

# **Methodology for the free allocation of emission allowances in the EU ETS post 2012**

## **Sector report for the non-ferrous metals industry**

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## **Disclaimer and acknowledgements**

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### **Disclaimer**

The views expressed in this study represent only the views of the authors and not those of the European Commission. The focus of this study is on preparing a first blueprint of an allocation methodology for free allocation of emission allowances under the EU Emission Trading Scheme for the period 2013 – 2020 for installations in the non-ferrous metals industry. The report should be read in conjunction with the report on the project approach and general issues. This sector report has been written by the Fraunhofer Institute for Systems and Innovation Research.

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# 1 Introduction

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A large variety of products is produced in the non-ferrous metals industry. Table 1 gives an overview of EU27 production volumes of different non-ferrous metals in the year 2007.

Table 1 Non-ferrous metal production of EU27 Member States in 2007, World Bureau of Metal Statistics (2008)

<b>Product</b>	<b>Production (kt)</b>
Primary aluminium	3125.0
Secondary aluminium (remelting)	4900.0
Secondary aluminium (refining)	2700.0
Copper	2386.0
Zinc	2102.0
Lead	1633.0
Nickel	122.5
Tin	8.4
Tungsten	5.0
Cadmium	2.0
Silver	1.8
Mercury	0.0
Antimony	0.0
Magnesium	0.0

The aluminium industry, being the largest industry in the non-ferrous metals sector, is described in a separate sector report. Among the remaining non-ferrous metals, the 2007 production volume of copper, zinc and lead cover about 98 % of the total production volume. Within our report we will therefore concentrate on these three products.

In order to acquire information and data on the non-ferrous metals sector, Fraunhofer ISI is in contact with Eurométaux, the European Copper Institute (ECI), the International Zinc Association (IZA) and the International Lead Association (ILA).

Copper is produced via the primary as well as the secondary production route. In the primary production process copper concentrates (up to 30 % copper) are roasted and smelted in order to obtain copper matte ( $\text{Cu}_2\text{S}$ ). The sulphur content of copper matte is oxidised in the following converting process and copper matte reduced to unrefined copper in form of copper anodes (> 98 % copper). Further purification is achieved in a refining step in which copper cathodes are formed by electrolysis (99.99 % copper). Secondary copper cathodes are produced out of copper scrap of varying composition (1 – 99 % Cu). Further processing includes casting of billets, cakes and slabs and production of wire rods. Copper metal (cathodes) and concentrates are mainly imported from Chile, Peru, Mexico and Indonesia.

Primary zinc is produced via either the RLE (Roasting – Leaching – Electrolysis) or the ISF (Imperial Smelting Furnace) route. In the RLE route calcine (ZnO) is produced from zinc concentrates in a roasting process and a zinc sulphate solution (ZnSO<sub>4</sub>) obtained following a leaching and purification step. Pure zinc metal is finally produced by electrolysis. Two different RLE processes are distinguished by either hydrometallurgical or pyrometallurgical treatment of the leaching residues. In the ISF process zinc concentrate is fed as a sinter and then directly lead into the Imperial Smelting Furnace together with coke. Further purification of crude zinc is achieved through refining. In the RLE as well as in the ISF process secondary raw materials such as zinc oxide or EAF dusts can be added. Further processing of zinc is production of alloys, which are then delivered to the die casting, galvanizing, etc. industries.

Most of the primary lead production in the EU27 is carried out in processes with one or two furnaces with one or two process stages. Alternative production methods offer many potential advantages in terms of overall efficiency, energy consumption and lower emissions (e.g. QSL, Kivcet, Isasmelt, TBRC) and include considerable amounts of secondary materials in their feedstock. 60 % of the European lead production stems from recycled materials (mainly batteries). Secondary smelters either separate out the plastics and smelt the lead containing fractions in furnaces (mostly rotary furnaces) or process the batteries as a whole in shaft furnaces after removing the acid. Subsequent to the primary as well as the secondary smelting process, the recovered lead bullions need to be refined to marketable qualities.

According to Annex I to the amended Greenhouse Gas Emission Allowance Trading Directive<sup>1</sup>, ‘production and processing of non-ferrous metals, including production of alloys, refining, foundry casting etc., where combustion units with a total rated thermal input (including fuels used as reducing agents) exceeding 20 MW are operated’ are to be included in the ETS. Table 2 gives an overview of the NACE classification of this Annex I category of activities.

Table 2 Division of the non-ferrous metals industry according to the Annex I of the amended Directive and corresponding activities in NACE Rev. 1.1 classification

<b>Annex I category of activities</b>	<b>NACE code (Rev. 1.1)</b>	<b>Description (NACE Rev. 1.1)</b>
Production and processing of non-ferrous metals, including production of alloys, refining, foundry casting etc., where combustion units with a total rated thermal input (including fuels used as reducing agents) exceeding 20 MW are operated.	27.41	Precious metals production
	27.43	Lead, zinc and tin production
	27.44	Copper production
	27.45	Other non-ferrous metal production
	27.53	Casting of light metals
	27.54	Casting of other non-ferrous metals

Information on the number of copper producing installations in the EU 27 that are included in the ETS and average estimates for total production volumes and total direct CO<sub>2</sub> emissions for

<sup>1</sup> Directive 2009/29/EC amending Directive 2003/87/EC, Non-ferrous metals were not part of the ETS under the Directive 2003/87/EC, except via the “combustion of fuel activity”.

the years 2005 - 2007 have been provided by the European Copper Institute<sup>2</sup>. Information on copper matte production is, however, still missing. An overview is given in Table 3.

Table 3 Overview of copper production and GHG emissions of EU27 ETS installations, average estimates 2005 – 2007; excluding Norway and Iceland, data is based on sector data collection and is provisional (ECI, 2009)

Product	No. of installations	Total production (kt)	Total direct CO <sub>2</sub> emissions (kt)	Specific direct CO <sub>2</sub> emissions (kg CO <sub>2</sub> /t product) <sup>1</sup>
Cathodes (primary smelting)	8	1490	1700	1140
Cathodes (secondary smelting)	7	710	220	310
Wire rod <sup>2</sup>	10	1770	150	85
Shapes (billets, cakes & slabs)	8	800	80	100
Anodes <sup>3</sup>	6	370	100	270
<b>Total</b>			<b>2250</b>	

<sup>1</sup> Calculated as the quotient of total direct CO<sub>2</sub> emissions and total production

<sup>2</sup> Less than 33 % of these are members of the European Copper Institute ECI

<sup>3</sup> Only contains anodes transferred to another installation. The emissions of anodes that are used within the same installation to produce cathodes are included in the cathode's direct emissions

Information on the number of zinc production installations in the EU 27 that are possibly included in the ETS and average estimates for total production volumes and total direct CO<sub>2</sub> emissions for the years 2005 - 2007 have been provided by the International Zinc Association<sup>3</sup>. An overview is given in Table 4.

Table 4 Overview of zinc production and GHG emissions of EU27 ETS installations 2007; excluding Norway and Iceland (IZA, 2009)

	No. of installations	Total production (kt)	Total direct CO <sub>2</sub> emissions (kt) <sup>1</sup>	Specific direct CO <sub>2</sub> emissions (kg CO <sub>2</sub> /t product)
RLE Zinc production with hydrometallurgical treatment of leaching residues <sup>2</sup>	7	1925.0	83.7	43
RLE Zinc production with pyrometallurgical treatment of leaching residues <sup>2</sup>	2	103.5	147.5	1425
Zinc production in the Imperial Smelting Furnace (ISF)	2	66.5	287.6	4325
<b>Total</b>			<b>518.8</b>	

<sup>1</sup> Calculated as the total production volume multiplied with the arithmetic average of the emission factors of all participating installations

<sup>2</sup> All RLE production units in the EU do have an installed capacity exceeding 20MW and are therefore falling under the ETS for their direct emissions.

<sup>2</sup> Personal communication, ECI via e-mail, 3<sup>rd</sup> of July 2009

<sup>3</sup> Personal communication, IZA via e-mail, 3<sup>rd</sup> of June 2009

For other non-ferrous metals similar information is compiled in Table 5.

Table 5 Overview of other non-ferrous metals EU27 installations 2007, excluding Norway and Iceland (Eurométaux 2009, investigations of Fraunhofer ISI)

<b>Product</b>	<b>No. of installations</b>	<b>Total production (kt)</b>	<b>Total direct CO<sub>2</sub> emissions (kt)</b>	<b>Specific direct emissions (kg CO<sub>2</sub>/t product)</b>
	47	1633 <sup>3</sup>	1328 <sup>4</sup>	
Lead <sup>1</sup>	7 (primary) 40 (secondary) <sup>2</sup>	653 (primary) 980 (secondary)	953 (primary) 375 (rotary process)	1459 (primary lead) 383 (rotary process) <sup>5</sup>
Nickel <sup>6</sup>	2 <sup>7</sup>	68.2	91.4	1340
Tin		8.4	136.1 <sup>8</sup>	16200 <sup>5</sup>
Tungsten		5.0		
Cadmium		2.0		
Silver		1.8		
Mercury		0.0		

<sup>1</sup> Personal communication, ILA via e-mail, 6<sup>th</sup> of July 2009

<sup>2</sup> Some of the primary (average: 136 kt/installation) and the majority (> 90 %) of the secondary smelters (average: 9 kt/installation) have a rated thermal capacity of less than 20 MW or are below 25,000 t/y of CO<sub>2</sub>-emissions. For the moment the exact number is unknown. This implies that not more than ten installations for lead production are part of the ETS.

<sup>3</sup> Source: World Bureau of Metal Statistics (2008). According to information of the ILA, the total capacity of primary smelters adds up to 500,000 t, the capacity of secondary smelters to 1,200,000 t.

<sup>4</sup> Rough estimate based on the assumption of 40% primary lead and 60% rotary process. The real emissions could be lower.

<sup>5</sup> Source: Giegrich, Liebich and Fehrenbach (2007)

<sup>6</sup> Personal communication, European Nickel Industry Association (ENIA) via e-mail, 29<sup>th</sup> of May, 2009

<sup>7</sup> There are 3 more Nickel producing installations in EU27, but probably not part of the ETS.

<sup>8</sup> Rough estimate made by the consortium. The real emissions could be lower.



## 2 Production process and GHG emissions

### 2.1 Description of the production process

#### Copper

Primary copper production starts from concentrates with a copper content of up to 30 %. In a first production step copper concentrates are roasted and smelted in order to obtain copper matte ( $\text{Cu}_2\text{S}$ ) with a copper content of about 70 %. In the following converting process the sulphur content is oxidised by blowing oxygen through the hot copper matte. Copper matte is reduced to unrefined copper with a copper content of more than 98 % and cast into anodes. Further purification is achieved in the refining process, where copper anodes are electrolytically reduced to copper cathodes with a copper content of 99.99 %.

Pure copper scrap for secondary production can directly be melt into billets, cakes and slabs. Less pure scrap with a copper content between 1 and 99 % is transformed to anodes by different treatments, depending on the scrap quality. In the following refining step, copper cathodes with a copper content of 99.99 % are formed.

Semi-fabrication of copper cathodes and direct melt scrap includes casting of billets, cakes and slabs as well as production of wire-rod. Further downstream activities are e.g. ingot-making, casting, tube, wire and powder-making.

Copper concentrates and copper scrap mostly contain a variety of metals in addition to copper. These are simultaneously extracted in the copper smelting process.

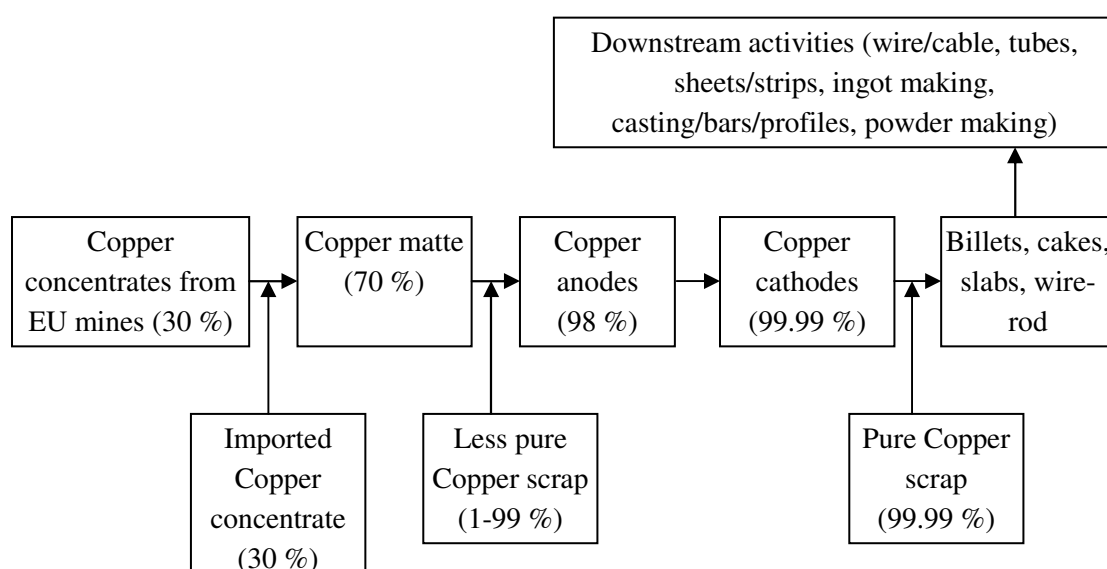


Figure 1 Schematic overview of the copper production chain

## **Zinc**

Primary zinc is produced via two different routes, namely “Roasting – Leaching – Electrolysis” (RLE) and the Imperial Smelting Furnace (ISF). Only two ISF installations are left in Europe with one of them momentarily out of production. Both production routes start from concentrates with a zinc content of 10 – 50 %.

In the first production step of the RLE route, calcine (ZnO) is produced in an exothermic roasting process. The released SO<sub>2</sub> is then used to produce H<sub>2</sub>SO<sub>4</sub> either in-house or by the chemical industry. RLE continues with a neutral leaching step followed by a purification step where a zinc sulphate (ZnSO<sub>4</sub>) solution is obtained. In the purification step copper, cadmium, cobalt, nickel and possible other impurities are taken out, can be further treated and sold. Pure zinc cathodes containing less than 50g of impurities per t of zinc are obtained by electrolysis. This is also called SHG (Special High Grade) zinc or 99.995 % pure zinc. RLE zinc production can further be categorised by the kind of treatment of the leaching residues, in which still > 15 % of the original zinc input may be contained.

In the case of hydrometallurgical treatment the residues are decomposed into zinc sulphate (ZnSO<sub>4</sub>), possibly a lead/silver by-product and an iron precipitate by high temperature acid leaching and further precipitation. The zinc sulphate obtained is recirculated to the leaching step. In the pyrometallurgical residue treatment process, the residues are burnt under addition of cokes in a Waelz Kiln. The outputs are slag and ZnO fume, which is recirculated to the leaching process.

The first production step of the ISF route consists in sintering of the concentrates. Crude zinc is then obtained from the Imperial Smelting Furnace where sinter is burnt together with coke. Further purification of crude zinc is achieved through refining.

Zinc oxides and scrap can be used for secondary zinc production. In the RLE as well as in the ISF primary production process zinc oxides and scrap can be added and account for 10 to 30% of total input. In comparison to RLE plants, ISF plants are better prepared to take secondary raw material in.

Further processing of zinc cathodes takes place in a foundry, where either SHG (super high grade) zinc is melted and given its “sales shape” or alloys are produced. Downstream activities include galvanizing, brass production (by the copper industry), die casting, sheet production and chemicals. About 50 % of the overall zinc demand is used for galvanising.

## **Lead**

The traditional primary lead production process route via sintering and shaft furnace has been phased out by most of the producers in the EU 27 and replaced by processes with only one or two furnaces with one or two process stages. Alternative production methods offer many potential advantages in terms of overall efficiency, energy consumption and lower emissions (e.g. QSL, Kivcet, Isasmelt, TBRC) and include considerable amounts of secondary materials in their feedstock. One plant in Germany relies on the environment-friendly and energy-saving technology of the QSL process. Here, lead is won by charging lead concentrates and secondary raw materials to a single, self-contained aggregate, the so-called QSL reactor.

60 % of the lead in Europe is produced from recycled materials (mainly batteries). Much less energy (less than half) is required for secondary production in comparison to the production of lead from ore (energy need for primary production: 7000 - 20000 MJ/t lead, secondary production: 5000 - 10000 MJ/t lead). Secondary smelters either separate out the plastics and smelt the lead containing fractions in furnaces (mostly rotary furnaces) or process the batteries as a whole in shaft furnaces after removing the acid.

Subsequent to the primary as well as the secondary smelting process, the recovered lead bullions need to be refined to marketable qualities. The refining process is more complex for metals of primary origin involving the removal of impurities (Ag, Bi, etc.) arising in the ore concentrate.

## **2.2 Direct emissions and steam use**

### **Copper**

In the primary copper matte production process (roasting and smelting) direct CO<sub>2</sub> emissions result from fossil fuel and coke input as well as from the carbon, which is dissolved in the concentrates. During the following copper anode production (converting) direct CO<sub>2</sub> emissions occur due to fossil fuel input. No direct CO<sub>2</sub> emissions stem from the electrolysis process as electricity is used. Secondary copper smelting leads to direct CO<sub>2</sub> emissions due to fossil fuel input. Apart from that, a significant amount of carbon may be embodied in secondary raw material like electronic scrap and cause up to 60 % of total direct emissions. Steam can be used in the copper refining step to heat the electrolysis bath.

### **Zinc**

Direct emissions in the zinc sector are very limited. Fuel combustion is required for starting up the roaster, but following the start-up it is an exothermic process which is only asking for electric driven fans, blowing air into the roaster. Further fuel is used in foundries where cathodic zinc is molten and possibly alloyed with other metals. Foundries can be heated with either gas or electricity and in many cases a mix of both energy carriers is used. In pyrometallurgical treatment of the leach residues, coke is used.

### **Lead**

CO<sub>2</sub> emissions occur from smelting and reducing with gas and coal. Kettles used for the refining processes are indirectly heated with gas and oil.

## **3 Allocation methodology**

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### **3.1 Background**

Emissions from copper activities in the EU ETS represent about 2.25 Mt of CO<sub>2</sub><sup>4</sup>. Emissions from other non-ferrous metals represent together a similar amount, mostly due to lead. Compared to the emissions from aluminium-related activities, this represents not more than 20 % of the overall emissions from the non-ferrous metals sector including aluminium. Compared to the overall industrial emissions from the EU 27 under the ETS of around 850 Mt, this represents about 0.5 % only. Beyond that, each of the processes in the non-ferrous metals sector involves a very limited number of installations, which makes a benchmark system based on the average of the 10 % most efficient installations hardly possible. We therefore recommend treating copper, zinc, lead and other non-ferrous metals through a fall-back approach (see section 5 of the report on the project approach and general issues).

The obstacles to a benchmark approach for the non-ferrous metal sector are discussed in more detail in Chapter 4.

#### **Electricity benchmarks**

The compensation mechanism for indirect emissions is not within the scope of this study. In the electrolysis step to produce copper cathodes, the electric furnaces in copper production and the electrolysis of zinc are all electricity-intensive processes that could possibly be considered for the development of electricity benchmarks in the non-ferrous metals industry. So far, no data is available on the electricity consumption in the non-ferrous metals industry.

### **3.2 Relevant PRODCOM codes**

As mentioned earlier we recommend treating the whole non-ferrous metal sector with a fall-back approach (see section 5 of the report on the project approach and general issues) and do not consider a benchmark approach described as follows an adequate approach for the non-ferrous metal sector. Below we give overviews of the relevant PRODCOM codes for copper, zinc and lead in case the final decision is made to develop a product benchmark for the copper, zinc and lead sector. A full list of the PRODCOM codes of non-ferrous metals in unwrought form is attached to this report (see appendix A).

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<sup>4</sup> See Table 3.

Table 6 Overview of eventual benchmark products of the copper sector and their corresponding PRODCOM codes

<b>Product</b>	<b>Corresponding PRODCOM codes</b>	<b>PRODCOM description</b>
Copper matte	27.44.11.00	Copper mattes; cement copper (precipitated copper) (excluding copper powder)
Copper	27.44.13.30	Unwrought unalloyed refined copper (excluding rolled, extruded or forged sintered products)

Table 7 Overview of eventual benchmark products of the zinc sector and their corresponding PRODCOM codes

<b>Product</b>	<b>Corresponding PRODCOM codes</b>	<b>PRODCOM description</b>
Non-alloy zinc	27.43.12.30	Unwrought non-alloy zinc (excluding zinc dust, powders and flakes)
Zinc alloys	27.43.12.50	Unwrought zinc alloys (excluding zinc dust, powders and flakes)

Table 8 Overview of eventual benchmark products of the lead sector and their corresponding PRODCOM codes

<b>Product</b>	<b>Corresponding PRODCOM codes</b>	<b>PRODCOM description</b>
Lead	27.43.11.30	Refined unwrought lead (excluding lead powders or flakes)

## 4 Emission intensity data

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As stated earlier, we do not consider product benchmarking an adequate approach for the non-ferrous metal sector and therefore recommend applying a fall-back approach (see section 5 of the report on the project approach and general issues). Below we nevertheless give information on emission intensity differences for several copper, zinc and lead production steps as it was obtained from the relevant sector organizations. This data supports our opinion that product benchmarking is not an appropriate approach for the non-ferrous metals sector. In addition, we also give some reflections for copper on the various products that need to be distinguished in case a decision on product benchmarking is being made.

### Copper

The European Copper Institute has collected data on direct emissions among its members. The whole benchmark curves for primary cathodes, secondary cathodes, wire rod, shapes (cakes, slabs and billets) and anodes can in principle be provided but are not public for confidentiality reasons, even more because of the low number of installations in each curve. The copper sector has nevertheless provided the values of the lowest and highest performer. Table 9 gives an overview of the spread factor for benchmarking curves of the different copper production steps, i.e. the factor describing the distance from the lowest to the highest emitter in the curve (ECI, 2009a).

Table 9 Overview of the factors reflecting the spread in the benchmark curves for different copper production steps, average of the years 2005-2007<sup>5</sup>. (ECI, 2009a)

Activity	Range of direct emissions (t CO <sub>2</sub> /t product)	Spread factor
Primary cathodes	0.20 – 3.85	19
Secondary cathodes	0.05 – 0.65	13
Wire rod production <sup>1</sup>	0.05 – 0.30	6
Shape production	0.05 – 0.30	6
Anode production <sup>2</sup>	0.15 – 1.20	8

<sup>1</sup> Data is from a limited number of installations (ECI members only). It has to be checked how many installations are missing

<sup>2</sup> Only contains anodes transferred to another installation. The emissions of anodes that are used within the same installation to produce cathodes are included in the cathode's direct emissions

The values given for primary cathodes include both, the emissions arising in copper matte production and in converting of copper matte into copper anodes. According to the ECI, import of copper matte to Europe is considerable, while trade within Europe plays a rather insignificant role. If a benchmarking approach for the non-ferrous metals sector was applied, copper matte should in accordance with starting point 6 (separate benchmarks for intermediate products) described in the report on the project approach and general issues receive a separate benchmark in order to ensure adequate allocation to installations purchasing this intermediate product from outside the ETS. Since trade of copper anodes that

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<sup>5</sup> ECI stresses that data are provisional. Norway and Iceland are not included.

are produced in the converting process is considerable, a separate benchmark for copper anodes would be required as well. No direct emissions occur in the following electrolysis step and no direct emission benchmark would therefore be necessary for the production of copper cathodes from anodes.

It becomes clear from Table 9 that the spread in the benchmarking curves of the copper sector is high, which means that a benchmark approach would practically result in auctioning for a number of installations. In the case of anodes and primary and secondary cathodes the reasons for the high spreads in the benchmark curves have been investigated by the ECI. It was found out that the main reasons for outliers are firstly the use of electricity versus fossil fuel as source of energy, secondly a high share of carbon content in the feed, which varies between 0.2 % and 7 % for concentrates and even more strongly for secondary raw material and thirdly the share of copper content of concentrates varying between 25 and 40 %. Specific energy consumption of copper matte production depends strongly on the concentrates' copper content, based on the volume of gases to pump in the smelter and acid plants per unit of copper. According to a rough estimate of the ECI, considering all the energies involved in primary cathode production, the specific energy consumption of primary cathode will increase by 1.5 % with every 1 % lower copper content.

shows the variation in the composition of direct emissions in primary and secondary cathode production. The category “raw material” represents direct emissions occurring due to the carbon embodied in the feed, the category “fuel” the share of direct emissions that are due to the kind of fuel input and the category “process” direct emissions due to process technology. Figure 2 helps to understand the reasons for the high spread factors, making obvious the strong impacts on direct emissions caused by the share of carbon embodied in the feed as well as by the choice of fossil fuel versus electricity. Note, however, that according to the benchmarking principles set up, none of these three factors (raw materials, fuel, process) would justify a distinction in benchmarks given the fact that the same product is produced.

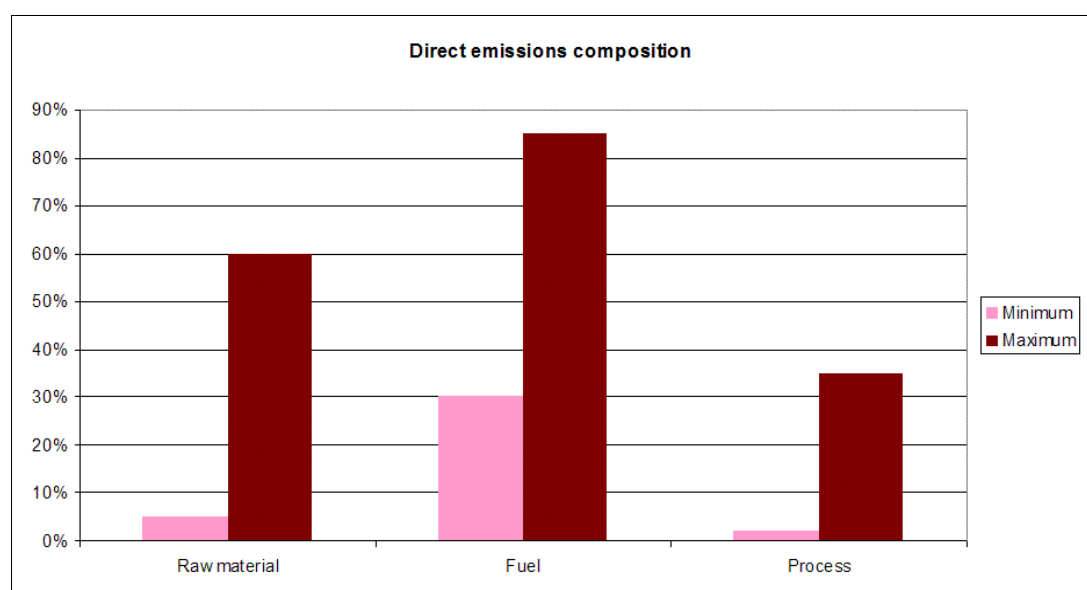


Figure 2 Composition of direct emissions for primary and secondary copper production (ECI, 2009)

Scrap quality has got a high impact on the energy consumption and direct emissions of secondary copper furnaces, i.e. production of secondary copper from low quality scrap is more energy and CO<sub>2</sub>-intensive than from high quality scrap. Recycling of electronic scrap in particular leads to high CO<sub>2</sub> emissions, since on the one hand electronic scrap contains a high share of carbon leading to additional process emissions and on the other hand two smelting steps are necessary instead of one. This indicates that there are conflicting environmental goals: CO<sub>2</sub> reduction and waste recycling. With the aim of saving resources, production of non-ferrous metals from low quality scrap is required from European environmental policies<sup>6</sup>. Considerable investment in environmentally friendly technology has been made by European copper smelters in the last years. Stakeholders from the non-ferrous metal industry therefore argue that companies should not be punished for their recycling efforts and a consideration of scrap quality in the allocation would be necessary. In our opinion consideration of different recycling efforts will however be difficult within a benchmark approach for the non-ferrous metal industry, even more since the share of recycling material in the feed of secondary production varies continuously between 30 and 100 % between different European installations<sup>7</sup>. In view of the very limited number of producers in combination with the limited amount of emissions, the occurrence of intermediate process steps with varying shares of primary versus secondary inputs and, related to this, some interchangeability of electricity and fuel use, it is very difficult to develop a benchmark approach for the copper production chain. We therefore recommend a fall-back approach for this sector (see section 5 of the report on the project approach and general issues).

## Zinc

Table 10 gives an overview of a data collection that has been provided by the International Zinc Association<sup>8</sup>. For lack of the whole benchmarking curve, the values of the highest and lowest emissions and the resulting spread factors are given.

Table 10 Overview of the factors reflecting the spread in benchmark curves for different zinc production steps 2007, (IZA 2009)

Activity	Range of direct emissions (t CO <sub>2</sub> /t product)	Spread factor
RLE zinc production, roasting step	0.000 - 0.035 <sup>1</sup>	-
RLE zinc production, hydrometallurgical leaching & electrolysis	0.002 - 0.030	15
RLE zinc production, pyrometallurgical leaching & electrolysis	1.0 - 1.8	1.8
ISF zinc production, furnace	4.3 - 5.0	1.2
Foundry/Casting of zinc	0.005 - 0.050 <sup>2</sup>	10

<sup>1</sup> In some installations the whole or part of the feedstock passes through the roaster, in others it is directly introduced to the neutral leaching step.

<sup>2</sup> Gas or electricity can be used as melting energy.

<sup>6</sup> See “Waste Electrical and Electronic Equipment Directive”, regulating the return of waste equipment by the electronic industry and “End of Life Vehicle Directive”, regulating the return of scrap from cars

<sup>7</sup> Personal communication – ECI via e-mail, 27<sup>th</sup> of July 2009

<sup>8</sup> Personal communication – IZA via e-mail, 3<sup>rd</sup> of June 2009. Norway and Iceland are not included.



Energy consumption of zinc oxide production depends amongst others on the zinc content of the concentrates varying between 10 and 50 %, but also on the share of electricity versus fuel use in the different process routes. Given the overall size of the sub sector with only a limited amount of installations and emissions (11 installations with only about 0.5 Mt CO<sub>2</sub> emissions), we recommend a fall-back approach for this product (see section 5 of the report on the project approach and general issues).

## Lead

Table 11 gives an overview of an estimation of emissions values of the International Lead Association<sup>9</sup>. For lack of a data collection and the whole benchmarking curve, estimations for the values of the highest and lowest emissions and the resulting spread factors are given.

Table 11 Estimation of the factors reflecting the spread in benchmark curves for primary and secondary lead production (ILA, 2009)

Activity	Range of direct emissions (t CO <sub>2</sub> /t of product)	Spread factor
Primary lead production	0.7 – 1.5	2.1
Secondary lead production	0.4 – 1.5	3.8

The lead sector contains only very few ETS installations with in total only a limited amount of emissions. Most of the installations have a rated thermal capacity of less than 20 MW or are below 25000 tCO<sub>2</sub> emissions per year. We therefore recommend applying a fall-back approach (see section 5 of the report on the project approach and general issues) for the whole sector.

<sup>9</sup> Personal communication – ILA via e-mail, 6<sup>th</sup> of July 2009. Norway and Iceland are not included.

## **5 Additional steps required**

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If, as recommended by the consortium, a fall-back approach for the whole non-ferrous metal sector was chosen, no more data would be required from the sector associations.

In case that the choice of a benchmark approach would be made for parts of the non-ferrous metal industry, additional data would be necessary.

1. For further work on the determination of final benchmark values based on the average of the 10% most carbon efficient installations, benchmark curves including all installations from EU27, Norway and Iceland would be required for each of the benchmark groups.
2. Separate benchmark curves for copper matte and the production of copper anodes from copper matte would be required.
3. The data that has been provided from the ECI is given on copper cathodes (primary and secondary) as end-products. We emphasize that the benchmarks should, however, be based on copper anodes, since the import of copper anodes to Europe is significant and no allocation should be given to installations producing copper cathodes from imported anodes<sup>10</sup>.
4. It would in particular be essential that system boundaries would be made clear to all installations participating in the data collection, in order to ensure high quality of the data provided.

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<sup>10</sup> No further direct emissions arise during transformation of anodes into cathodes via electrolysis.

## **6 Stakeholder comments**

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### **6.1 Comments of the copper sector**

Comments on the interim report have been made by the ECI on the following issues<sup>11</sup>.

#### **Product choice**

The ECI does not understand the logic for a separate benchmark for copper matte. This product is primarily treated in house, with merchant trade being very small. A separate benchmark for copper anode production is also not considered advisable, since these anodes are not traded internationally at the LME. Finally, the ECI wishes to have more than one benchmark for secondary cathode production depending on the complexity of the feed.

#### **Fall-back approach**

It is important to note that in some cases the potential for additional measures to reduce CO<sub>2</sub> emissions reaches technological and physical limits. In the discussion of any generic efficiency improvement factor combined with a fallback approach it should be taken into account that the improvement potential for the production processes of copper wire rod and shapes is extremely limited due to mature technology. The factor should be based on performance, which could be assessed from the reference document on best available techniques for the non-ferrous metals industry (BREF non-ferrous metals-draft, 2008).

For some installations, a large amount (up to 60 % of direct emissions) is due to the carbon content of the raw materials (in naturally occurring ores, concentrates and secondary materials for recycling). The processors of these raw materials have no control over the quality of these resources. For the whole copper sector it represents ca. 30 % of total direct emissions (i.e. 690,000 t of CO<sub>2</sub>). As a result it seriously reduces the potential scope for decreasing CO<sub>2</sub> emissions.

The ultimate solution for treating recycling in ETS would be grandfathering. Furthermore for grandfathering the generic efficiency improvement factor has to be designed in such a way that carbon in feed and fuel should be excluded from the calculations.

#### **Recycling**

During copper processing, recycling plays a major role as it supplied 41 % of the European demand in 2007. Furthermore, copper plays an important role as “collector” of precious metals and trace metals, which, if not recycled, would be entirely lost to dumping grounds or exported to non-EU countries. Thus to improve supply security, resource conservation and environmental protection, the EU is increasing its support. As recovery and recycling rates increase, e.g. from End-of Life Vehicles (ELV) and Waste Electrical & Electronic Equipment (WEEE), the copper content in the feedstock decreases and the carbon content increases (e.g.

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<sup>11</sup> Personal communication – ECI via e-mail, 3<sup>rd</sup> of July 2009

plastics from cable insulation and from printed circuit boards.) Both of these drive up carbon emissions per t.

European copper smelters/foundries have the highest environmental standards worldwide. For example, in 2008, European smelters emitted twelve times less SO<sub>2</sub> compared to international smelters. Unfortunately the operation of environmental abatement techniques is connected with high energy consumption. CO<sub>2</sub> emissions, which are caused by environmental protection measures, must be fully compensated or recycling and environmental abatement measures must be excluded from the ETS.

Considering the fact that producing cathodes with recycled materials saves ca. 650.000 t of CO<sub>2</sub>, because specific direct emissions of secondary smelters are 4 times less than of primary smelters, designing suitable compensation measures (e.g. free allocation for direct emissions and financial compensation for indirect emissions) during the ETS implementation will be an effective and efficient driver for recycling and further processing. Failing such compensation measures, recycling materials will either leave Europe or will be driven towards landfill.

### **Carbon leakage**

Copper cathode is a commodity for which the price is quoted on London Metal Exchange. This LME price is a worldwide reference. Additional CO<sub>2</sub> related burdens in Europe do not affect this global price in any way. In other words, if the CO<sub>2</sub> related burden is imposed to European manufacturers, it will have to be absorbed by European producers and can not be charged to the customers. This will lead to loss of competitiveness for European manufacturers and will result in carbon leakage.

If raw materials with a high carbon content are subject to ETS in Europe, and carry a financial burden either directly or indirectly, then EU will increasingly export high-carbon raw materials and secondary materials, thereby increasing carbon leakage; a threat recently recognised by the EC in its preliminary list of sectors “at significant risk of carbon leakage” (which includes the copper industry).

Substantial investments have been made since 1995 by the industry to improve energy efficiency and reduce CO<sub>2</sub> emissions. European copper production is the most energy-efficient in the world and energy is produced from a comparatively clean fuel mix. For example, for the production of cathodes, the 2006 unit energy consumption is 54 % lower than that of 1995. The possibilities for further improvements for this subsector and others, like wire-rod and shapes or electro-refining of anodes to cathodes, are very limited and would be dependent on future technological breakthroughs. Without realistic improvements targets, full free allocations for direct emissions and financial compensation for indirect emissions; these installations would close down, and the objective of mitigating carbon leakage would not be met.

### **Capacity expansion**

Capacity increases and full utilisation of approved capacities for all feed materials and new installations must be taken into account in the allocation, because the greatest efficiency improvements and specific emission decreases are reached by production increases in Europe.

In the past the copper sector has already invested in the most modern technology to improve energy efficiency and to decrease the specific direct and indirect CO<sub>2</sub> emissions. This has been mainly supported by capacity expansion. Therefore capacity expansion should be promoted by the free CO<sub>2</sub> emission rights allocation, and full financial compensation for the indirect emissions where required.

## **6.2 Comments of the zinc sector**

The following further comments on the interim report have been made by the IZA<sup>12</sup>.

### **Product choice**

In the opinion of the IZA, it would not make sense to have the hydro- and pyrometallurgical treatment of the leaching residue combined with RLE in one group. We are of the opinion that benchmarking cannot be done due to the low number of installations in the benchmarking group.

Whether combined or separate, benchmarking within the RLE group is very difficult due to the diversity of process variants. Even if the absolute numbers are low, the relative differences are high.

### **Indirect emissions**

Because of the influence of the pass through of CO<sub>2</sub> costs in electricity prices on the production cost of zinc we feel it is important and appreciate that realistic energy efficiency benchmarks will be developed related to the consumption of electricity and primary zinc production. These will be used in the light of provisions being made in the amended Directive for compensation of the pass through of these CO<sub>2</sub> costs in electricity prices.

### **Real improvement possibilities as basis**

It also needs to be realized that for an RLE based production scheme our sector is entirely tied in to the two physical laws of Faraday – completely linked to physical constants - and there is no real room for further optimizing of the process and stay in an economical viable situation. In the light of the carbon leakage discussions, this has to be taken into account for these type of sectors, mostly primary production, when setting possible limitations to the amount of free allocation provided to such sectors, for instance when an “improvement factor” is applied in a fallback position on free allocation: there is very little to no room for improvement in such case.

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<sup>12</sup> Personal communication – IZA via e-mail, 4<sup>th</sup> September 2009

## 7 References

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## **Appendix A: PRODCOM codes of the non-ferrous metals sector**

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The products of the non-ferrous metals sector are covered by 77 PRODCOM codes. The following table gives an overview of the PRODCOM codes of non-ferrous metals in unwrought form. Downstream processes are neglected. (For the latter, 47 more PRODCOM codes would have to be mentioned.)

Table 12 PRODCOM codes of non-ferrous metal products in the Annex I of the amended Directive

<b>Product</b>	<b>PRODCOM Code</b>
Silver, unwrought or in powder form (including plated with gold or platinum)	27.41.10.30
Gold, unwrought or in powder form for non-monetary use (including plated with platinum)	27.41.20.30
Platinum, palladium, rhodium, iridium, osmium and ruthenium, unwrought or in powder form	27.41.30.30
Refined unwrought lead (excluding lead powders or flakes)	27.43.11.30
Unwrought lead containing antimony (excluding lead powders or flakes)	27.43.11.50
Unwrought lead (excluding lead powders or flakes, unwrought lead containing antimony, refined)	27.43.11.90
Unwrought non-alloy zinc (excluding zinc dust, powders and flakes)	27.43.12.30
Unwrought zinc alloys (excluding zinc dust, powders and flakes)	27.43.12.50
Unwrought non-alloy tin (excluding tin powders and flakes)	27.43.13.30
Unwrought tin alloys (excluding tin powders and flakes)	27.43.13.50
Copper mattes; cement copper (precipitated copper) (excluding copper powder)	27.44.11.00
Unrefined copper, copper anodes for electrolytic refining (including blister copper) (excluding electrocopper-plating, electroplating anodes)	27.44.12.00
Unwrought unalloyed refined copper (excluding rolled, extruded or forged sintered products)	27.44.13.30
Master alloys of copper (including alloys which are not usefully malleable) (excluding copper phosphide (phosphor copper) containing > 15 % by weight of phosphorous)	27.44.13.70
Nickel mattes, nickel oxide sinters and other intermediate products of nickel metallurgy (including impure nickel oxides, nickel speiss, impure ferro-nickel)	27.45.11.00
Non-alloy unwrought nickel (excluding nickel powders and flakes)	27.45.12.30
Unwrought nickel alloy (excluding nickel powders and flakes)	27.45.12.50
Unwrought tungsten (wolfram) bars and rods obtained by sintering, tungsten powders, waste and scrap (excluding carbide)	27.45.30.13
Molybdenum, articles thereof, powders, waste and scrap (excluding alloy molybdenum without a predominance of molybdenum, carbide)	27.45.30.17

Continuation Table 12

<b>Product</b>	<b>PRODCOM Code</b>
Tantalum, articles thereof, powders, waste and scrap (excluding carbide)	27.45.30.23
Magnesium, articles thereof, powders, waste and scrap (excluding carbide)	27.45.30.25
Cobalt mattes and other intermediate products of cobalt metallurgy; cobalt, articles thereof, powders, waste and scrap (excluding carbide)	27.45.30.27
Bismuth, articles thereof, powders, waste and scrap (including bismuth-lead-tin alloys, bismuth-indium-lead-tin-cadmium alloys) (excluding carbide)	27.45.30.33
Unwrought cadmium, powders, waste and scrap (including cadmium zinc alloys) (excluding carbide)	27.45.30.35
Titanium, articles thereof, powders, waste and scrap (excluding carbide)	27.45.30.43
Zirconium, articles thereof, powders, waste and scrap (excluding carbide)	27.45.30.45
Antimony, articles thereof, powders, waste and scrap (excluding carbide)	27.45.30.47
Manganese, articles thereof, powders, waste and scrap (excluding carbide)	27.45.30.53
Beryllium, chromium, germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium, thallium, articles of these metals, powders, waste and scrap (excluding carbide)	27.45.30.55
Cermets, articles thereof, waste and scrap (excluding cermets containing fissile or radioactive substances, carbide)	27.45.30.57