDS or information according to Art. 32. These risk management measures can consist e.g. in further purification steps to eliminate impurities or measures to ensure the safe handling of the substance with the impurities in it.'*

### **Substances in copper scrap with end-of-waste status**

Under REACH only substances are subject to registration. According to REACH, a recovered metal may be:

1. A mono-constituent substance. The content of main metal must be  $[Me1] \geq 80\%$ . This substance may contain impurities, in principle below 20% for the purposes of naming the substance. The 'foreign materials' (end-of-waste criteria  $< 5\%$ ) should be covered by these 20%. As mentioned in the guidance for substance identification (Section 4.2.1.2), deviation from this 80% rule (i.e. content below 80%) has to be justified (e.g. the same physicochemical properties are found and the same hazardous profile can be seen, the range of concentration of the main constituent and the impurities overlap the 80% criterion and the main constituent is only occasionally  $\leq 80\%$ ).

2. A mixture. When the metal scrap is an alloy (a special mixture of metals) or the metal scrap is intentionally selected for the presence of several metals [Me1], [Me2], [Me3]. Mixtures are composed of two or more substances. In the particular case of scrap metals the majority of substances, if not all, are metals. As in this case, each substance can bring to the mixture a maximum of 20% impurities and, thus, the theoretical maximum of impurities should be 20 % (only in the case that each substance brings 20 % of impurities in the mixture). However, in reality the percentage of impurities would be less.

Note: Producers of scrap applying the end-of-waste status (as manufacturers) have the obligation under REACH to decide which of these cases applies. This rather short summary should not prevent recyclers from reading and using the guidance for substance identification and naming in REACH available on the ECHA web pages.

To understand which substances, as defined by REACH, there are in copper scrap with end-of-waste status, the following technological aspects need to be considered. Copper scrap with end-of-waste status would:

- a. always contain copper as a component that has been intentionally selected for recovery and that has a main function in the recovered material,
- b. sometimes also contain other components that have been intentionally selected for recovery and that have a main function in the recovered materials, for example tin, zinc, lead, etc.,
- c. always also contain small amounts of elements that do not have a particular function in the recovered material. These elements may be metals or non-metals, which occasionally occur in parts of the waste from which the recovered material originates. (The proposed end-of-waste criteria limit the possible total content of foreign components to about 5% by weight and exclude any copper scrap that has hazardous properties included in Annex III of the Waste Framework Directive.).

From these considerations it follows that copper scrap with end-of-waste status can often be considered a mixture under REACH which contains several metals. The components mentioned under a) and b), for example, can be considered substances under REACH. More specifically, they can be considered recovered substances. The elements mentioned under c) can be considered impurities that do not need to be registered. Irrespective of whether those impurities were original impurities of the substance or whether there are foreign materials in the metal scrap, they will need to be allocated as impurities of the substance(s) in the mixture. This is needed if there are impurities that are relevant in terms of the naming of the substances and the sameness question for the purposes of the application of Article 2(7)(d)<sup>14</sup>.

#### **Registration of substances in copper scrap with end-of-waste status**

Following the argumentation above, the substances contained in copper scrap with end-of-waste status are recovered substances (metals). REACH registration of recovered metals is not required if the conditions of Article 2.7.d of REACH are complied with:

- the metals have been registered (Article 2.7.d.i), and
- the relevant safety information is available (Article 2.7.d.ii).

<sup>14</sup> Failing this, the scrap metal as a whole would be seen as one substance and hence could be subject to registration.

As the following assessment will show, it can be expected that these conditions will normally be able to be met without disproportionate efforts. This implies that in practice processors will not have to register any substances under REACH. Industry associations can contribute decisively to keep the burden low for companies that want to demonstrate compliance with these conditions.

### *Article 2.7.d.i*

- Recovered substances in copper scrap

Under REACH, recovered copper scrap can be considered either a single recovered substance (copper) or a mixture containing various recovered substances (copper and other alloying metals).

Copper scrap (No 1 copper with a high copper content) meeting the end-of-waste criteria could often be considered a substance (copper). All other constituents would qualify as impurities should the scrap not have been selected for their presence.

Copper alloys scrap will in most cases consist of alloyed metal and would therefore contain further metals with a function such as lead, zinc or tin. They would have to be considered substances subject to registration under REACH.

- Will a substance be registered or has it already been registered?

Copper and the other main metals used in copper alloys had to be registered by the December 2010 deadline. Metals used only for special and rarer alloys may be manufactured and imported in lower quantities so that registration may happen according to later deadlines. In any case, industry representatives expect that these metals will also be registered by the time producers of copper scrap with end-of-waste status would be faced with the need to apply the Article 2.7.d exemption.

- Sameness

The CA document 24/2008/rev3 explains that in assessing whether the recovered substance is the same as a substance that has already been registered or whether the substances are different, recovery installations need to apply the rules of the guidance on substance identification and the guidance on data sharing.

The CA document notes that variations in the composition and the impurity profile, including a variation in the percentage of impurities, do not necessarily mean that substances are different. According to the guidance on data sharing, *'for substances with a well-defined composition (i.e. mono-constituent and multi-constituents substances) the sameness of the naming is in principle sufficient to be able to share data even though certain impurities might lead to a different classification/hazard profile. Only in cases where all data is clearly not suitable for the other substance these substances can be regarded as different (e.g. in case of very different physical properties which have essential impact on the hazard properties, like water solubility).'*

It should be noted that the possible amounts and variation of impurities are limited by the end-of-waste criteria. Copper scrap that complies with the end-of-waste criteria will contain only very limited amounts of substances other than copper and other metals. This will be ensured by the end-of-waste criteria by limiting the content of 'foreign materials/metal content/metal

yield' and by the process requirements. Foreign materials that would change the hazardous properties of the recovered metal scrap are excluded by the end-of-waste criteria. This facilitates considering the metals contained in copper scrap the same substances as the substances produced by the producers of copper and the other metals.

In this context it is useful to highlight again that impurities (whether from original impurities of the substance or from foreign materials in the metal scrap) will need to be allocated as impurities of the substance(s) registered and identified in the metal scrap as subject to registration. This is needed in terms of the naming of the substance and the sameness for the purposes of the application of Article 2(7)(d). Failing this, the scrap metal as a whole would be seen as one substance, which could mean that identifying sameness with the registered substance would be more difficult.

The responsibility for determining sameness lies in the hands of the producers of copper scrap that apply the end-of-waste status as the 'manufacturers' of the substances<sup>15</sup>. There is no confirmation given on 'sameness' by the European Chemicals Agency. The manufacturer will need to have information on the substance itself and its impurities<sup>16</sup>.

European recycling industry associations have announced that they will prepare standard documents with the necessary information (including the chemical composition of the different scrap categories) and guidance that will allow individual companies to decide about the sameness of substances. The guidance may also explain how to allocate any impurities in mixtures to the individual substances. It is therefore not expected that individual companies will have to carry any testing or chemical analysis in order to demonstrate the sameness of the substances.

#### **Article 2.7.d.ii**

Article 2.7.d.ii provides that '*the information required by Articles 31 or 32 relating to the substance that has been registered in accordance with Title II is available to the establishment undertaking the recovery*'. Such an establishment will normally not receive on SDS or other safety information in the framework of Title IV of REACH, so to benefit from the registration exemption, the required information must be available by other means. The manufacturer can use any available information, starting with the information on the ECHA's website and published in accordance with Article 119, but must make sure that no property rights are violated. When using an existing SDS, the manufacturer should therefore make sure that access to the information is legitimate. The same applies to other safety information, if required.

Article 32 information will be sufficient for most of the other substances that may appear in copper scrap. The information required under Article 32 (i.e. if no safety data sheet is required) is rather limited (registration number, information on authorisation and restriction if any, and any other available and relevant information to enable appropriate risk management measures).

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<sup>15</sup> As stated in the CA document 24/2008/rev.2 on 'Waste and recovered substances': '[...] all forms of recovery are [...] considered as a manufacturing process whenever, after having undergone one or several recovery steps, they result in the generation of one or several substances that have ceased to be waste.'

<sup>16</sup> If the manufacturer has pre-registered the substance, discussions within the SIEFs will allow companies to address sameness and refine and if necessary the correct substance identity, as long as it is clear that the pre-registration was done for the concerned substance.

Industry associations have expressed that they will prepare standard information for their members. Having access to such standard information will allow individual companies to show that the required information under Article 2.7.d 'is available to the establishment undertaking the recovery'.

### ***Imports***

The exemptions under Article 2.7.d apply only to substances which are recovered in the Community. It should be noted that Recital 22 of the WFD says that for 'the purposes of reaching end-of-waste status, a recovery operation may be as simple as the checking of waste to verify that it fulfils the end-of-waste criteria.' If the waste is checked to verify that it fulfils the end-of-waste criteria after it has been imported in the Community and not before, then it would have waste status when it is imported and it seems logical then to consider that the substances it contains are recovered in the Community.

### **Provision of information required under Articles 31 or 32 of REACH**

According to Art 31 and 32 of the REACH Regulation suppliers of substances or mixtures have to provide the recipients with safety information. This requirement is not exempted under Art 2(7)(d) for recovered substances. For certain substances and mixtures, safety information has to be provided in the form of safety data sheets (SDSs) according to Art 31. If SDSs are not needed, safety information according to Art 32 has to be provided. Normally an SDS will not be needed for end-of-waste scrap unless the scrap has to be classified as dangerous because of the content of certain alloys, because the end-of-waste criteria do not allow the scrap to have hazardous properties for other reasons. The following assessment discusses this in more detail.

### ***When is it necessary to provide an SDS (Article 31)?***

1. An SDS, including where relevant (> 10 t/yr) exposure scenarios, must be provided when:
  - a. The substance/mixture meets criteria for classification as dangerous in accordance with Directives 67/548/EEC or 1999/45/EC (Art 31.1a of REACH); or
  - b. The substance on its own or in a mixture is a PBT, vPvB in accordance with the criteria set out in Annex XIII (Art 31(1)(b) of REACH); or
  - c. The substance on its own or in a mixture is on the REACH Candidate list (Art 31(1)(c) of REACH); or
  - d. The customer has requested on SDS (Art. 31(4) of REACH). For commercial reasons, a recycler may choose to produce an SDS at the request of a customer, even if he is not legally obliged to do so. Art. 31(4) specifies that SDSs need not to be supplied where dangerous substances or mixtures offered or sold to the general public are provided with sufficient information (Art 31(4), ie. SDSs are only for professional users (downstream user or distributor under REACH)).
2. The supplier shall provide the recipient at his request with an SDS where mixtures do not meet the criteria for classification as dangerous but contain individual concentrations of  $\geq 0.1\%$  by weight for non-gaseous mixtures at least one substance that is a PBT or vPvB in accordance with the criteria set out in Annex XIII or has been included for reasons or a substance which there are Community workplace exposure limits (Art. 31(3)).

### ***Obligations under Article 32***

In the case that a supplier is not required to provide an SDS, the supplier still needs to comply with Art. 32 of REACH: duty to communicate information down the supply chain for

substances on their own or in mixture for which an SDS is not required. The information to be provided is:

- a. registration number(s), if available,
- b. if the substance is subject to authorisation,
- c. details on any restriction imposed,
- d. any other available and relevant information about the substance that is necessary to enable appropriate risk management measures to be identified and applied.

Such information should be provided free of charge and at the time of delivery (Art 32(2)). The information should be updated in cases where new information on hazards or risk management measures are available or in cases where it is subject to authorisation or restriction (Art 32(3)).

***Information requirements for copper scrap with end-of-waste status:***

The cases where an SDS is needed will be very limited because the end-of-waste criteria for copper scrap will exclude a scrap from ceasing to be waste if it has any of the properties which render waste hazardous (Annex III WFD), with the exception mentioned in the next paragraph. For most of the properties the same criteria have to be applied as according to Directives 67/548/EEC and 1999/45/EC. It should also be noted that, in the meeting on 14 October 2009, industry associations representing the users of copper scrap have expressed that the users have no interest in demanding SDSs from the copper scrap suppliers because they would regard this as 'unnecessary paperwork'.

The end-of-waste criteria will, however, allow metals contained in metal scrap even if they are dangerous substances, and an SDS may be required in such as case.

A producer of copper scrap that applies the end-of-waste status does not have to generate a chemical safety report or an exposure scenario for a substance (or substance in a mixture) that is exempted from registration (under Article 2.7.d). The same safety information that must be available to fulfil the condition under Article 2(7)(d)(ii) can usually be used for communicating the information down the supply chain.

The information required under Article 32, i.e. if no safety data sheet is required, will be limited to any other available and relevant information to enable appropriate risk management measures. For recovered substances that have not been registered (Article 2.7.d exemption), no registration numbers or information on authorisation or restriction have to be supplied.

***Compilation of information to comply with safety information requirements***

Producers of copper scrap with end-of-waste status are generally not downstream users under REACH and will therefore not automatically receive safety information together with the waste materials intending to be processed. The information chain stops at the last downstream user and, consequently, post-consumer waste does not come with safety information.

European industry associations have, however, committed to preparing guidance and standard documents for the provision of information in the supply chain and SDSs for recovered substances and mixtures in accordance with Art. 2(7)(d), 31 and 32 of REACH. The use of such standard information would allow for minimising the burden individual companies may face.

The standard documents should consider fully any guidance developed by the ECHA on this issue in order to ensure the acceptance by the competent authorities of information provided by individual suppliers according to the standard documents.

The same safety information that must be available to fulfil the condition under Article 2(7)(d)(ii) can be used for communicating the information down the supply chain. (It is understood that this applies also to the exposure scenarios, if these are required for a substance.)

The guidance documents prepared by ECHA can be found at:

[http://guidance.echa.europa.eu/guidance4\\_en.htm](http://guidance.echa.europa.eu/guidance4_en.htm) and

[http://guidance.echa.europa.eu/docs/guidance\\_document/waste\\_recovered\\_en.pdf](http://guidance.echa.europa.eu/docs/guidance_document/waste_recovered_en.pdf)

### ***Sub-categories for copper/copper alloys scrap***

Several Member States have proposed that there should be separate customs codes for scrap which has ceased to be waste and which would allow all enforcement personnel to operate with the same clear parameters and reduce uncertainty. At this moment scrap is considered as waste and is classified, e.g. according to NACE codes (NACE codes, 2011) and/or CN trade codes (CN Codes, 2011). However, when end-of-waste criteria and by-product legally apply, new sub-categories for scrap would be recommended.

### **Valued Added Tax (VAT)**

The Valued Added Tax (VAT) is a general tax that applies in principle to all commercial activities, including the supply of metal scrap. When metal scrap ceases to be waste, there is a possibility that the VAT will be applied. The supply of metal scrap is a transfer of the right to dispose of tangible property which is defined by Article 14 (1) of the VAT Directive (Council Directive 2006/112/EC of 28 November) as a taxable transaction. Normally, the supplier is liable to pay the tax on taxable transactions, however, Article 199 (1) (d) of the VAT Directive establishes the possibility of Member States to decide that the person liable for payment of VAT is the taxable person to whom the supplies of materials listed in Annex VI of the Directive are made. This list includes metal scrap, confirming that the supply of metal scrap is indeed subject to VAT.

The Commission is responsible for ensuring the correct application of Community law, which in this case is the VAT Directive. However, since this Community legislation is based on a Directive, each Member State is responsible for the transposition of these provisions into national legislation and their correct application within its territory. Therefore, the details about the taxation of metal scrap in a specific Member State are based on the national tax administration.

Concerns were raised during the development of iron and steel scrap and aluminium scrap criteria that the end-of-waste status of scrap may in certain countries affect the applicability of reverse-charge VAT on scrap. It should be noted that the end-of-waste criteria are not intended to change the way in which VAT is payable on scrap. It would therefore be preferable that scrap-specific provisions in national VAT law refer directly to scrap as a good, regardless of the status as waste or not (end-of-waste).



#### 4.4 Summary of impacts of EoW on copper scrap

Health and environment	<p>Facilitate recycling – EoW will stimulate the collection and treatment of copper scrap to a higher quality in Europe.</p> <p>More collection and recycling of copper scrap imply savings in energy use and GHG emissions associated with copper production.</p> <p>EoW criteria include requirements on radioactivity monitoring which are likely to improve the risk control related to radioactive metal scrap.</p> <p>By better controlling the content of foreign materials, end-of-waste criteria limit the environmental and health risks associated with the use of scrap also if the scrap is used in facilities outside the EU.</p>
Economy and market	<p>Administrative costs, in particular related to the shipment of waste (permits, licences, uncertainty) will be reduced. However, not all parts of industry see facilitated scrap export as an advantage.</p> <p>This will be directly beneficial for the trading of scrap, which again may lead to more collection of scrap and an improvement in the overall economics of recovering copper from waste.</p> <p>More conversion of middle quality scrap categories (No 2) to high quality (No1) to meet EoW criteria might tighten the market for No 2 grades in Europe.</p>
Legislation	<p>The EU-wide clarification of end-of-waste status instead of case-by case decisions has clear advantages for a material that is widely traded. The functioning of the internal market of the EU will be improved.</p> <p>In some case adjustments may be needed in national law, for example regarding the taxation of metal scrap.</p> <p>Certain provisions of the chemicals regulation (REACH) will apply to end-of-waste scrap.</p>



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## GLOSSARY

**Blister copper** a matte of 96 to 99% copper, having a blistered surface after smelting because of gases generated during solidification

**Brass** a term comprising various metal alloys consisting mainly of copper and zinc

**Bronze** a term comprising various metal alloys consisting essentially of copper and tin

**Collection** the gathering of waste scrap, including the preliminary sorting and preliminary storage of waste for the purposes of transport to a waste treatment facility (following the definition of the Waste Framework Directive (2008/98/EC))

**Consignment** a batch of metal scrap which is intended for delivery from a producer to another holder and may be contained in several transport units, such as containers

**Copper cathode** an electrolytic copper in a cathode form

**Copper and copper alloy scrap** scrap metal which consists predominantly of copper and copper alloying elements

**Direct melt scrap** a scrap which is used during semi-fabrication processes

**Electrorefining** a process for refining a metal in an electrolytic cell, in which the impure metal is used as the anode and the refined metal is deposited on the cathode

**Electrowinning**, also called electroextraction; the recovery of metal from metallic salts by means of electrolysis

**Holder** the natural or legal person who is in possession of scrap metal

**Hydrometallurgy** a technique for the recovery of a metal from an aqueous medium in which the metal or the gangue is preferentially dissolved

**Importer** any natural or legal person established within the Union who introduces scrap metal which has ceased to be waste into the customs territory of the Union

**ISRI specification** is a specification developed by the USA trade association, the Institute of Scrap Recycling Industries (ISRI), which classifies non-ferrous scrap, ferrous scrap, glass cullet, paper stock, plastic scrap, electronics scrap, and tyre scrap

**Matte (copper)** a term used for the molten copper(I) sulphide

**Primary** a metallurgical process which usually uses materials directly from the mine, but may also handle some recycled material such as scrap

**Producer** a maker of products or goods by manual or mechanical means. In the context of end-of-waste and EU waste legislation, is the holder who transfers scrap metal to another holder for the first time as scrap metal which has ceased to be waste

**Pyrometallurgy** the branch of metallurgy involving processes performed at high temperatures, including sintering, roasting, smelting, casting, refining, alloying, and heat treatment

**Qualified staff** staff which is qualified by experience or training to monitor and assess the properties of metal scrap

**Recovery** any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy (following the definition of the Waste Framework Directive (2008/98/EC)). Annex II of the Directive sets out a non-exhaustive list of recovery operations. Recovery includes recycling and energy recovery. Energy recovery means 'the use of combustible wastes as a means to generate energy through direct incineration with or without other waste but with recovery of the heat'

**Recycling** any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes (following the definition of the Waste Framework Directive (2008/98/EC)). It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations

**Refinery** an industrial plant where the metal is treated and upgraded into its pure form

**Re-melt** the action of melting again a metal that has previously been melted, e.g. scrap, ingots

**Secondary** a metallurgical process which uses process recycled metals (scrap)

**Semi** see semi-fabrication

**Semi-fabrication** a production of products from ingots, billets, etc. by various processes, such as rolling, extruding, drawing, casting and forging

**Shaft furnaces** a type of a furnace for the production of metals

**Smelting** a way of extracting metals, usually from their ore. A smelting primary metallurgical process uses materials directly from the mine, but may also handle some recycled material (scrap). A smelt secondary metallurgical process usually uses recycled metals such as scrap, slag, etc.

**SX/EW process**, stands for solvent extraction/electrowinning. A two-stage process that first extracts and upgrades copper ions from low-grade leach solutions into a concentrated electrolyte, and then deposits pure copper onto cathodes using an electrolytic procedure.

**Treatment** a term covering recovery or disposal operations, including preparation prior to recovery or disposal (following the definition of the Waste Framework Directive (2008/98/EC))

**Visual inspection** inspection of metal scrap covering all parts of a consignment and using human senses or any non-specialised equipment

**Wire-rod** one of the hot rolled metal product classified by shape (having a round, rectangular or other cross-section).





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## **ANNEX 1: SCRAP CATEGORIES ACCORDING TO EN 12861:1999.**

This European Standard specifies the requirements for characteristics, condition, moisture, composition, metal content, metal yield and test procedures of secondary raw materials for direct melting (melting grades) in the form of copper and copper alloy scrap.

### **Copper scrap**

#### **Type S-Cu-1 (Cu min. 99.90%, P-free)**

Production electrolytic copper scrap consisting of scrap from processing (wire), extrusion discards and discarded material from electrical lines (connection bars, wire, cable etc.) with a minimum size in at least one direction of 30 mm. Smaller sizes shall be subject to agreement between the purchaser and the supplier. The minimum wire diameter shall conform to the requirements given in table B.1. in EN 12861:1999. The scrap shall be bright, with the exception of extrusion discards, clean and free from foreign substances. The scrap shall be free from moisture.

#### **Type S-Cu-2 (Cu min. 99.90%, P-free)**

Old electrolytic copper scrap consisting of wire (not burned) and connection bars with a minimum size in at least one direction of 30 mm. Smaller sizes shall be subject to agreement between the purchaser and the supplier. The minimum wire diameter shall conform to the requirements given in table B.3. The scrap shall be clean and free from foreign substances. The scrap shall be free from moisture. The composition shall conform to the requirement given in table B.4. in EN 12861:1999.

#### **Type S-Cu-3 (enamelled copper wire, P-free)**

Production copper scrap consisting of enamelled wire with a minimum length of 30 mm. Smaller lengths shall be subject to agreement between the purchaser and the supplier. The minimum wire diameter shall conform to the requirements given in table B.5. in EN 12861:1999.

The scrap shall be clean and free from foreign substances other than enamel. The scrap shall be free from moisture. The composition shall conform to the requirements given in table B.6. in EN 12861:1999.

#### **Type S-Cu-4 (Cu min. 99.90%, P-containing)**

Production copper scrap consisting of tubes, strips, plates, discs and extrusion discards with a minimum size in at least one direction of 30 mm. Smaller sizes shall be subject to agreement between the purchaser and supplier. The scrap shall be clean and free from foreign substances. The scrap shall be free from moisture. The composition shall conform to the requirements given in table B.7. in EN 12861:1999.

#### **Type S-Cu-5 (Cu min. 99.90%, P-containing)**

Old copper scrap consisting of tubes, strips, plates, discs and extrusion discards with a minimum size in at least one direction of 30 mm. Smaller sizes shall be subject to agreement between the purchaser and the supplier. The scrap shall be clean and free from foreign substances. The scrap shall be free from moisture. The composition shall conform to the requirements given in table B.8. in EN 12861:1999.

**Type S-Cu-6 (Cu min. 99,7%)**

Old copper scrap consisting of burned but not brittle wire and cuttings with a minimum size in at least one direction of 30 mm. The minimum wire diameter permitted is 1 mm. Smaller sizes or wire diameters shall be subject to agreement between the purchaser and the supplier. Paper insulated wire shall be subject to agreement between the purchaser and the supplier. The amount of paper shall be deducted. The scrap may contain foreign substances (ashes, burned paper residues). The scrap shall be free from moisture. The composition shall conform to the requirements given in table B.9. in EN 12861:1999. The metal content shall be at least 98.5%.

**Type S-Cu-7 (The metal content shall be at least 98.5% (m/m))**

Old copper scrap consisting of tubes, punchings, cuttings, shearings of strip, plates, discs, copper ware and burned but not brittle wire with a minimum size in at least one direction of 30 mm. The minimum thickness of punchings and strip permitted is 0.2 mm. The minimum wire diameter permitted is 0.5 mm. Smaller sizes, thicknesses of punchings and strips or wire diameters permitted shall be subject to agreement between the purchaser and the supplier. The scrap may contain foreign substances (e.g. non-metallic sediments). The scrap shall be free from moisture. The composition shall conform to the requirements given in table B.10. in EN 12861:1999. The metal content shall be at least 98.0% (m/m).

**Type S-Cu-8 (Cu min. 98%)**

Old copper scrap consisting of burned but not brittle wire, cuttings, shearings of strip, plate discs or tube and copper ware with a minimum size in at least one direction of 30 mm. Smaller sizes shall be subject to agreement between the purchaser and the supplier. There shall be no radiators or boilers.

The scrap may contain foreign substances. Turnings, sawings and millings shall be subject to agreement between the purchaser and the supplier. The scrap shall be free from moisture. The metal content shall be at least 96.0 % (m/m). The composition shall conform to the requirements given in table B.11. in EN 12861:1999.

**Type S-Cu-9 (Cu min. 96%)**

Old copper scrap consisting of wire, either brittle or not, plate, copper ware and other forms with a minimum size in at least one direction of 30 mm, unclassifiable in any of the other types defined (S-Cu-1 to S-Cu-8) because of excessive metallic impurities. Smaller sizes shall be subject to agreement between the purchaser and the supplier. Coated and/or plated scrap shall be accepted only if impurity levels after melting are within the limits given in table B.12. in EN 12861:1999.

The scrap may contain foreign substances. Turnings, sawings and millings shall be subject to agreement between the purchaser and the supplier. The scrap shall be free from moisture.

The metal content shall be at least 92.0% (m/m).

**Type S-Cu-10 (Granulated copper wire)**

Copper wire, either coated or uncoated, that has been granulated. The minimum diameter permitted is 0.5 mm. Smaller diameters shall be subject to agreement between the purchaser and the supplier. The scrap shall be clean and free from other metallic substances. The scrap shall be free from moisture. The composition shall conform to the appropriate requirements given in table B.13. in EN 12861:1999.

**Copper-zinc scrap****Type S-CuZn-1 (Cu min. 63.5%)**

Production brass scrap. Plates and tubes shall be subject to agreement between the purchaser and the supplier. Scrap may be from individual wrought materials or combinations which will result in the scrap designations shown in table C.1. in EN 12861:1999.

The scrap shall be bright and clean, free from 'free iron' and free from foreign substances. Coated or plated material shall be subject to agreement between the purchaser and the supplier. The scrap shall be free from moisture. The composition shall conform to the appropriate requirements given in table C.2. in EN 12861:1999.

**Type S-CuZn-2 (Cu min. 69%)**

Brass scrap in the form of shell cases. The scrap shall consist of clean, fired brass shell cases without primers and any other foreign material. Coated or plated material shall be subject to agreement between the purchaser and the supplier. The scrap shall be free from moisture. The composition shall conform to the requirements given in table C.3. in EN 12861:1999.

**Type S-CuZn-3 (Cu min. 69%)**

Brass scrap in the form of cartridge cases. The scrap consist of clean, fired, muffled, not shattered cartridge cases free from foreign substances other than residues from burned powder. Plated material and sealed ends shall not be accepted. Shattered material shall be subject to agreement between the purchaser and the supplier. The scrap shall be free from moisture. The composition shall conform to the requirements given in table C.4 in EN 12861:1999.

**Type S-CuZn-4 (lead brass)**

Lead brass scrap consisting of rods, extrusion discards and cuttings or from cold- or hot-firming processes (not casting), with a minimum size in at least one direction of 30 mm. Smaller sizes and shells with primers without silicon shall be subject to agreement between the purchaser and the supplier. The scrap shall not contain other alloys, coated or plated material and shall be free from 'free iron'. The scrap shall be free from moisture. The composition shall conform to the appropriate requirements given in table C.5. in EN 12861:1999.

**Type S-CuZn-5 (lead brass turnings)**

Lead brass turnings free from filings and grindings. Material with a size smaller than 0.59 mm shall be free from foreign substances.

The scrap shall not contain other alloys and shall be free from 'free iron'. If either are present, up to 0.5% (m/m), the determined quantity shall be doubled and subtracted as mass deduction. The inspection lot may contain fractions of max. 30% (m/m) fine material when sieved with 30 mesh (0.59 mm) may contain max. 1% (m/m) fine material when sieved again with 120 mesh (0.125 mm).

For S-CuZn-5A the moisture content is expected to be less than 2% (m/m). Moisture content between 2% to 4% (m/m) shall be subtracted as mass deduction. Moisture contents between 4% to 6% (m/m) shall be doubled and subtracted as mass deduction.

For S-CuZn-5B the moisture content is expected to be less than 3% (m/m). Moisture contents between 3% to 5% (m/m) shall be subtracted as mass deduction. Moisture contents between 5% to 7% (m/m) shall be doubled and subtracted as mass deduction.

The composition shall conform to the appropriate requirements given in Table C.6. in EN 12861:1999.

The metal yield of S-CuZn-5B shall be at least 91% (m/m)

#### **Type S-CuZn-6**

Mixed brass valves and taps. Chromium and nickel coatings or platings shall be accepted. No manganese and/or silicon-bearing brass shall be accepted. The scrap shall be free from 'free iron'. The scrap shall be free from moisture. The composition shall conform to the requirements given in Table C.7. in EN 12861:1999. The metal content shall be at least 97% (m/m).

#### **Type S-CuZn-7**

Brass scrap from various sources including brass castings, rolled brass, brass rod including plated material. Maximum dimension permitted in any one direction is 400 mm. No aluminium, manganese and/or silicon bearing alloys shall be accepted unless within the composition given in Table C.8. in EN 12861:1999. The maximum content of 'free iron' shall not exceed 1% (m/m). Shredded material shall be excluded. No cartridge cases shall be accepted. The scrap shall be free from moisture. The metal content shall be at least 95% (m/m). The composition shall conform to the requirements given in table C.8. in EN 12861:1999.

#### **Condenser tube scrap**

The metal content shall be at least 98%.

Open ended condenser tube scrap of a single composition according to Table D.1. in EN 12861:1999. The scrap shall be clean, free from 'free iron' and organic residues. The scrap shall be free from coated material. The scrap shall be free from moisture.

#### **Miscellaneous copper and copper alloy scrap**

The scrap shall be bright and clean, free from 'free iron' and free from foreign substances. Coated or plated material shall be subject to agreement between the purchaser and the supplier. The scrap shall be free from moisture.

The composition shall either conform to a European product standard or any other specification subject to agreement between the purchaser and the supplier.



## ANNEX 2. COPPER AND COPPER ALLOYS SCRAP CATEGORIES ACCORDING TO ISRI SPECIFICATION.

The US trade association 'Institute of Scrap Recycling Industries' (ISRI) publishes yearly a so-called *scrap specifications circular*. The standard specifications are intended to assist members of ISRI in the buying and selling of their materials and products.

The specifications refer to many sectors of the metals, paper stock, plastics, glass, and electronics industries and are constructed to represent the quality or composition of the materials bought and sold in the industry.

The specifications are internationally accepted and are used throughout the world to trade the various commodities. Parties to a transaction may specify particular variations or additions to these specifications as are suited for their specific transactions and for their individual convenience. Any deviation from the standard specifications, however, should be mutually agreed to and so stipulated in writing by the parties to the transactions.

Copper and copper alloys are referred to as 'Red metals'. The following grades are distinguished in the 2009 circular:

Barley No. 1 COPPER WIRE
Berry No. 1 COPPER WIRE
Birch No. 2 COPPER WIRE
Candy No. 1 HEAVY COPPER
Cliff No. 2 COPPER
Clove No. 1 COPPER WIRE NODULES
Cocoa COPPER WIRE NODULES
Dream LIGHT COPPER
Drink REFINERY BRASS
Drove COPPER-BEARING SCRAP
Druid INSULATED COPPER WIRE SCRAP
Ebony COMPOSITION OR RED BRASS
Eland HIGH GRADE—LOW LEAD BRONZE/BRASS SOLIDS
Elder GENUINE BABBITT-LINED BRASS BUSHINGS
Elias HIGH LEAD BRONZE SOLIDS AND BORINGS
Enerv RED BRASS COMPOSITION TURNINGS
Engel MACHINERY OR HARD BRASS SOLIDS
Erin MACHINERY OR HARD BRASS BORINGS
Fence UNLINED STANDARD RED CAR BOXES (CLEAN JOURNALS)
Ferry LINED STANDARD RED CAR BOXES (LINED JOURNALS)
Grape COCKS AND FAUCETS
Honey YELLOW BRASS SCRAP
Ivory YELLOW BRASS CASTINGS
Label NEW BRASS CLIPPINGS
Lace BRASS SHELL CASES WITHOUT PRIMERS
Lady BRASS SHELL CASES WITH PRIMERS
Lake BRASS SMALL ARMS AND RIFLE SHELLS, CLEAN FIRED
Lamb BRASS SMALL ARMS AND RIFLE SHELLS, CLEAN MUFFLED (POPPED)
Lark YELLOW BRASS PRIMER
Maize MIXED NEW NICKEL SILVER CLIPPINGS
Major NEW NICKEL SILVER CLIPPINGS AND SOLIDS
Malar NEW SEGREGATED NICKEL SILVER CLIPPINGS

## Annex 2

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Malic OLD NICKEL SILVER
Melon BRASS PIPE
Naggy NICKEL SILVER CASTINGS
Niece NICKEL SILVER TURNINGS
Night YELLOW BRASS ROD TURNINGS
Noble NEW YELLOW BRASS ROD ENDS
Nomad YELLOW BRASS TURNINGS
Ocean MIXED UNSWEATED AUTO RADIATORS
Pales ADMIRALTY BRASS CONDENSER TUBES
Pallu ALUMINUM BRASS CONDENSER TUBES
Palms MUNTZ METAL TUBES
Parch MANGANESE BRONZE SOLIDS

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## ANNEX 3. SUMMARISED PROPOSAL OF THE CRITERIA

### **Definitions:**

Copper and copper alloy scrap means scrap metal which consists predominantly of copper and copper alloying elements.

Qualified staff means staff which is qualified by experience or training to monitor and assess the properties of metal scrap.

Visual inspection means inspection of metal scrap covering all parts of a consignment and using human senses or any non-specialised equipment.

Consignment means a batch of metal scrap which is intended for delivery from a producer to another holder and may be contained in several transport units, such as containers.

Producer means the holder who transfers scrap metal to another holder for the first time as scrap metal which has ceased to be waste.

Holder means the natural or legal person who is in possession of scrap metal.

Importer means any natural or legal person established within the Union who introduces scrap metal which has ceased to be waste into the customs territory of the Union.

Criteria	Remarks	Self monitoring	Explanation
<p data-bbox="309 236 512 264"><b>Product quality</b></p> <p data-bbox="152 272 669 368">The total amount of foreign materials shall be x % by weight (the final number shall be within the range from 2% to 5%).</p> <p data-bbox="152 408 669 568">The scrap shall not contain excessive metal oxide in any form, except for typical amounts arising from outside storage of prepared scrap under normal atmospheric conditions.</p>	<p data-bbox="689 272 1008 336">Foreign materials are (inter alia):</p> <p data-bbox="689 360 949 456">(1) metals other than copper and copper alloys;</p> <p data-bbox="689 496 999 592">(2) non-metallic materials such as earth, dust, insulation and glass;</p> <p data-bbox="689 632 1003 831">(3) combustible non-metallic materials such as rubber, plastic, fabric, wood and other chemical or organic substances;</p> <p data-bbox="689 871 987 999">(4) slags, dross, skimmings, baghouse dust, grinder dust, sludge.</p>	<p data-bbox="1028 272 1509 743">Qualified staff shall carry out visual inspection of each consignment. At appropriate intervals, representative samples of each grade of copper/copper alloy scrap shall be analysed to measure the total amount of foreign materials. The total amount of foreign materials shall be measured by weighing after separating copper/copper alloy metallic particles and objects from particles and objects consisting foreign materials by hand sorting or other means of separation (e.g. by magnet or based on the density).</p> <p data-bbox="1028 759 1509 895">The appropriate frequencies of analysing representative samples shall be established taking into account the following factors:</p> <p data-bbox="1028 911 1509 1007">(1) the expected pattern of variability (for example as shown by historical results);</p> <p data-bbox="1028 1031 1509 1158">(2) the inherent risk of variability in the quality of waste used as input for the recovery operation and in the performance of the treatment processes;</p> <p data-bbox="1028 1182 1509 1246">(3) the inherent precision of the monitoring method; and</p> <p data-bbox="1028 1270 1509 1366">(4) the proximity of results to the limit values for the total amount of foreign materials.</p>	<p data-bbox="1532 272 2089 983">Frequency of monitoring includes both the number of times a parameter is monitored over any given time period and the duration of each monitoring event so that it is a representative sample of the total. In the absence of historical results for any relevant parameter, it is considered good monitoring practice to carry out an intensive monitoring campaign over a short period (e.g. a month or a few months) in order to characterise the material stream and provide a basis for determining an appropriate, longer-term monitoring frequency. The process of determining monitoring frequencies should be documented as part of the overall quality assurance scheme and as such should be available for auditing. The result of the monitoring frequency determination should provide a stated statistical confidence (often a 95 % confidence level is used) in the ultimate set of monitoring results</p> <p data-bbox="1532 1015 2089 1385">The Commission adopted a reference document in July 2003 entitled 'Reference Document on Best Available Techniques for General Principles of Monitoring' which was developed under the provisions of the IPPC Directive but which remains a relevant reference document for the determination of appropriate monitoring frequencies in this respect. It is available for download from the following web site:  <a data-bbox="1532 1350 2089 1385" href="http://eippcb.jrc.es/reference/download.cfm?">http://eippcb.jrc.es/reference/download.cfm?</a></p>

Criteria	Remarks	Self monitoring	Explanation
			<a href="#">twg=mon&amp;file=mon_bref_0703.pdf</a> .
The scrap shall be free of visible oil, oily emulsions, lubricants or grease except negligible amounts that will not lead to any dripping.		Qualified staff shall carry out a visual inspection of each consignment, paying particular attention to those parts where oil is most likely to drip.	Oil, oily emulsion, lubricants or grease should not be visible in any part of the scrap load, except negligible amounts that will not lead to any dripping. Visual inspection shall pay particular attention to those parts of the load where oil is most likely (the bottom).
The scrap shall not display any of the hazardous properties listed in Annex III to Directive 2008/98/EC. The scrap shall comply with the concentration limits laid down in Commission Decision 2000/532/EC and not exceed the concentration limits laid down in Annex IV of Regulation 850/2004/EC.  Properties of alloy metals included in copper alloys are not relevant for this requirement.		Qualified staff shall investigate each consignment by visual inspection. Where visual inspection raises any suspicion of possible hazardous properties, further appropriate monitoring measures shall be taken, such as sampling and testing where appropriate. The staff shall be trained on potential hazardous properties that may be associated with copper/copper alloys scrap and on material components or features that allow for recognising the hazardous properties. The procedure of recognising hazardous materials shall be documented under the quality management system.	Staff shall be trained on potential hazardous properties that may be associated with copper/copper alloy scrap and on material components or features that allow for recognising the hazardous properties.
The scrap does not contain any pressurised, closed or insufficiently open containers that could cause explosions in a metalwork furnace.		Qualified staff shall investigate each consignment by visual inspection.	

Criteria	Remarks	Self monitoring	Explanation
<p>There is no need for response action according to national or international rules on monitoring and response procedures for radioactive scrap metal.</p> <p>This requirement is without prejudice to the legislation on the health protection of workers and members of the public adopted in Chapter III of the Euratom Treaty, in particular Council Directive 96/29/Euratom.</p>		<p>Qualified staff shall monitor the radioactivity of each consignment. Each consignment of scrap shall be accompanied by a certificate established in accordance with national or international rules on monitoring and response procedures for radioactive scrap metal. The certificate may be included in other documentation accompanying the consignment.</p>	<p>All scrap grades shall be checked as early as possible, preferably at the origin of the material source when scrap enters the material chain, and in all subsequent stages of the scrap supply chain, in strict compliance with state-of-the-art and the most efficient detection equipment and within the limitations of accessibility to identify radioactive materials</p>
<p>The scrap shall be graded according to an industry specification, a standard for direct use or a customer specification in the production of metal substances or objects by smelters, refiners, re-melters or other metals producers.</p>		<p>Qualified staff shall grade each consignment.</p>	<p>The specification used may be agreed across an industry sector (e.g. EN 12861, ISRI) or may be defined by one or more individual companies.</p>
<p>The scrap shall not contain PVC in coatings, paints, and plastics.</p>		<p>Qualified staff shall carry out a visual inspection of each consignment.</p>	
<b>Input materials</b>			
<p>Only waste that contained recoverable copper or copper alloys may be used as input.</p> <p>Hazardous waste shall not be used as an input except where proof is provided that the processes and techniques specified under 'criteria on treatment and techniques' to remove all hazardous properties have been applied.</p> <p>The following wastes shall not be used as</p>		<p>Acceptance control of all waste received (by visual inspection) and of the accompanying documentation shall be carried out by qualified staff which is trained on how to recognise waste that does not fulfil the criteria set out in this section.</p>	<p>Acceptance control procedures shall be covered by the quality assurance system</p> <p>This would normally include that the undertaking applying the end-of-waste criteria requires certain quality assurance also by the supplier.</p> <p>Staff carrying out the acceptance control shall be trained on how to recognise operationally input material that does not fulfil the</p>

Criteria	Remarks	Self monitoring	Explanation
<p>an input:</p> <ul style="list-style-type: none"> <li>• filings and turnings that contain fluids such as oil or oily emulsions and</li> <li>• barrels and containers, except equipment from end-of-life vehicles, which contain or have contained oil or paints.</li> </ul>			requirements
<b>Processes and techniques</b>			
<p>The copper and copper alloys scrap shall have been segregated at source or while collecting and shall have been kept separate or the input wastes shall have been treated to separate the copper and copper alloys scrap from the non-metal and non-copper metal components.</p> <p>All mechanical treatments (like cutting, shearing, shredding or granulating; sorting, separation, cleaning, de-polluting, emptying) needed to prepare the metal scrap for direct input into final use shall have been completed.</p> <p>For waste containing hazardous components the following specific requirements shall apply:</p> <p>(1) Input materials that originate from waste electrical or electronic equipment or from end-of-life vehicles shall have undergone all treatments required by Article 6 of</p>		<p>All required treatments shall have been completed. Compliance to be assessed by the undertaking applying the end-of-waste criteria based on knowledge on the treatment applied to the input materials and on the own treatments.</p>	

Criteria	Remarks	Self monitoring	Explanation
<p>Directive 2002/96/EC of the European Parliament and of the Council and by Article 6 of Directive 2000/53/EC of the European Parliament and of the Council;</p> <p>(2) Chlorofluorocarbons in discarded equipment shall have been captured in a process approved by the competent authorities;</p> <p>(3) Cables shall have been chopped or stripped. If a cable contains organic coatings (plastics), the organic coatings shall have been removed in accordance with the best available techniques;</p> <p>(4) Barrels and containers shall have been emptied and cleaned;</p> <p>(5) Hazardous substances in waste not mentioned in point (1) shall have been efficiently removed in a process which is approved by the competent authority.</p>			
<p><b>Quality assurance</b></p>			
<p>(1) The producer shall implement a quality management system suitable to demonstrate compliance with the criteria.</p>			



Criteria	Remarks	Self monitoring	Explanation
<p>(2) The quality management system shall include a set of documented procedures concerning each of the following aspects:</p> <p>(a) acceptance control of waste used as input for the recovery operation;</p> <p>(b) monitoring of the treatment processes and techniques (described under section treatment processes and techniques);</p> <p>(c) monitoring of the quality of scrap metal resulting from the recovery operation (including sampling and analysis);</p> <p>(d) effectiveness of the radiation monitoring (described under section of radiation and monitoring);</p> <p>(e) feedback from customers</p>			

<sup>17</sup> For waste containing hazardous components the following specific requirements shall apply:

- (1) Input materials that originate from waste electrical or electronic equipment or from end-of-life vehicles shall have undergone all treatments required by Article 6 of Directive 2002/96/EC of the European Parliament and of the Council and by Article 6 of Directive 2000/53/EC of the European Parliament and of the Council;
- (2) Chlorofluorocarbons in discarded equipment shall have been captured in a process approved by the competent authorities;
- (3) Cables shall have been chopped or stripped. If a cable contains organic coatings (plastics), the organic coatings shall have been removed in accordance with best available techniques;
- (4) Barrels and containers shall have been emptied and cleaned;
- (5) Hazardous substances in waste not mentioned in point (1) shall have been efficiently removed in a process which is approved by the competent authority.

Criteria	Remarks	Self monitoring	Explanation
<p>concerning the product quality;</p> <p>(f) record keeping of the results of monitoring conducted under points (a) to (d);</p> <p>(g) review and improvement of the quality management system;</p> <p>(h) training of staff.</p> <p>(3) The quality management system shall also prescribe the specific monitoring requirements set out for each criterion.</p> <p>(4) Where any of the treatments referred to in the section on specific process requirements for waste containing hazardous components<sup>17</sup> is carried out by a prior holder, the producer shall ensure that the supplier implements a quality management system which complies with the requirements.</p> <p>(5) The importer shall require his suppliers to implement a quality management system which complies with the requirements of points 1 to 4 and has been verified by an independent external verifier.</p> <p>(6) A conformity assessment body as defined in Regulation (EC) No 765/2008, which has obtained accreditation in accordance with that Regulation, or any other</p>			

Criteria	Remarks	Self monitoring	Explanation
<p>environmental verifier as defined in Art 2(20) (b) of Regulation (EC) No 1221/2009 shall verify that the quality management system complies with the requirements of this Article. The verification should be carried out every three years.</p> <p>(7) The producer shall give competent authorities access to the quality management system upon request.</p>			

Information provided with the product			
The producer or the importer shall issue, for each consignment of scrap metal, a statement of conformity conforming to the model set out below:			
1. Producer/importer of scrap metal:			
Name:			
Address:			
Contact person:			
Tel.:			
Fax:			
E-mail:			
2. a) Name or code of the scrap metal category, in accordance with an industry specification or standard:			
b) Where relevant, main technical provisions of a customer specification, such as composition, size, type and properties:			
3. The scrap metal consignment complies with the industry specification or standard referred to in point 2(a) or with the customer specification to in point 2(b)			
4. Quantity of the consignment in kg <sup>18</sup> :			
5. A radioactivity test certificate has been established in accordance with national or international rules on monitoring and response procedures for radioactive scrap metal			
6. The producer of scrap metal applies a quality management system complying with Article 6 of Regulation (EU) No....[will be inserted once this Regulation adopted], which has been verified by an accredited verifier or, where scrap metal which has ceased to be waste is imported into the customs territory of the Union, by an independent verifier.			
7. The scrap metal consignment meets the criteria referred above.			
8. Declaration of the producer/importer of scrap metal: I certify that the above information is complete and correct to the best of my knowledge.			
Name:			
Date:			
Signature:			
The statement of conformity may be issued in an electronic format.			

<sup>18</sup> By using kg instead of tonne, one uses a unit which is part of the International System of Units (SI), and avoids any possible confusion in international transport between the SI accepted unit tonne (1000 kg), also called metric tonne, and the units of the Imperial UK and US customary units "tonne" (long tonne = 1.016 tonnes, short tonne = 0.9072 tonnes).

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Title: End-of-waste Criteria for Copper and Copper Alloy Scrap: Technical Proposals

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**Abstract**

This report is the JRC-IPTS contribution to the development of the end-of-waste criteria for copper and copper alloy scrap in accordance with Article 6 of Directive 2008/98/EC of the European Parliament and of the Council on waste (the Waste Framework Directive).

This report includes a possible set of end-of-waste criteria and shows how the proposals were developed based on a comprehensive techno-economic analysis of copper and copper alloy recycling and an analysis of the economic, environmental and legal impacts when copper scrap cease to be wastes. The purpose of end-of-waste criteria is to avoid confusion about the waste definition and to clarify when certain waste that has undergone recovery ceases to be waste. Recycling should be supported by creating legal certainty and an equal level playing field and by removing unnecessary administrative burdens. The end-of-waste criteria should provide a high level of environmental protection and an environmental and economic benefit.

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