

# Sustainable Development and the Global Copper Supply Chain: International research team report

Five Winds International  
International Council on Mining and Metals

June 2011



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## List of Acronyms

ASR	automobile shredder residue
CNIA	Chinese Non-Ferrous Metals Industry Association
CSR	corporate social responsibility
ELV	end-of-life vehicle
EMPA	Swiss Federal Institute for Materials Testing and Research
EPR	extended producer responsibility
ICA	International Copper Association
ICMM	International Council on Mining and Metals
IFC	International Finance Corporation
IISD	International Institute for Sustainable Development
ILO	International Labour Organization
LCA	life cycle assessment
MFA	material flow analysis
RoHS	restriction of hazardous substances
SX-EW	solvent extraction/electrowinning process
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
WEEE	waste electrical and electronic equipment

## Executive Summary

The primary purpose of this report is to compile and analyze information on market trends and policy drivers affecting the international copper supply chain, within the context of sustainable development. The report provides input into a broader, ongoing study conducted by the International Institute for Sustainable Development (IISD), the Chinese Ministry of Commerce (MOFCOM), the International Council on Mining and Metals (ICMM), the Chinese Non-Ferrous Metals Industry Association (CNIA), and the Swiss Federal Institute for Materials Testing and Research (EMPA) and is financed by the Swiss State Secretariat for Economic Affairs (SECO). The information gathered focuses on Flows C and D of the copper supply chain, as identified by the project team in an earlier phase of the project.

### **Supply Chain Structure**

This report focuses on two major copper supply chains for China, involving (1) the import of copper scrap (Flow C) and (2) the import of foreign copper mining products (Flow D). Flow C is a closed-loop process that encompasses secondary copper production (refined copper production using recycled scrap feed) and does not include any primary copper production (the extraction of copper-bearing ores). Flow D represents international primary copper production, beginning with the extraction of copper-bearing ores by mining processes and ending in end-of-life management processes for copper-containing products.

In order to identify sustainability concerns and foster mutually beneficial relationships throughout the copper supply chain, it is important to analyze the major players within the supply chain, as well as existing market dynamics, relevant international regulations and major impacts affecting the sustainability of the entire system. Because China is the largest consumer of copper mining products in the world, it has the greatest potential to effect change across many countries' operations. In addition, it will become increasingly important for China to reduce its own impacts of production and consumption.

### **Global Copper Production Levels and Trends**

The world's consumption of copper has almost tripled since 1970 and, despite the economic recession in the late 2000s, growth is likely to continue in the near future and be principally driven by increasing demand in China. This expansion in China's demand for copper has created a boom for international suppliers, leading to unintended environmental and social impacts in the rush to serve the market and pursue economic growth. Increasing dependence on Chinese demand has also increased risks for countries whose GDP is highly dependent upon copper output (e.g., Chile, Peru, Zambia).

Because China is the largest importer of copper worldwide, the impacts of a decrease in world copper supply due to resource depletion, steep increases in metal prices, new international regulations and standards related to sustainability, or the loss of a major producer's social licence to operate would be felt the greatest in China. In addition, since China does not possess the mining and smelting capacity to meet its own copper needs, the country relies on raw material resources (both post-consumer scrap and primary raw materials) from international producers of primary and secondary copper.

As the demand for copper increases in China and other economies in transition, the share of total copper production accounted for by primary production has not displayed a tendency to decline over time. This is largely because the pool of secondary copper generation is largely limited by availability rates (i.e., most copper is still in use and not yet available for recycling).

Copper and copper-based alloys are necessary for societal development because they are an essential component of transportation equipment, communication technologies, and the building and maintaining of a country's infrastructure. Mineral resource security in China is therefore directly linked to meeting human development objectives. To improve its mineral resource security, China can develop policies to increase domestic recycling rates; however, such measures will only have a limited effect on increasing the copper supply. Other investments in primary copper production, ideally in extraction technologies having lower environmental impacts (e.g., solvent extraction and electrowinning, or SX-EW, technology), will continue to play important roles in meeting Chinese copper demand.

### ***International Environmental Impact***

Beyond the scope of the life cycle assessment conducted on Chinese copper production, other elements for consideration include toxicological impacts (for which risk assessment can be used), resource sustainability (for which material flow analysis can be used), and the environmental benefits provided in the use phase of copper-containing products (for which cradle-to-grave life cycle assessments can be used).

Using risk assessment, the European Commission has deemed that the use of copper products is, in general, safe for the environment and human health. Using material flow analysis, researchers have highlighted the importance of recycling for future copper production and consumption in the world. While few cradle-to-grave life cycle assessments could be found on copper-containing products, the copper industry is developing information and data on the positive environmental contributions that the use of copper provides, particularly in electrical applications.

### **International Social Impact**

The international social impacts of copper cover a broad range of issues that are not necessarily unique to the Chinese copper supply chain, but rather a result of mining or recycling activities in general. Social benefits from recycling in China (and throughout the world) typically arise from creation of jobs in the recycling industry. Social benefits from copper mining are also created through job production and, in the case of foreign investments, through development of supporting infrastructure, community development, and tax and royalty benefits paid to the countries where the operations are located.

In addition to China's domestic challenges, foreign investment in countries throughout Africa, as well as in other developing economies, adds another level of complexity, because domestic policies vary greatly—and with them, so do environmental and social performance requirements expected of foreign operated companies.

In terms of social impacts of recycling, China's main challenge is to regulate its recycling infrastructure. This formalization would potentially eliminate many of the negative social impacts that arise from informal approaches to recycling.

### **International Policy Context**

There are numerous regulatory and voluntary sustainability drivers affecting primary and secondary copper production. Very few initiatives are specifically aimed at copper; most are aimed at the mining industry as a whole (for primary production) or aimed at one of four copper-containing product groups (for secondary production)—automobiles, building and construction, electrical and electronic equipment, and infrastructure.

For the analysis of regulatory and voluntary policies affecting secondary copper production (Flow C), this report found that the majority of policies affecting recycling in the regions studied (Europe, the United States and Japan) have been designed to minimize harm to humans and the environment, rather than to maximize the amount of recoverable materials available for recycling. While some of these policies—such as Europe's End-of-Life Vehicle (ELV) and Waste Electrical and Electronic Equipment (WEEE) Directives—may have the indirect impact of improving the flow of recoverable materials, others—such as the Basel Convention—have had the indirect impact of reducing the flow of recoverable materials to China.

For the analysis of regulatory and voluntary policies affecting primary copper production (Flow D), the policies of Australia, Chile and Zambia were examined. The research indicates that although there are no significant differences between the regulations of each of the three countries, there is a

notable discrepancy in the capacity of the Zambian government to enforce these regulations. The sustainable development impact of weak enforcement is that the local communities and national government may not receive an appropriate return from the harvesting of non-renewable resources and, as a result, these funds would not be available for important social services such as health and education.

Weak enforcement of regulations, on one hand, reduces the costs of compliance for copper mining and producing firms, which has the effect of keeping production costs low. On the other hand, companies want to minimize the reputational risks associated with conflicts with local stakeholders and any unwanted attention from non-governmental organization (NGO) and media campaigns. Abiding by voluntary measures beyond what is required by law—such as those espoused in the Equator Principles or ICMM’s Sustainable Development Principles—can be seen as a way to mitigate these risks and remain competitive.

### **Policy Recommendations**

Based on the research conducted in this report, which is aimed at gathering information that will improve our understanding of how sustainable development outcomes from the copper supply chain can be improved, the following policy recommendations were derived.

**Fill data gaps:** Due to the growing interest and scrutiny in monitoring and quantifying post-consumer metal exports from the United States and European Union, there are new customs requirements and better ways to track the quantity of post-consumer metals being exported. Improving the consistency of these requirements between exporting and importing countries would help to improve the quality of the data on the trade of post-consumer copper.

**Allow the import of e-waste:** The social and environmental problems associated with electronic waste (e-waste) treatment in China need to be balanced with the clear need for secondary copper and the social and environmental benefits of recycling. It is therefore recommended that China forcefully monitor the trade in such products rather than forcing it underground, while simultaneously strictly enforcing safe handling standards over the treatment process.

**Support extended producer responsibility policies:** China has several existing and forthcoming extended producer responsibility (EPR) policies, including China RoHS [restriction of hazardous substances] (effective in 2007), standards for the recycling of end-of-life vehicles (effective in 2010) and China WEEE (effective in 2011). These initiatives present an opportunity for China to anticipate when the “in-stock” copper will become available, set recycling targets, write standards and technical specifications, and develop the infrastructure required for efficient recovery and recycling:

- *Develop better understanding of availability of “in-stock” copper*
  - Developing a better understanding of consumer behaviour in key product sectors will be important to more accurately predict recycling flows.
- *Set standards and technical specifications with copper recycling in mind*
  - Standards and technical specifications should have the goal of maximizing the efficiency of recovering valuable materials such as copper.
- *Learn from best practices in the development of recycling infrastructure*
  - Promote the transfer of best available technology between regions and between different product groups (e.g., the automotive and e-waste sectors) to improve recycling infrastructure.
- *Work with industry on materials stewardship*
  - In today’s global marketplace, the credibility and effectiveness of industry materials stewardship initiatives, such as life cycle assessment and risk assessment studies of copper products, would be greatly enhanced with the participation of Chinese companies and other stakeholders.

***Extend corporate social responsibility policy to Chinese State-owned enterprises and Chinese private enterprises operating overseas:*** As China looks more and more to Africa and other developing regions as sources for raw materials, it would be beneficial to develop guidance for both State-owned and privately-owned Chinese enterprises operating overseas (similar to that developed for State-owned enterprises operating in China on corporate social responsibility reporting and protection of labour rights, as well as the draft “Guidelines on Corporate Social Responsibility Compliance by Foreign Invested Enterprises”).

***Strengthen government capacity:*** National governments have a central and unavoidable role to play in improving governance for sustainable development through national policy frameworks, regulations, and enforcement. But not all governments have the capacity to make the changes. It is evident that effective governance in the mining sector is lacking in some developing countries, particularly in Africa. The international community should focus on strengthening the capacity of national governments to design and enforce regulations so that they contribute to the country’s economic growth and human development.



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## 1.0 Introduction

The primary purpose of this report is to compile and analyze information on market trends and policy drivers affecting the international copper supply chain within the context of sustainable development. The report provides input into a broader, ongoing study conducted by the International Institute for Sustainable Development (IISD), the Chinese Ministry of Commerce (MOFCOM), the International Council on Mining and Metals (ICMM), the Chinese Non-Ferrous Metals Industry Association (CNIA), and the Swiss Federal Institute for Materials Testing and Research (EMPA) and is financed by the Swiss State Secretariat for Economic Affairs (SECO).

To prepare the report, Five Winds International conducted a literature search and compiled and analyzed the information relevant to the international component of the broader study scope. The information gathered focuses on Flows C and D of the copper supply chain, as identified by the project team in an earlier phase of the project.

## 2.0 Supply Chain Structure

### 2.1 Flow C

#### 2.1.1 *Main Stages of Supply Chain*

Flow C is a closed-loop process that encompasses secondary copper production (refined copper production using recycled scrap feed) and does not include any primary copper production (the extraction of copper-bearing ores). For the purposes of this study, the copper industrial chain for Flow C has been divided into four main stages: materials processing, product manufacturing, consumption and end-of-life management (note that although the collection and recovery of copper scrap could be considered a part of material acquisition, an initial life cycle stage, it is covered under end-of-life management in this study). It is assumed that materials are distributed among each of these four stages, with the largest distances travelled between the manufacturing and use phases and between the end-of-life management and materials processing phases.

In this report, copper recycling includes processes utilizing both “new scrap” (copper and copper alloy products either discarded in semi-fabrication or finished product manufacturing processes), and “old scrap” (copper and copper alloys derived from end-of-life products). Figure 2.1 shows the copper supply chain for Flow C, from processing through manufacturing and end-of-life management. In Flow C, copper scrap and copper-containing products are imported to Chinese “domestic” supply chains, where they are processed and used to manufacture new products that are then exported back to global supply chains for consumption.

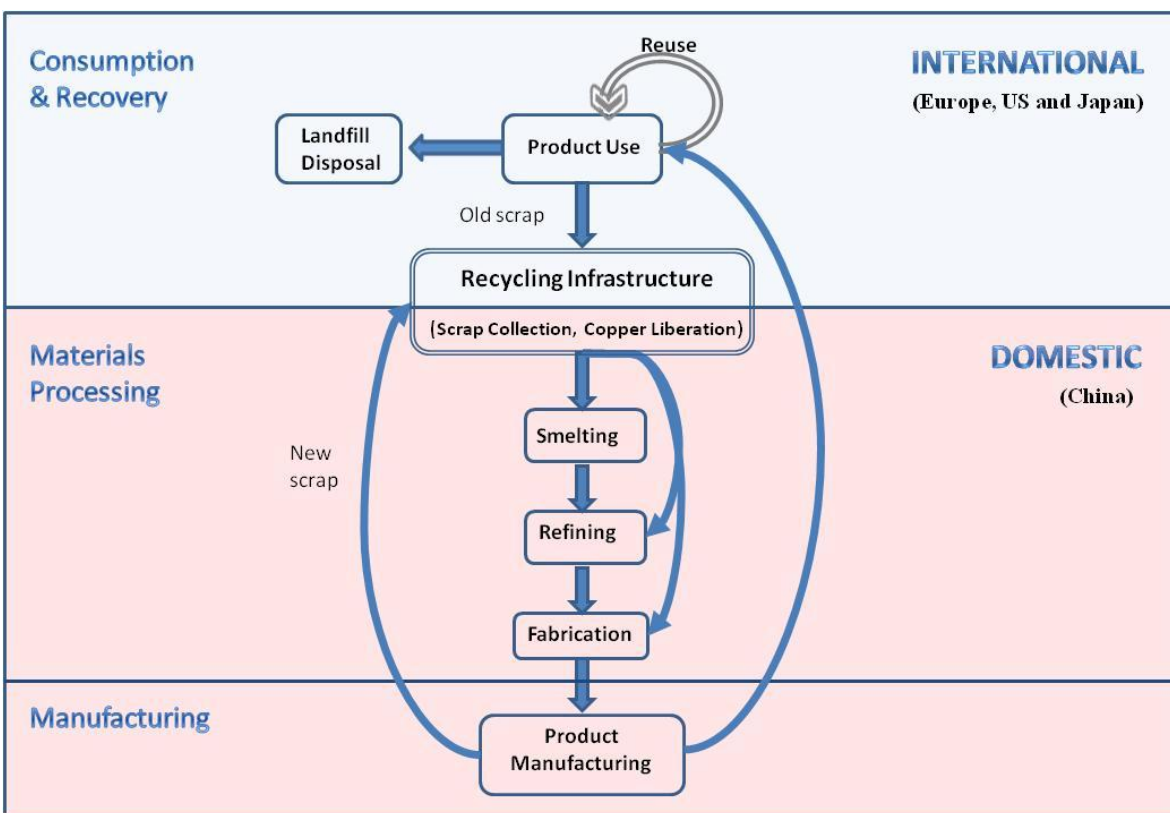


Figure 2.1 Secondary copper production supply chain (Flow C).

In 2008, the leading exporters of recycled copper were the European Union (Germany, France, the United Kingdom and Belgium accounted for 1.3 million tonnes), the United States (0.9 million tonnes) and Japan (0.4 million tonnes). China is the largest secondary copper consuming country in the world, importing approximately 5.6 million tonnes of recycled copper (68 per cent of global recycled copper imports). Based on trade share and the assumption that the European Union, the United States and Japan would also be major importers of copper-containing products from China, Flow C is therefore assumed to begin in Europe, the United States and Japan and, in large part, end in the same areas.<sup>1</sup>

It is important to note that Flow C represents a simplified supply chain structure that focuses on China's consumption of copper scrap from international markets and the associated challenges related to sustainable development. An analysis of the global supply chain for copper recycling in its entirety would not be feasible due to the complexity and lack of available data. Therefore, some process flows (e.g., domestic copper scrap collection and the domestic consumption of copper-containing products manufactured in China) have been excluded.

<sup>1</sup> Jolly, 2010.

In Figure 2.1, the recycling infrastructure spans domestic and international borders to account for the trade of both old and new copper scrap and the illegal export of post-consumer products, such as electronic waste (e-waste), from international markets to China. Although China has banned the import of e-waste, increasing amounts still enter the country each year to be collected and processed by informal recycling systems (see section 6.1.1 of this report, Case Study: Electronics Recycling in China). Because these trade flows are illegal, they are very difficult to define and quantify. Tshingua University, drawing on data from the Beijing Zhongse Institute of Secondary Metals, estimates total illegal imports of e-waste to be around 1.5 million tonnes per annum.<sup>2</sup> The Basel Action Network estimates that 70 per cent of the 20 to 50 million tonnes produced globally end up in China (e.g., 14 million to 35 million tonnes annually).<sup>3</sup> Even at the lower estimates, illegal trade represents a significant portion of the global copper scrap trade and reveals important challenges associated with copper disposal and recycling for China and the global community.

### 2.1.2 Supply Chain Processes

Copper reuse and recycling are inextricably intertwined and some of the copper-containing products collected for recycling may actually be reused. Although the recycling process varies depending on the grade of the scrap and the end-of-life product category (e.g., electronics, building and construction materials, vehicles, industrial machinery and equipment, consumer products), the recycling infrastructure is generally comprised of two stages:

1. *Scrap collection* – post-consumer products are collected for recycling.
2. *Copper liberation* – products are dismantled and shredded to liberate copper (and other) fractions, simplify material handling, minimize storage space and reduce transportation costs.

Copper scrap can be returned to the manufacturing loop in several ways. As a general rule, post-consumer copper scrap is processed by refineries, while new scrap is directly melted by semi-fabricators. However, lower-grade new scrap may also be sent to a smelter or refinery for copper recovery. Most post-consumer scrap is used to make wrought copper and copper alloys (e.g., brass, bronze) that form sheets, rods and pipes. Higher-grade post-consumer copper may also be used at foundries, ingot makers and in secondary smelters. Post-consumer copper from electronics, printed circuit boards, and clad materials with a copper content between 10 per cent and 65 per cent is considered lower-grade scrap and is more commonly processed by secondary smelters and refineries.<sup>4</sup>

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<sup>2</sup> IISD, 2008.

<sup>3</sup> IISD, 2008.

<sup>4</sup> Five Winds International, 2008.



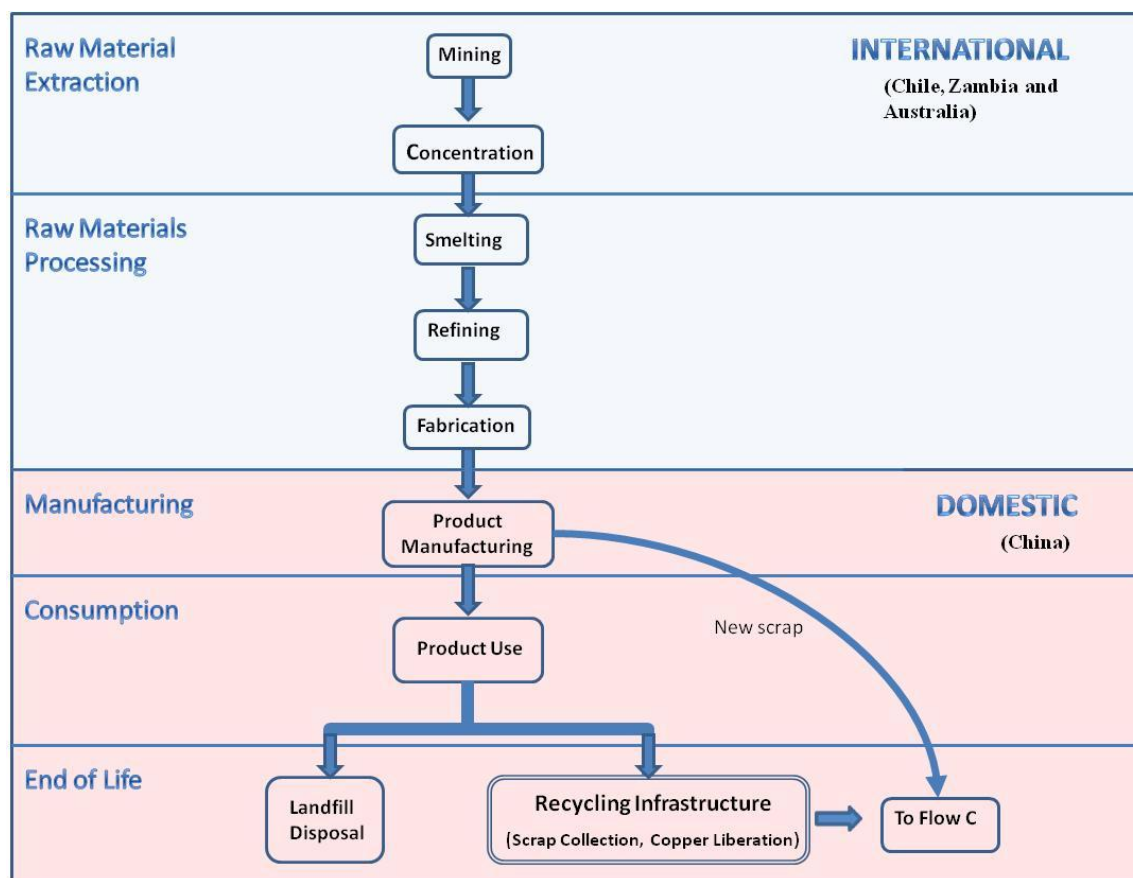
As copper can be recycled over and over again without degrading or losing its chemical or physical properties in the process, closed metal loops, through increased reuse and recycling, enhance resource productivity and increase the sustainability of production and consumption. Secondary copper production is not in opposition to primary production—it is a necessary and beneficial complement.

## **2.2 Flow D**

### **2.2.1 Main Stages of Supply Chain**

Flow D represents international primary copper production, beginning with the extraction of copper-bearing ores by mining processes and ending in end-of-life management processes for copper-containing products. For the purposes of this study, the copper industrial chain for Flow D has been divided into five stages: raw material extraction, materials processing, product manufacturing, consumption and end-of-life management. Materials are distributed among each of these five stages, with the largest distances travelled between the international supply chains and the Chinese “domestic” supply chains.

Figure 2.2 shows the copper supply chain for Flow D, in which copper ore is mined and processed internationally, then exported to China, where it is used to manufacture new products for Chinese consumption. Circular relationships through recycling occur domestically (Flow C) and provide copper scrap for domestic manufacturing processes.



**Figure 2.2 Primary copper production supply chain (Flow D).**

China is the largest importer of copper mining products (28 per cent of copper ores and concentrates), the second largest importer of copper generated from smelting processes (18 per cent of blister and anodes), and the largest importer of refined copper products worldwide (20 per cent of refined copper). Two of the leading exporters of copper ores and concentrates worldwide are Chile (36 per cent) and Australia (10 per cent). In addition, the two largest exporters of refined copper are Chile (38 per cent) and Zambia (7 per cent).<sup>5</sup> Flow D is therefore assumed to begin in Chile, Zambia and Australia, and end in China based on: (1) trade share, (2) the importance of these countries as sources to China, (3) regional sustainability challenges, and (4) availability of data.

It is important to note that Flow D represents a simplified supply chain structure that focuses on China's consumption of primary copper raw materials from international markets and the associated challenges related to sustainable development. An analysis of the global supply chain for foreign copper production in its entirety would not be feasible due to the complexity of the system, and is

<sup>5</sup> International Copper Study Group, 2009.

out of the scope of this study. Therefore, some process flows (e.g., foreign production of concentrates for export to Chinese smelters, foreign production of copper cathode for export to Chinese fabrication plants) have been excluded.

### **2.2.2 Supply Chain Processes**

The analysis of the sustainability challenges facing international copper mining and processing in Flow D is important both for informing Chinese mining companies operating in foreign countries and to use as a comparison with Chinese domestic production. The processes that will be analyzed in this respect are described in the following section.

There are two basic ways of mining copper: open-pit mining and underground mining; open-pit mining is the predominant method used worldwide. After the ore is mined, it is ground up and concentrated to separate the copper metal bound up within valuable ore minerals from unwanted rock materials. The copper is then processed in a smelter and refinery and cast into anodes for electro-refining. Alternatively, copper can be extracted from low-grade oxide ores and sulphide ores through a solvent extraction and electrowinning process (SX-EW). Both electro-refining and SX-EW produce refined copper cathodes. Copper cathodes may then be shipped as melting stock to mills or foundries, where they are cast into wire rod, billets, cakes or ingots used to manufacture products.<sup>6</sup>

## **2.3 Summary**

This section outlined two major copper supply chains for China, involving (1) the import of copper scrap (Flow C), and (2) the import of foreign copper mining products (Flow D). The objective was to define the life cycle stages involved in Flow C and D, describe major processes and technologies, and identify major global trade partners in order to understand copper production and consumption processes, address unwanted outcomes, and foster symmetric relationships and positive outcomes.

A major sustainability challenge identified in the supply chain for Flow C is the transport of e-waste from international markets to China. Although efforts (e.g., the Basel Convention, Kobe 3R Action Plan) have attempted to control the transboundary movement of hazardous waste, the import of e-waste into China is a rapidly growing industry. This trade flow represents an important sustainability challenge for China, as the end-of-life management of many copper-containing products manufactured in China takes place on domestic soil—even if the products were exported for international consumption. However, as this exchange is illegal and the majority of the waste processed in China is conducted by informal recycling facilities, it is very difficult to track and

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<sup>6</sup> International Copper Study Group, 2009.

quantify these trade flows, as well as the associated environmental and social impacts. This issue is further explored in section 6.1.1 of this report (see Case Study: Electronics Recycling in China).

In order to identify sustainability concerns and foster mutually beneficial relationships throughout the copper supply chain, it is important to analyze the major players within the supply chain, as well as existing market dynamics, relevant international regulations and major impacts affecting the sustainability of the entire system. Since China is the largest consumer of copper mining products in the world, it has the greatest potential to effect change across many countries' operations. In addition, it will become increasingly important for China to reduce its own impacts of production and consumption. These issues are explored in more detail below.

## 3.0 Market Trends

### 3.1 Global Copper Production Levels and Trends

#### 3.1.1 Global Copper Mines Production Levels and Trends—Flow D

According to the U.S. Geological Survey (USGS), a mineral reserve is “that portion of an identified resource from which a usable mineral or energy commodity can be economically and legally extracted at the time of determination.”<sup>7</sup> In 2008, it was estimated that world copper reserves reached 550 million tonnes,<sup>8</sup> up from 90 million tonnes in 1950. Global mine production processes currently extract over 15 million tonnes of copper from the reserve base per year, representing an annual growth rate of 4 per cent since 1900.<sup>9</sup>

Since 1960, all major regions of the world have steadily and significantly increased copper mine production (Figure 3.1), with the exception of Africa, whose production level has significantly fluctuated over the past 50 years due to low copper prices, political instability and lack of investment.<sup>10</sup> In 2008, the Americas represented the largest regional producer of mined copper in the world (59 per cent), mainly due to copper mining in Chile, which increased its share of world production from 14 per cent in 1960 to 35 per cent in 2009. The second largest producer of mined copper was Asia (18 per cent), followed by Europe (10 per cent), Oceania (7 per cent) and Africa (6 per cent). Table 3.1 shows the top five global producers of copper by country (2008)<sup>11</sup> and Table 3.2 shows the top five exporters of copper mine materials to China (2009).<sup>12</sup>

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<sup>7</sup> U.S Geological Survey, undated.

<sup>8</sup> tonnes = metric tons.

<sup>9</sup> International Copper Study Group, 2009.

<sup>10</sup> International Copper Study Group, 2009.

<sup>11</sup> International Copper Study Group, 2009.

<sup>12</sup> World Bureau of Metal Statistics, 2010.

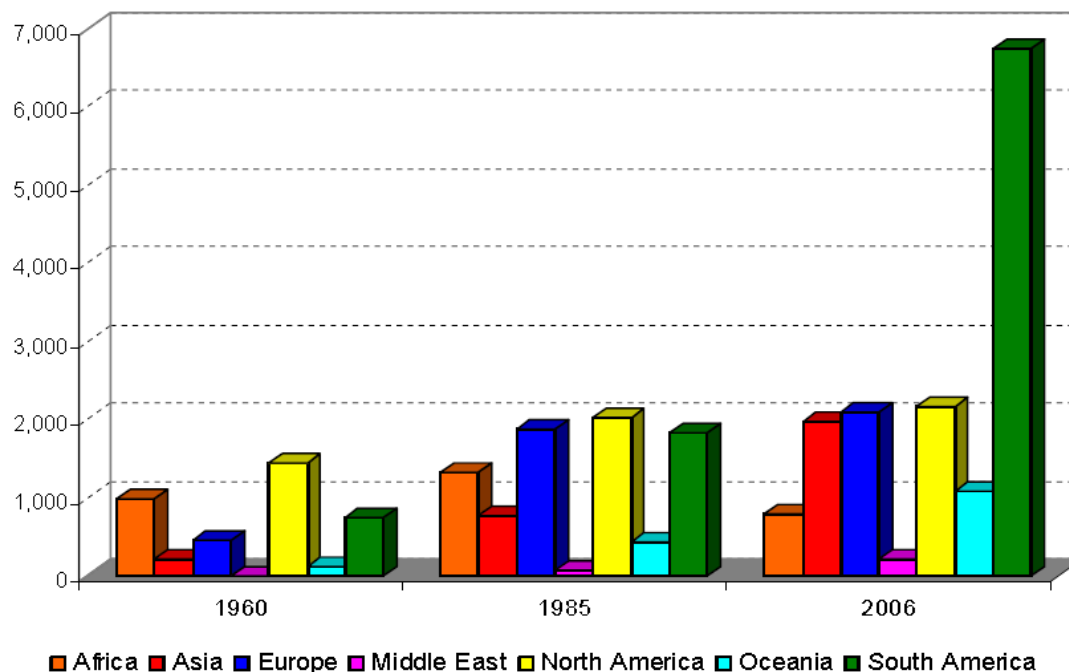


Figure 3.1 Copper mine production from 1960–2006 (thousand tonnes).

Source: International Copper Study Group, 2007.

Table 3.1 Top five copper mine producers, by country (2008).

Rank	Country	Mine production level (thousand tonnes)	Share of world production (%)
1	Chile	5,328	35
2	United States	1,335	9
3	Peru	1,268	8
4	China	951	6
5	Australia	883	6

Table 3.2 Top five countries exporting copper concentrates to China (2009).

Rank	Country	Copper concentrates (thousand tonnes)
1	Chile	1,628
2	Peru	1,057
3	Australia	640
4	Mongolia	587
5	Kazakhstan	377

As the export numbers in Table 3.2 clearly demonstrate, China imports most of its copper concentrates from copper-rich South America. Other significant sources of copper concentrates are imported from neighbouring Asian countries.

World copper mine capacity, or production potential, has increased from 9.5 million tonnes to 19.6 million tonnes (an increase of 106 per cent) over the period of 1980–2009.<sup>13</sup> According to a recent study conducted by the International Copper Study Group that analyzed existing mining facilities and project developments announced to the public, global mine capacity will continue to grow at an average rate of 4.3 per cent per year between 2009 and 2013, reaching 23.1 million tonnes in 2013. Of the total projected increase, copper concentrate capacity is expected to increase by 2.7 million tonnes (4.3 per cent/year) and SX-EW production by 0.8 million tonnes (4.4 per cent/year). It is anticipated that South America and Africa will account for the majority of the increase in projected mine capacity over this period, with most of the new mine projects and expansions occurring in Brazil, Chile, Peru, the Democratic Republic of Congo, Zambia, Mongolia and the United States.<sup>14</sup>

With the discovery of SX-EW technology in 1959,<sup>15</sup> copper production from leaching ores has been widely adopted and is on the rise. Over the last 20 years, improved electrowinning technologies have led to lower costs, higher productivity, and high-purity cathodes. In addition, several new technologies (e.g., alternative anodes and alternative anode reactions) are being developed to reduce energy consumption and the production of hazardous/harmful by-products in the process.<sup>16</sup> Because the SX-EW process is also capable of removing copper from low-grade deposits, oxidized ores and mine wastes that would not otherwise be viable using conventional smelting and electro-refining processes,<sup>17</sup> this technology may become increasingly important as ore grades continue to decline in developed copper areas (e.g., the United States and Chile) and the extraction of low-grade oxide ores and sulphide ores becomes more economically feasible.<sup>18</sup> Currently, almost one-half of the 20 largest copper mines in the world, in terms of production capacity, have adopted SX-EW technology to process low-grade ores and metal remaining in floatation tailings.<sup>19</sup> Figure 3.2 demonstrates global copper production trends by process.

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<sup>13</sup> International Copper Study Group, 2009.

<sup>14</sup> International Copper Study Group, 2010.

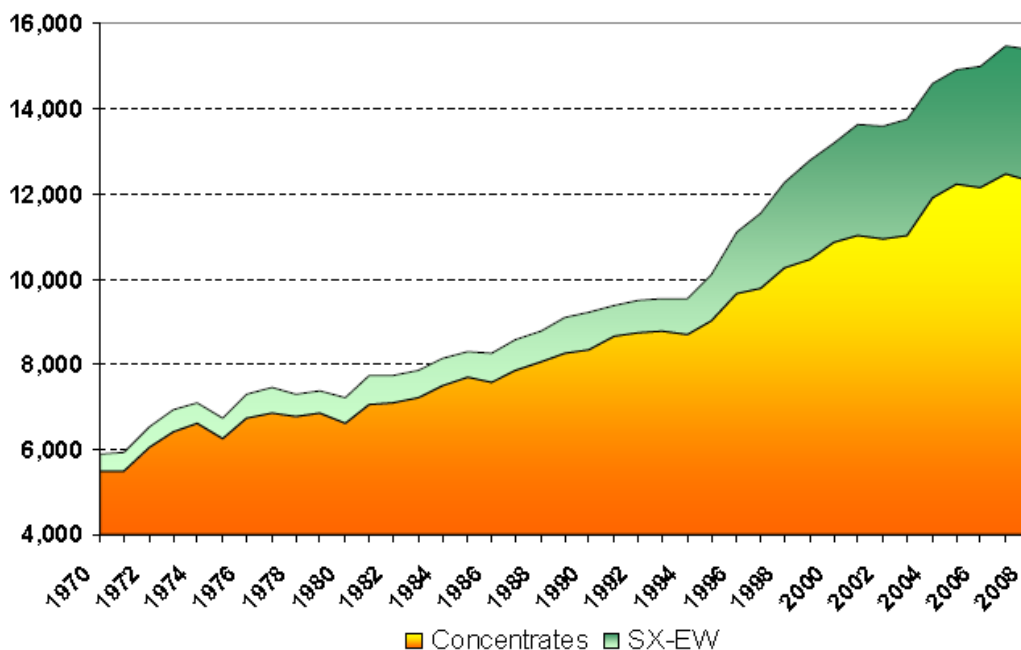
<sup>15</sup> Drescher, 2001.

<sup>16</sup> Moats & Free, 2007.

<sup>17</sup> Drescher, 2001.

<sup>18</sup> International Copper Study Group, 2009.

<sup>19</sup> International Copper Study Group, 2009.



**Figure 3.2 Global copper mine production by process from 1970–2008 (thousand tonnes).**

Source: International Copper Study Group, 2009.

### 3.1.2 Global Refined Copper Production Levels and Trends—Flows C and D

In general, primary copper processors use mine concentrates and electrowon (metal extracted from SX-EW processes) as their main source of feed, and secondary processors use copper scrap (mainly low-grade) as their feed. In 2008, it was estimated that 85 per cent of global refined copper production was generated from primary refineries (12.2 million tonnes) and 15 per cent came from secondary refineries (2.7 million tonnes). Within primary refined production, 17 per cent of the feed originated from electrowinning processes (3.1 million tonnes).<sup>20</sup>

Currently, Asia produces the largest share of global refined copper production (42 per cent), followed by the Americas (32 per cent), Europe (20 per cent), Oceania (3 per cent) and Africa (3 per cent). Table 3.3 shows the present top five countries that produce refined copper (2008) and Table 3.4 shows the top exporters of smelted and refined copper materials to China (2009).

<sup>20</sup> International Copper Study Group, 2009.



**Table 3.3 Top five producers of refined copper, by country (2008).**

Rank	Country	Refined production (thousand tonnes)	Share of world production (%)
1	China	3,791	21
2	Chile	3,058	17
3	Japan	1,540	8
4	United States	1,282	7
5	Russian Federation	862	5

Source: International Copper Study Group, 2009.

**Table 3.4 Top countries exporting copper smelting and refinery products to China (2009).**

Blister/anode copper		
Rank	Country	Weight (thousand tonnes)
1	Chile	78
2	Namibia	11*
3	Finland	12
Refined copper		
1	Chile	1,333
2	Japan	361
3	Kazakhstan	149

\*Because data were unavailable for Namibia in 2009, this value is from 2008.

Source: World Bureau of Metal Statistics, 2010.

Over the period from 1980–2009, global copper refinery capacity has almost doubled, from 11.9 million tonnes to 23.4 million tonnes, with Asia demonstrating the largest regional increase in refinery capacity, followed by South America (Figure 3.3). According to data from the International Copper Study Group, world refinery capacity is expected to increase over the next few years at an average rate of 3.2 per cent, reaching 26.6 million tonnes in 2013. This represents a total increase of about 3.2 million tonnes (13 per cent) over the period 2009–2013. About 72 per cent of the expansion is projected to come from electrolytic refineries (conventional technology) and 26 per cent from electrowinning capacity (SX-EW process technology). Most of the new projects and expansions accounting for the increase in projected refinery capacity are located in China, India, Indonesia, Iran, Congo, Peru and Zambia.<sup>21</sup>

<sup>21</sup> International Copper Study Group, 2010.

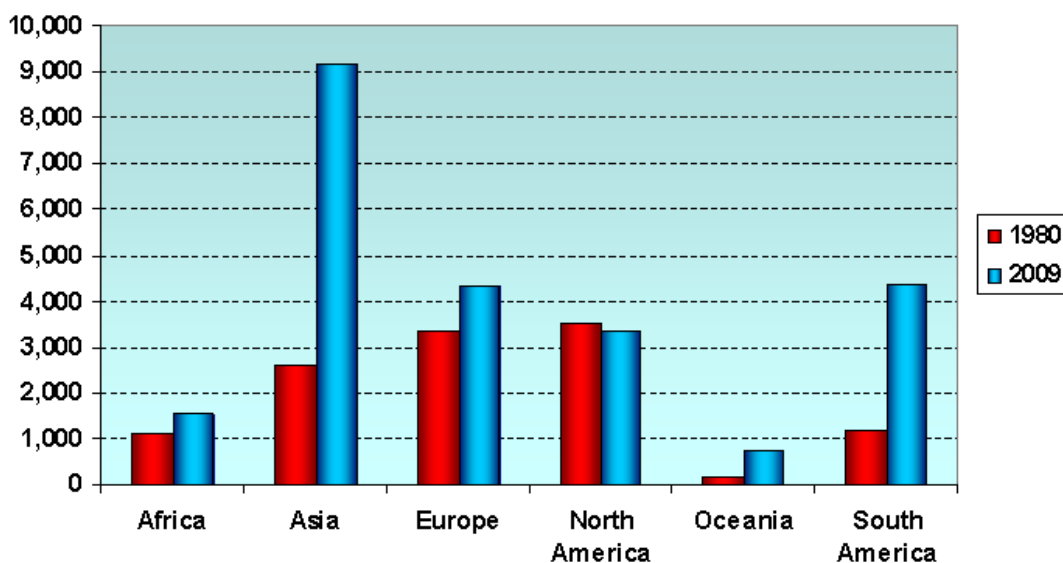


Figure 3.3 Refined copper capacity by geographical area, 1980 and 2009 (thousand tonnes).

Source: International Copper Study Group, 2009.

### 3.1.3 Global Copper Processing Product Levels and Trends—Flows C and D

Semi-fabricators process refined copper in the form of cathodes, wire bar, ingot, billet slab and cake into semi-finished copper and copper alloy products, using both unwrought copper materials and direct melt scrap as raw material feed (see fabrication processes in Figures 2.1 and 2.2). Examples of semi-fabricator facilities include wire rod plants, brass mills, alloy wire mills, foundries and foil mills. Wire rod plants are estimated to have accounted for just fewer than 50 per cent of all semi-fabricator capacity in 2008.<sup>22</sup>

Semi-fabricators produce “semis” such as wires, rods, tubes, sheets, castings and other shapes, which are often shipped to downstream processors before being incorporated into finished products or components of finished products. However, some semis can be used without any further processing (e.g., copper plumbing tubes).<sup>23</sup>

In 2007, Asian countries produced 11.4 million tonnes of semis products, which accounted for 50 per cent of worldwide semis production and represented an increase of 22 per cent since 1980. Figure 3.4 compares global copper semis and casting production by geographical region in 1980 and 2007. Currently, the largest exporter of semi-fabricated products in the world is Germany, followed by the Russian Federation, France, Taiwan and the Republic of Korea. The largest importers of

<sup>22</sup> International Copper Study Group, 2009.

<sup>23</sup> Simon Payton, copper industry expert, correspondence with ICMM, 2010.

semi-fabricated copper products are China, the United States, Italy, Germany and the United Kingdom, respectively.<sup>24</sup>

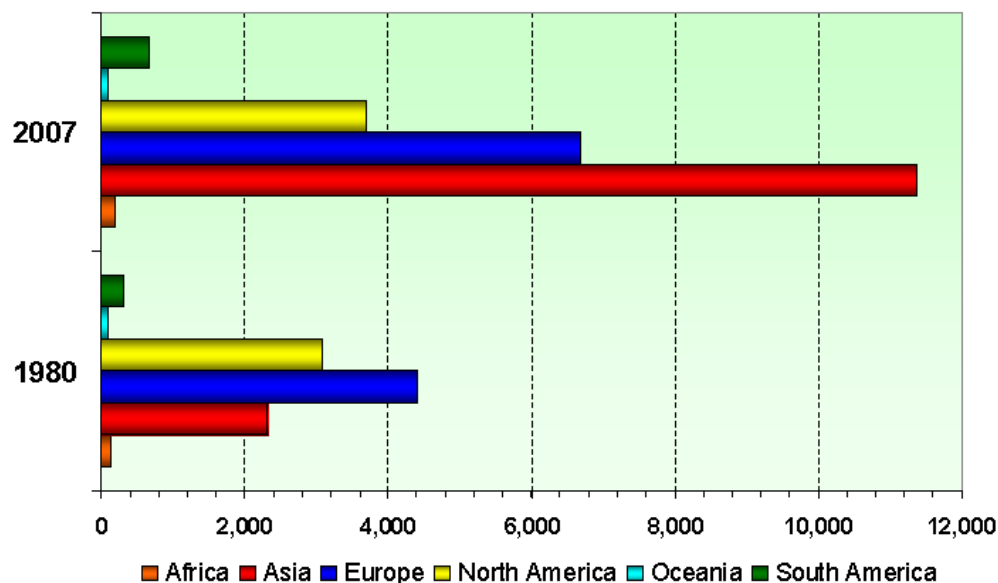


Figure 3.4 Copper semis and casting production by geographical region, 1980 and 2007 (thousand tonnes).

Source: International Copper Study Group, 2009.

### 3.1.4 Global Copper Scrap Recycling Levels and Trends—Flow C

The global copper supply is distributed among several reservoirs, including virgin ore in mines, new scrap discarded in semi-fabrication or product manufacturing processes, manufactured components/products being used or stored, and expended products disposed of in landfills. Since copper can withstand chemical and thermal treatment and can be repeatedly reprocessed, the amount of copper in manufactured products (“in-service” and disposed of in landfills) represents the total amount of copper theoretically available for recycling sometime in the future.

Accurate and reliable statistics on post-consumer copper consumption have always been difficult to obtain, but as world trade in low-grade post-consumer copper has increased, statisticians have found it even more difficult to obtain accurate data. For example, in 2007 exports to China totalled 3.4 million tonnes, but imports received in China totalled 7.0 million tonnes—a difference of over 3 million tonnes.<sup>25</sup> Possible reasons for the discrepancy include the way that copper is measured for export in contrast to the way it is reported at the importing country (for example, post-consumer copper may be reported by weight as “white goods” instead of simply the much smaller copper

<sup>24</sup> International Copper Study Group, 2009.

<sup>25</sup> Jolly, 2010.

content in the end-of-life product). Anecdotal comments<sup>26</sup> suggest that some of the discrepancy may be attributed to “black market” or informal shipments of e-waste, or large exports from Middle East war zones. Because of the growing interest and scrutiny in monitoring and quantifying post-consumer metal exports from the United States and European Union, there are new customs requirements and improved tracking of the quantity of post-consumer metals being exported.<sup>27</sup>

In addition to the data gaps on the flow of post-consumer copper, there are also data gaps on the amount of copper available to be recycled. The amount of in-service copper varies by region and is generally larger in developed countries. As developing countries use more copper to build urban infrastructures and manufacture more consumable goods, the amount of copper available for recycling increases. This regional variability makes it hard to precisely predict the amount of copper available for recycling.<sup>28</sup> And while mass flow models are useful for estimating the stock of in-service copper (there are a number of estimates for global copper flows and regional flows in the United States and European Union), recycling programs are designed around waste generation and disposal rates.

In addition, there are several product attributes affecting recycling rates, including the ease with which the copper can be recovered, the product’s life span and the amount of recoverable material in the product. For example, the recycling rate of underground industrial electrical equipment waste (e.g., cables, pipes) may be lower than surface equipment (e.g., transformers, busbars) because it is not always cost-effective to recover buried copper products. However, because the metal will remain intact, it may eventually be collected, if recovery cost and incentives are right.<sup>29</sup> Estimates of recovery rates, end-use fractions and residence times of in-service copper are presented in Tables 3.5 and 3.6.

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<sup>26</sup> Copper Mining Representative and Diversified Manufacturer, Five Winds interviews, 2008.

<sup>27</sup> Copper Commodity Specialist, Five Winds interviews, 2008.

<sup>28</sup> Five Winds International, 2008.

<sup>29</sup> Jolly, 2010.

**Table 3.5 Estimates of copper recycling rates for various end-of-life product categories in Western Europe.**

Reservoir	Copper recycling rate (collection rate * recovery rate)(%)
Construction and demolition waste (C&D) (e.g., plumbing, building wire and cable)	71
Industrial electrical equipment waste (IEW) (e.g., underground/surface cables, transformers)	60
Industrial non-electrical equipment waste (INEW) (e.g., ships, rail, aircraft, plants and machinery)	76
End-of-life vehicles (ELV) (e.g., cars, trucks, buses)	41
Waste electric and electronic equipment (WEEE) (e.g., household appliances, consumer electronics)	43
Municipal solid waste (MSW) (e.g., coinage, furniture, MSW incineration)	32

Source: Ruhrberg, 2006.

**Table 3.6 Estimates of global copper end-use fractions and residence times for various copper reservoirs.**

Reservoir	Predominant Copper-Containing Final Good	End-Use Fraction (%)	Estimated Residence Time (Years)
Building and construction	Building wire and copper tube	50	25–40
Infrastructure	Copper cable used by telecom utilities and power utilities	22	50
Transportation	Automotive equipment, railway equipment, ship building, aviation	5	10–30
Consumer durables	Appliances and extension cords, consumer electronics, fasteners and closures, household products	5	10
Business durables	Business electronics, lighting and wiring	10	20
Industrial durables	Industrial (in-plant) machinery and equipment	8	20

Source of data: United Nations Environment Programme (UNEP), 2010.

In 2008, the amount of copper that was recovered from all forms of scrap (post-consumer copper and new scrap) worldwide was estimated at about 7.8 million tonnes, representing about one-third of total worldwide copper consumption. It was estimated that about 2.7 million tonnes of the recovered copper scrap was refined, which comprises about 15 per cent of total world refined copper production.<sup>30</sup> Most of this secondary refined copper stream is accounted for by lower-grade, post-consumer copper.<sup>31</sup> More secondary copper is returned to the manufacturing chain as direct melt for semi-fabricators.

<sup>30</sup> Jolly, 2010.

<sup>31</sup> Copper Commodity Specialist, Five Winds interviews, 2008.

The amount of global secondary copper consumption has been fairly steady over time, but has not kept pace with total copper consumption. For the past 40 years, the rate of secondary copper use, as a percentage of total copper consumption, has hovered between 30 per cent and 40 per cent. In 2007, the proportion of total secondary copper consumption was reported to be about 33 per cent, which is down from a high of 40 per cent in 1995.<sup>32</sup> One possible explanation for this trend is that copper scrap generation is growing quickly in developing countries, in particular in electric and electronic waste, and these countries often lack the technology and formal recycling infrastructure to deal with increasing volumes of low quality copper scrap. Detailed information on collection and recovery rates in developing countries is also not widely available. In addition, the trend in secondary copper use parallels fluctuations in copper price and supply, and low quality copper scrap is more sensitive to price changes than copper scrap with a high copper content.<sup>33</sup>

Not only has secondary copper consumption increased, but world trade in secondary copper has also increased, with the flow of post-consumer copper generally travelling from the West to the East.<sup>34</sup> World trade in copper and copper alloy scrap (*note that this includes metallic scrap where copper is the predominant material, but excludes mixed materials and low-grade residues*<sup>35</sup>) has increased by more than 385 per cent over the last two decades, largely as a result of increased economic growth in Asia and Europe.<sup>36</sup> Over the past 30 years, China's economy has changed from a centrally planned system that was largely closed to international trade to a market-oriented economy that has a rapidly growing private sector. This restructuring of the economy, combined with its ever growing population, has resulted in China's GDP growing by more than tenfold since 1978.<sup>37</sup> To support its expanding economy, China now imports the largest share of copper and copper alloy scrap in the world (68 per cent), followed by Germany, Belgium and the Republic of Korea. The United States continues to be the largest exporter (18 per cent) of secondary copper worldwide, followed by Germany, the United Kingdom and Japan.<sup>38</sup>

China's increasing consumption of secondary copper resources has created a ripple effect around the world. China's Ministry of Finance allows duty-free treatment of copper scrap imported into China, while imposing heavy taxes on exports of copper scrap from China. U.S. and European makers of brass and copper products have expressed concern about how these Chinese tax measures drain copper scrap from the United States and Europe to China for manufacture into value-added products for export. The shift in volume increases U.S. and European producers' costs for copper

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<sup>32</sup> Jolly, 2010.

<sup>33</sup> International Copper Study Group, 2009.

<sup>34</sup> Five Winds International, 2008.

<sup>35</sup> Simon Payton, copper industry expert, correspondence with ICMM, 2010.

<sup>36</sup> Jolly, 2010.

<sup>37</sup> U.S. Central Intelligence Agency, 2010.

<sup>38</sup> Jolly, 2010.

scrap and prices for downstream products, while Chinese producers' costs for copper scrap and prices for downstream products are lowered.<sup>39</sup>

### 3.1.5 Global Copper Product Consumption Levels and Trends—Flows C and D

Copper and copper-based alloys are used in a variety of applications that contribute to economic and sustainable development. Copper is ductile, corrosion resistant, malleable, recyclable and an excellent conductor of heat and electricity. When alloyed with other metals, such as zinc, aluminum, tin or nickel, copper forms new materials (e.g., brass, bronzes), which can acquire new characteristics for highly specialized applications. The major uses of copper include electrical applications (e.g., power cables), electronics and communications (e.g., mobile phones, personal computers), building and construction (e.g., plumbing systems), transportation (e.g., motors, radiators), industrial machinery and equipment (e.g., gears, bearings) and consumer products (e.g., coins for currency, keys).<sup>40</sup>

In 2008, worldwide usage of copper reached 24 million tonnes. An estimated 60 per cent of this product supply was used in the manufacturing of equipment (e.g., industrial, transportation, consumer and general products, electronic), 25 per cent in the building and construction sector (e.g., plumbing, architecture, communications, electrical power) and 15 per cent for infrastructure (e.g., power utility, telecommunications).<sup>41</sup>

Regional copper demand by product sector for China, the European Union and the United States is shown in Table 3.7. In China, consumption of copper is used mostly for industrial equipment (29 per cent of total), whereas in the European Union and the United States demand for copper is largest in the building and construction sector (40 per cent and 52 per cent of total copper consumption, respectively).<sup>42</sup>

**Table 3.7 Copper demand in China, the European Union and the United States, by product sector.**

	China (%)	European Union (%)	United States (%)
Building and construction	24	40	52
Infrastructure	21	10	8
Industrial equipment	29	23	13
Consumer products	17	15	16
Automotive	9	12	11

<sup>39</sup> Fabricating and Metalworking, 2010.

<sup>40</sup> International Copper Study Group, 2009.

<sup>41</sup> International Copper Study Group, 2009.

<sup>42</sup> Five Winds International, 2008.

### 3.2 Summary

The world's consumption of copper has almost tripled since 1970 and, despite the economic recession in the late 2000s, growth is likely to continue in the near future and be principally driven by increasing demand in China. The rapid increases in global copper consumption have been principally driven by the following factors:

1. Social and economic development in China: China is a populous region of 1.3 billion people; the rate of population growth is currently 0.5 per cent per year<sup>43</sup> and copper and copper-based alloys are necessary for societal development, as they are an essential component of transportation equipment, communication technologies, and building and maintaining a country's infrastructure.
2. China's expansion of smelting and refinery capacity has not been matched with an expansion in mine capacity.
3. China's increasing demand for copper in the production of copper semis and copper alloy products has not been met by the domestic production of primary or secondary copper.
4. International requirements from downstream industries and foreign direct investment have increased the quality of copper raw material inputs that are required for copper-containing products (e.g., wire rod, air conditioning and refrigeration tube).

This expansion in China's demand for copper imports has created a boom for international suppliers, leading to unintended environmental and social impacts in the rush to serve the market and pursue economic growth. Increasing dependence on Chinese demand has also increased risks for countries whose GDP is highly dependent upon copper output (e.g., Chile, Peru, Zambia).

Because China is the largest importer of copper worldwide, the impacts of a decrease in world copper supply due to resource depletion, steep increases in metal prices, new international regulations and standards related to sustainability, or the loss of a major producer's social licence to operate would be felt the greatest in China. In addition, since China does not possess the mining and smelting capacity to meet its own copper needs, the country relies on raw material resources (both post-consumer scrap and primary raw materials) from the international community.

As the demand for copper increases in China and other economies in transition, the share of total copper production accounted for by primary production has not displayed a tendency to decline over time. This is largely because the pool of secondary copper generation is largely limited by availability rates (i.e., most copper is still in use and not yet available for recycling).

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<sup>43</sup> World Bank, 2010.



Because copper and copper-based alloys are necessary for societal development, mineral resource security is therefore directly linked to meeting China's human development objectives. To improve its mineral resource security, China can continue to develop policies to increase domestic recycling rates; however, such measures will have a limited effect on increasing copper supply. Other investments in primary copper production, ideally in extraction technologies having lower environmental impacts (e.g., SX-EW technology), will continue to play important roles in meeting Chinese copper demand.

## 4.0 International Commercial Governance

This section looks at the distribution of market power and decision-making authority across the supply chain for Flows C and D by identifying the major producers of copper mining, smelting and refinery products worldwide.

### 4.1 Global Major Copper Producers—Flows C and D

Table 4.1 shows the five largest copper mines in the world by capacity, of which four are located in Chile.<sup>44</sup>

**Table 4.1 Top five copper mines worldwide, by capacity (2009).**

Rank	Mine name	Country	Owner(s)	Method of extraction	Capacity (thousand tonnes)
1	Escondida	Chile	BHP Billiton (57.5%), Rio Tinto Corp. (30%), Japan Escondida (10%), IFC (2.5%)	Concentrates & SX-EW	1,330
2	Codelco Norte	Chile	Codelco	Concentrates & SX-EW	900
3	Grasberg	Indonesia	P.T. Freeport Indonesia Co. (PT-FI), Rio Tinto	Concentrates	750
4	Collahuasi	Chile	Anglo American (44%), Xstrata plc (44%), Mitsui + Nippon (12%)	Concentrates & SX-EW	498
5	El Teniente	Chile	Codelco Chile	Concentrates	440

Table 4.2 shows the six largest copper smelting facilities in the world by capacity, of which two-thirds are located in Asia.<sup>45</sup>

**Table 4.2 Top six copper smelters worldwide, by capacity (2009).**

Rank	Smelter name	Country	Owner(s)	Capacity (thousand tonnes)
1	Guixi	China	Jiangxi Copper Corp.	900
2	Birla Copper (Dahej)	India	Birla Group	500
3	Codelco Norte	Chile	Codelco	460
4	Hamburg	Germany	Aurubis	450
4	Saganoseki/Ooita	Japan	Pan Pacific Copper Co. Ltd.	450
4	Besshi/Ehime (Toyo)	Japan	Sumitomo Metal Mining Co. Ltd.	450

<sup>44</sup> International Copper Study Group, 2009.

<sup>45</sup> International Copper Study Group, 2009.

Table 4.3 shows the six largest refineries in the world by capacity.<sup>46</sup>

**Table 4.3 Top six copper refineries worldwide, by capacity (2009).**

Rank	Refinery	Country	Owner(s)	Process	Capacity (thousand tonnes)
1	Guixi	China	Jiangxi Copper Corporation	Electrolytic	900
2	Birla	India	Birla Group Haldar	Electrolytic	500
3	Chuquibambilla Refinery	Chile	Codelco	Electrolytic	490
4	Codelco Norte (SX-EW)	Chile	Codelco	Electrowinning	470
5	Toyo/Niihama (Besshi)	Japan	Sumitomo Metal Mining Co. Ltd.	Electrolytic	450
5	Amarillo	United States	Grupo Mexico	Electrolytic	450

<sup>46</sup> International Copper Study Group, 2009.

## 5.0 International Environmental Impact

As part of the Global Copper Supply Chain Project, EMPA conducted a life cycle assessment (LCA) study on primary copper production in China. In addition to LCA, other tools and perspectives to consider include material flow analysis and risk assessment. It is also important to consider the environmental benefits that copper provides in its use phase.

The sections below describe these approaches and summarize the main findings as they pertain to the copper supply chain.

### 5.1 Material Flow Analysis

Material flow analysis (MFA), also known as substance flow analysis (SFA), is a tool for the study of the production and consumption of a material within a particular geographical boundary.

MFA is an important tool of industrial ecology and is used to produce better understanding of the flow of materials through an industry and connected ecosystems, to calculate indicators, and to develop strategies for the management of a material flow.

Copper is well studied in the MFA literature because of its wide usage in modern industries and concerns with its potential depletion as a natural resource. The Stocks and Flows (STAF) project based at Yale University conducted a comprehensive study on the contemporary cycle for stocks and flows of copper. The results provided estimates of copper stocks and flows at the global level, a regional level and a country level for 54 countries (Graedel et al., 2004). In a follow-up study, Gordon, Bertram and Graedel (2006) concluded that the world is likely to experience a growing scarcity of copper over this century. They argue that copper scarcity will raise the real prices of copper and will stimulate intensive recycling well above today's levels.

### 5.2 Risk Assessment

A risk assessment evaluates the potential adverse effects that human activities have on human and environmental health. For copper, risk assessments are often required to satisfy regulatory demands. In 2009, the European Copper Institute (ECI) completed a voluntary risk assessment in the European Union, which involved quantifying the emissions to the environment and the risks to human health from the production (although not including mining), use and disposal of copper. The

ECI's risk assessment did not include mining because concentrates are not covered by the European Union's REACH regulation.<sup>47</sup>

As part of the risk assessment, ECI evaluated at what concentration and exposure these emissions begin to cause adverse health effects. Where concentration levels are found to be above the critical threshold level, corrective action (i.e., risk management) is needed.

The main conclusions of the risk assessment, accepted by the European Commission and EU Member State experts, include the statements that follow.<sup>48</sup>

- The use of copper products is in general safe for the environment and human health.
- Environmental risks are possible at industrial sites where there is insufficient on-site water treatment or where the effluent goes into a water body with low dilution.
- Occupational health risks are possible at some industrial sites, specifically for workers involved in the production of copper chemicals and powders.
- Copper is not a CMR (carcinogenic, mutagenic, reprotoxic) or a PBT (persistent, bio-accumulative, toxic) material.

### 5.3 Environmental Benefits of Copper

Although the production of copper and copper-containing products has significant impacts on the environment, it is also important to incorporate the use phase of copper-containing products when assessing the material's overall environmental impact and benefits.

The following excerpt from the European Copper Institute demonstrates the type of environmental benefit that copper provides in electrical applications:

Copper has a significant positive impact on climate change mitigation by improving energy efficiency, lowering energy demand and enabling renewable technologies. The EU's 20/20/20 energy targets cannot be met without an increased use of copper products. As one example, electric motors consume about 60% of industrial electricity demand. Full implementation of the Minimum Energy Performance Standards for electric motors (published in OJ L 191/26) will require a typical 50% increase in the copper content in the motor windings. This will deliver electricity savings of 135 TWh/year (more than the

<sup>47</sup> Regulation on Registration, Evaluation, Authorisation and Restriction of Chemical Substances.

<sup>48</sup> European Copper Institute, 2009.

combined annual electricity consumption of Finland and Greece) and will avoid 63 million tonnes/year of CO<sub>2</sub> [carbon dioxide] emissions.<sup>49</sup>

Whether, and to what extent, copper provides an overall environmental benefit depends on its specific application. The example above illustrates the case for electrical applications. Similar arguments are also being developed for other applications of copper, such as in building and construction.

## 5.4 Summary

Beyond the scope of the LCA conducted on Chinese copper production, other elements for consideration include toxicological impacts (for which risk assessment can be used), resource sustainability (for which MFA can be used), and the environmental benefits provided in the use phase of copper-containing products (for which cradle-to-grave LCAs can be used).

Using risk assessment, the European Commission has deemed that the use of copper products is, in general, safe for the environment and human health. Using MFA, researchers have highlighted the importance of recycling for future copper production and consumption in the world. While no cradle-to-grave LCAs could be found on copper-containing products, the copper industry is starting to articulate the positive environmental contributions that copper provides in electrical and building and construction applications.

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<sup>49</sup> European Copper Institute, 2010.

## 6.0 International Social Impact

The copper supply chain has both positive and negative social impacts. A CNIA report has addressed many of these impacts within China's borders.<sup>50</sup> This section provides further input into the social impacts of the copper supply chain for Flows C and D.

### 6.1 International Social Impact—Flow C

The social impacts of recycling are often described in terms of the amount of avoided mining or other resource extraction activity, rather than direct impacts of the recycling itself. In many cases, this is likely due to a generally positive perception of recycling as a result of benefits such as waste diversion, energy efficiency and resource conservation. However, the social impacts of recycling often depend on the recycling infrastructure in a given region, as recycling systems for end-of-life copper-containing products vary by product sector and region. For automobiles, a well-established recycling infrastructure (along with a corresponding network for reusing parts) exists in the United States and the European Union; this infrastructure is in its early stages of development in China. Most recycling technology advancements in this sector focus on separating and recycling plastic components. In the building and construction sector, copper-containing products are recycled through the well-established and complex scrap metal recycling network.

The recycling infrastructure for the electronics and electrical equipment sector is still developing in all regions, as manufacturers and regional governments establish collection and processing systems for e-waste. Because the recycling infrastructure for electronics and electrical equipment is still in its early stages of development, this product sector also faces the greatest amount of attention with regards to social impacts. These social impacts are detailed further in the following case study.<sup>51</sup>

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<sup>50</sup> Shang, Zhao, Duan & Zhou, 2010.

<sup>51</sup> Five Winds International, 2008.

### 6.1.1 Case Study: Electronics Recycling in China

#### Overview

The social impacts of recycling waste electronics (or e-waste) are particularly contentious compared to other recycling streams, due to the transboundary movement of e-waste from developed countries to developing countries. Criticism from NGOs has been directed toward developed countries, in particular the United States,<sup>52</sup> for exporting e-waste under the name of “recycling” without bearing responsibility for the social and environmental costs of the process. In fact, the Basel Action Network and the Silicon Valley Toxics Coalition produced a report in 2002 titled “Exporting Harm: The High-Tech Trashing of Asia,” which estimated that more than 70 per cent of the high-tech waste from the United States is exported to China. In 2000, China banned the import of e-waste, yet China is still facing a rapidly increasing amount of e-waste from domestic generation and illegal imports.<sup>53</sup>

Recycling of e-waste is an important step for the copper value chain. Copper represents a significant proportion of scrap value in e-waste. One tonne of e-waste contains up to 0.2 tonnes of copper,<sup>54</sup> which can be sold for US\$1400 at the current world price of US\$7.00/kilogram.<sup>55</sup> Copper is also a key driver for recycling less valuable elements such as lead, tin, indium and ruthenium, which are typically not economically recoverable unless more valuable elements like copper are present.<sup>56</sup>

#### Positive Social Impacts

The informal recycling collection systems often found in China for electronics waste are, in fact, quite efficient and bring substantial social benefits to low income groups. This is due in part to door-to-door collection of materials, which is rare in more formal collection systems.<sup>57</sup> A study by the Öko-Institut in Germany (2007) compiled data from several previous studies to estimate that in the two major e-waste recycling centres in China (Luquiao in Zhejiang Province and Guiyu in Guangdong Province), approximately 70 per cent of the community is directly or indirectly active in the industry and as many as 440,000 local jobs have been created from the decentralized collection and disassembly processes.<sup>58</sup>

#### Negative Social Impacts

The key social impacts of electronics recycling typically arise from exposure to hazardous materials during, or as a result of, the recycling process. Informal recyclers often break the electronics into smaller components manually, and since they are not operating within a formal industry, they often do so without proper protective equipment or medical insurance.<sup>59</sup> Manual techniques include open burning of wires (to remove plastic insulation and retrieve copper) and breaking of the copper yoke from cathode ray tube (CRT) monitors. In terms of recovery of wire, this not only lowers the grade of the copper wire, but can release acid gases, dioxins or other air pollutants.<sup>60</sup> The trend in developed economies, especially the United States, is to use a mechanical device that has enabled post-consumer recyclers to recover wire as #1 grade instead of the #2 grade generated by burning.<sup>61</sup>

<sup>52</sup> Terazono et al., 2006.

<sup>53</sup> Leung, Duzgoren-Aydin, Cheung & Wong, 2008.

<sup>54</sup> Widmer, Oswald-Krapf, Sinha-Khetriwal, Schnellmann & Boni, 2005.

<sup>55</sup> Metalprices.com, accessed July 29, 2010.

<sup>56</sup> Meskers, Hagelüken & Van Damme, 2009.

<sup>57</sup> Hagelüken & Meskers, 2008.

<sup>58</sup> United Nations Environment Programme (UNEP), 2009.

<sup>59</sup> UNEP, 2009.

<sup>60</sup> Five Winds International, 2008.

<sup>61</sup> Five Winds International, 2008.



Much of the international focus has been based on several studies conducted in the Chinese village of Guiyu in Guangdong Province, which has been involved in e-waste recycling for more than ten years.<sup>62</sup> These studies cite elevated levels of lead and cadmium in workers and children.<sup>63,64</sup> Exposure to these and other contaminants during recycling of electronics have been linked to diseases of the skin, stomach, respiratory tract and other organs.<sup>65</sup>

#### **Data Gaps**

Although national law prohibits the trade of e-waste into China, the import of e-waste continues without formal monitoring. Due to the illicit and informal nature of e-waste recycling, it is difficult to quantify the flows of copper that are recovered and make an informed assessment as to whether recovery rates could be improved.

#### **Formal versus Informal Recycling**

Informal collection systems are in some ways limiting the successes of formal recycling systems. Consumers tend to prefer to sell their e-waste to those in the informal recycling business, resulting in formal treatment facilities being incapable of collecting sufficient domestic e-waste to sustain daily operation and capital flows.<sup>66</sup>

Chen and Zhang (2009) argue that a hybrid model of “mechanization tools plus manual dismantling” may be the best option forward for China. Several organizations, such as the UNEP/StEP Initiative and a collaboration of the Swiss and Chinese Governments with EMPA, are currently working to integrate the informal and formal markets to balance the local economic and social benefits of recycling with more sustainable practices that reduce human and environmental exposure to hazardous materials.<sup>67</sup>

## **6.2 International Social Impact—Flow D**

The social impacts of copper mining vary greatly across the lifetime of the mine. Social impacts from mining tend to increase with the proximity of the operations to surrounding communities and direct impacts, for this reason, may be negligible when mines are located in remote, unpopulated areas. However, indirect impacts on communities may still be significant as a result of employment practices, taxation structures and other societal factors. These impacts start at the exploration phase in the form of managing community expectations and gaining community trust, and then evolve as the project develops into issues related to the health and safety of workers during the construction and operation phases.<sup>68</sup> In cases where the development of a mine greatly increases the population of the region, i.e., through improved access or an influx of workers, there is also a potential for inadequate housing and stress on local educational and medical facilities.<sup>69</sup> An influx of workers from other regions or countries can potentially lead to tension in local communities as a result of

<sup>62</sup> Leung, Duzgoren-Aydin, Cheung & Wong, 2008.

<sup>63</sup> Li et al., 2008.

<sup>64</sup> Zheng et al., 2008.

<sup>65</sup> Öko-Institut, 2007.

<sup>66</sup> UNEP, 2009.

<sup>67</sup> UNEP, 2009.

<sup>68</sup> Franks, Fidler, Brereton, Vanclay & Clark, 2009.

<sup>69</sup> McMahon & Remy, 2001.

cultural differences or concerns of loss of local jobs to foreign workers.<sup>70</sup> As with environmental impacts of mining, the social impacts can also continue beyond the life of the mine and may include a variety of community-based issues, including impacts to the community due to the termination of employment for local workers.<sup>71</sup>

In many situations, the social impacts related to mining can be mitigated by actively managing the operations in a way that provides mutual benefits to the community, region or country, as well as to the mining company. In instances where the community was economically depressed prior to the mining operation, increased employment and supporting infrastructure can lead to improved social and economic health.<sup>72</sup> This type of effort is often driven by mining companies, particularly in areas where local governments do not have regulations in place to adequately protect the social interests of the community.<sup>73</sup>

For Flow D, a case study on the social impacts of copper mining in Zambia was selected, as this provides an example of China's impact and potential role in countries where it is providing significant investment into copper production. Although China is also investing in other developing countries (such as Peru, where reports of a violent attack on a Chinese-owned mining camp made headlines in 2009), the information available on Chinese investment in Zambia illustrates a more comprehensive example of both the positive and negative social impacts. It should also be noted that similar impacts in Zambia have been attributed to other foreign owned copper operations—for example, Konkola Copper Mines, which has had various primary owners originating in the United Kingdom.<sup>74</sup>

The impacts of Chinese mining in Zambia are not unique to either country or to copper, as other countries have struggled with similar issues for a variety of metals. Similar impacts have been documented in numerous countries including the Democratic Republic of Congo and Ghana in Africa,<sup>75</sup> as well as Honduras in Central America.<sup>76</sup> The following case study, however, illustrates the challenges faced by foreign owned mining operations in developing countries. In this type of situation, there is a significant potential for both positive and negative social impacts in the country of operation, as well as in the investment country.

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<sup>70</sup> McMahon & Remy, 2001.

<sup>71</sup> Franks, Fidler, Brereton, Vanclay & Clark, 2009.

<sup>72</sup> McMahon & Remy, 2001.

<sup>73</sup> McMahon & Remy, 2001.

<sup>74</sup> Dymond, 2007.

<sup>75</sup> Campbell et al., 2009.

<sup>76</sup> Center for Economic and Social Rights, 2001.

### 6.2.1 Case Study: Chinese Copper Mining in Zambia

#### Overview

Chinese copper mining in Zambia has garnered much international attention—both positive and negative. On the positive side, China has brought significant foreign investment into the country and, with that, significant job opportunities and infrastructure improvements. Chinese investment in Zambia has exceeded US\$1 billion (as of December 2009) and also accounts for the creation of approximately 15,000 jobs for Zambians.<sup>77</sup> However, the relationship between the two countries has also drawn harsh criticism by international media groups and NGOs, which attribute China's investments with lowered health and safety performance as well as lower wages for local workers (compared with other foreign owned mines).<sup>78</sup> The following case study was created through a literature review of relevant academic research, reports from the Zambia Development Agency and international media.<sup>79</sup>

#### Positive Social Impacts

The Zambia Development Agency attributes significant social benefits to Chinese investments in infrastructure projects (e.g., railways, hydroelectric power plants), which have also played an important part in Zambia's economic development.<sup>80</sup> The agency reports that further social benefits are anticipated now that the Investment Promotion and Protection Agreement (IPPA) has been signed with Zhougui Mining Group, a Chinese private mining company. In the agreement, an investment of US\$5 billion and employment for over 1,000 Zambians was pledged.<sup>81,82</sup> Beyond employment and infrastructure improvement, the high level of interaction with the Chinese government has also led to improved bilateral relations between the two countries. The Zambia Development Agency expects that these improved relations will lead to debt relief for the Zambian government, establishment of Chinese economic and trade zones in Zambia, construction of sports stadiums, and the provision of Chinese grants for partnership projects between Zambian and Chinese companies.<sup>83</sup>

#### Negative Social Impacts

While China's investment in copper mining in Zambia has undoubtedly increased jobs and infrastructure development, its negative social impacts have also been the focus of NGO activity and international media attention. Among the various organizations monitoring the industry, there are concerns that tax concessions made by the Zambian government have led to significantly reduced tax revenue from Chinese investments.<sup>84</sup> A study conducted in 2008 by the African Economic Research Consortium (AERC) reported that concessions that were previously granted to the China Non-Ferrous Metal Mining Group Corporation Limited in Chambishi were extended to an entire area covering 41 square kilometres to create what China refers to as the Chambishi Special Economic Zone (SEZ).<sup>85</sup> Although the use of an SEZ often has the potential to offer significant economic development, the AERC study argued that the special incentives accorded to the Chambishi copper

<sup>77</sup> Zambia Development Agency, 2010.

<sup>78</sup> McGreal, 2007.

<sup>79</sup> It should be noted that although media reports of activities should not be taken as direct factual evidence of these activities, they do contribute significantly to public perception and general societal awareness of particular issues. Because public perception and increased social pressure can influence private and public sector activities, these reports have been included in the case study.

<sup>80</sup> Zambia Development Agency, 2010.

<sup>81</sup> Zambia Development Agency, 2010.

<sup>82</sup> Although this IPPA received broad media coverage when it was announced, as of September 2010 no further information about the agreement or the project's progression was available.

<sup>83</sup> Zambia Development Agency, 2010.

<sup>84</sup> Mwanawina, 2008.

<sup>85</sup> Mwanawina, 2008.

mine and the establishment of the area as an SEZ deprived the country of the much needed tax revenue required for the country's development effort. The Zambia Development Agency refers to this area as the Chambishi Multi Facility Economic Zones. According to the agency, "...the main objective of the Multi Facility Economic Zones program in Zambia is to catalyze industrial and economic development through increased activity in the manufacturing sector where value addition to the numerous natural and agricultural raw materials hitherto exported in raw form will be processed for purposes of enhancing both domestic and export oriented business."<sup>86</sup> It is difficult to gauge the success of this zone, as its impact—both positive and negative—involves numerous international players, both public and private.

Although no specific study on working conditions in this area was found, the Chambishi mining zone has been cited by various media outlets as an area where workers have received lower wages and been exposed to poorer safety conditions than in other regions of Zambia. The media has attributed the reduced benefits workers received in the area to the high use of part-time or "casual" labour.<sup>87</sup> Again, these reports have focused on Chinese operations specifically, but similar issues are not uncommon in other developing countries or to other operations in Zambia that are run by foreign countries other than China.

#### **Governance Gap**

Much of the responsibility for monitoring the mining sector falls on the Zambian government and its ability to set out clear performance standards for the industry. The Zambian Mines Safety Department, which monitors health and safety incidents at mining companies, is severely underfunded and subsequently has a shortage of skilled workers needed to effectively monitor the industry.<sup>88</sup> These skill shortages also hamper Zambia's ability to monitor tax collection and fiscal regulation, making it difficult to track whether mining companies are paying appropriate taxes and duties.<sup>89</sup>

### **6.3 Summary**

The international social impacts of copper cover a broad range of issues, from community development issues surrounding mine sites to health impacts caused by exposure to chemicals during recycling. These impacts, while not unique to the Chinese copper supply chain, are still of significant importance, particularly as international societal awareness concerning supply chain responsibility increases. Social benefits from recycling in China (and throughout the world) typically arise from creation of jobs in the recycling industry. Social benefits from copper mining are also created through job production and, in the case of foreign investments, through development of supporting infrastructure, community development and tax and royalty benefits paid to the countries where the operations are located.

In addition to China's domestic challenges, foreign investment in countries throughout Africa—as well as in other developing economies—adds another level of complexity, because domestic policies vary greatly—and with them, so do environmental and social performance requirements expected of

<sup>86</sup> Zambia Development Agency, 2010.

<sup>87</sup> Behar, 2008.

<sup>88</sup> Haglund, 2008.

<sup>89</sup> Haglund, 2008.

foreign operated companies. This topic is discussed further in the Policy Recommendations section of this document.

In terms of social impacts of recycling, China's main challenge is to regulate its recycling infrastructure. This formalization would potentially eliminate many of the negative social impacts discussed in the case study above, which arise from less formal approaches to recycling.

## 7.0 International Policy Context

### 7.1 Flow C: Copper Supply Chain Policies

This section describes regulatory and voluntary policies affecting the management of post-consumer copper in Europe, the United States and Japan (Flow C). The research indicates that there are very few initiatives specifically aimed at copper, but rather aimed at one of four copper-containing product groups: automobiles (representing <5 per cent of copper use), building and construction (50 per cent), electrical and electronic equipment (approximately 15 per cent), and infrastructure (22 per cent). Industrial durables (8 per cent) are not considered in this analysis because the characteristics of industrial machinery and equipment, such as single ownership and static location, promote the achievement of high recovery rates without the need for additional policy measures.

The regulatory and voluntary initiatives affecting the recycling of post-consumer copper are summarized in Table 7.1. (Refer to Appendix A for a more comprehensive description of each of these initiatives.) The initiatives include national legislation affecting specific end-use sectors such as end-of-life vehicles (ELVs) and waste electrical and electronic equipment (WEEE), international treaties (Basel Convention), government policies that promote recycling, and voluntary initiatives such as green building schemes.

**Table 7.1 Summary of regulatory and voluntary drivers—Flow C.**

	Region(s) affected	Product sector(s) affected	Summary of intent of driver
<b>National Legislation</b>			
Recycling Law Effective 2000	Japan	All	Legislate recycling and use resources according to the 3Rs: reduce, reuse and recycle.
End-of-life Vehicle Recycling Law Effective 2005	Japan	Automobiles	Requires manufacturers to take back and recycle automobile shredder residue, airbags, and chlorofluorocarbons. Establishes recycling targets and infrastructure for collection and processing.
End-of-Life Vehicle (ELV) Directive Effective 2000	European Union	Automobiles	Requires automobile manufacturers to increase recycling of end-of-life vehicles and consider recyclability in the design of new vehicles. Mandates specific recycling targets.
Home Appliance Recycling Law (HARL) Effective 2001	Japan	EEE	Manufacturers required recycling end-of-life televisions, refrigerators, washing machines and air conditioners. Establishes specific recycling targets.

	Region(s) affected	Product sector(s) affected	Summary of intent of driver
Waste Electrical and Electronic Equipment Directive (WEEE) Effective 2003	European Union	EEE	Requires manufacturers to increase recycling of end-of-life EEE products and consider recyclability in the design of new units. Mandates specific recycling targets.
Various State Level Regulations Various effective dates	United States	EEE (consumer electronics)	Various regulations in about 25 existing and proposed state programs, including California, Wisconsin, Minnesota and Massachusetts. Approaches include fee driven requirements to promote the collection of used equipment, landfill bans on e-waste, and product stewardship.
<b>International Treaties</b>			
Basel Convention Effective 1992	Global	EEE	International treaty implemented by European Union and China, but not United States. Covers the international movement of hazardous waste and measures for appropriate management, treatment and disposal. The Ban Amendments (adopted in 1995 but not in effect) limit export of e-waste from OECD and EU countries. Basel Convention working groups are trying to resolve questions about how the Amendment applies if e-waste products are reused.
Kobe 3R Action Plan	G8	All	Agreed at the G8 Environmental Minister Meeting in Kobe in 2008, the Kobe 3R Action Plan intends to improve resource productivity, to establish an international sound material-cycle society and to bring forward 3R capacity in developing countries.
<b>Government Policy</b>			
3R Principle Effective 2000	Japan	All	National policy for recycling and promoting more effective use of resources by 3R: reduce, reuse and recycle. Provides framework for product-specific regulations.
European Union Integrated Product Policy (IPP) Effective 2003	European Union	All	Multinational policy to improve environmental performance of all products along the whole life cycle.
Waste Management Strategy Effective 2005	European Union	All	Multinational policy to reduce waste generation and boost recycling.

	Region(s) affected	Product sector(s) affected	Summary of intent of driver
Resource Conservation Challenge (RCC) Effective 2004	United States	All	National effort to encourage more efficient use of energy and resources and promote recycling.
<b>Representative Voluntary Initiatives</b>			
Government Green Procurement Programs	Regional	All	Voluntary or mandatory programs that promote government procurement of environmentally preferred products.
World Green Building Council (WGBC) Established 1999	Global	Building products	Voluntary initiative to promote global adoption of green building standards and programs. The WGBC works to accelerate the development of green building councils across the globe.
Leadership in Energy and Environmental Design (LEED) Established 1999	United States	Building products	US Green Building Council voluntary initiative to promote energy and environmentally efficient buildings, the use of recycled content in building products, the reuse of buildings, and recycling of end-of-life building products.
BREEAM Established 1990	United Kingdom	Building products	Voluntary initiative to promote energy and environmentally efficient buildings, in particular the use of recycled content in building products, promote the reuse of buildings, and promote recycling of end-of-life building products.
Sustainable Building Council Emerging Program	Germany	Building products	Uses life cycle assessment to promote the use of recycled content in building products, promote the reuse of buildings, and promote recycling of end-of-life building products.
Mobile Phone Partnership Initiative (MPPI) Effective 2002	Global	EEE (mobile phones)	Voluntary partnership of 10 major mobile phone manufacturers to improve management of mobile phones pursuant to the Basel Convention.
PACE Effective 2007	Global	EEE (personal Computers)	Voluntary partnership to improve management of personal computers pursuant to the Basel Convention.
Solving the E-Waste Problem (StEP) Effective 2007	Global	EEE	Industry and United Nations partnership to standardize recycling approaches.
European Recycling Platform Effective 2002	European Union	EEE	Voluntary industry initiative to promote electronics recycling.



	Region(s) affected	Product sector(s) affected	Summary of intent of driver
Electronic Product Environmental Assessment Tool (EPEAT) Issued 2007	United States	EEE	Voluntary electronics industry program created through Institute of Electrical and Electronics Engineers to promote environmentally responsible procurement. Includes system to help purchasers evaluate computer products based on environmental performance.
Green Initiatives – Electronics Action Plan Effective 2004	United States	EEE	US EPA-led effort to promote reuse and recycling of computers, televisions and mobile phones.
Federal Electronics Challenge Effective 2004	United States	EEE	US EPA-led program for federal agencies to purchase greener electronics and recycle them at end of life.
Plug-In to eCycling Effective 2003	United States	EEE	US EPA-led program to promote the development of recycling collection programs.

### 7.1.1 Impacts to Copper Supply Chains

The regulatory and voluntary initiatives summarized in Table 7.1 impact the recycling of post-consumer copper to varying degrees.

The product-specific regulatory drivers (such as the European Union's WEEE and ELV Directives shown in Table 7.1) are stronger than the policy, intergovernmental and voluntary drivers, primarily because the recycling targets are often mandated governmental requirements with penalties for non-compliance. Of the voluntary recycling drivers, the green building initiatives are the strongest.

Drivers affecting e-waste, with its market share of approximately 15 per cent of copper consumption, have the greatest impact on the copper supply chain. Drivers affecting the automobile sector are as strong as the e-waste drivers, but they currently have a smaller global reach and affect a smaller market share of copper (<5 per cent). Drivers affecting the building and construction sector and infrastructure sectors are the weakest and have the smallest global reach, but affect the largest market shares (50 per cent and 22 per cent, respectively).

Drivers pushing recycling (e.g., the WEEE and ELV Directives) are generally stronger than the drivers pulling for recycled products (green building initiatives), suggesting that the demand for copper recycling is greater than the demand for recycled copper products (but not the overall demand for copper). The strong regulatory e-waste drivers, which have the broadest regional reach, target the newly generated supplies of post-consumer waste from the most rapidly growing product sector. However, the largest pools of in-service post-consumer copper available for recycling are in

the building and construction and infrastructure sectors, which are targeted primarily by voluntary programs.

Of the three regions investigated, the most influential environmental drivers affecting recycling come from the European Union. Although the recycling requirements are legally binding only inside the European Union, the efforts influence manufacturing practices on a global level.

Several of the drivers have only secondary impacts on copper recycling. For example, the Basel Convention Ban Amendments, when ratified, will limit exports of e-waste and may affect the global flow of post-consumer copper. The European Union's RoHS regulations, which limit the use of hazardous constituents in manufactured products, will have far-reaching consequences on product design, but copper is not one of the targeted constituents. The REACH and RoHS type regulations in the European Union (and China) will advise manufacturers to develop products that contain lower amounts of regulated substances, such as lead; the impact on copper recycling is not clear, but these regulations could discourage recyclers from using post-consumer copper with higher lead content. Over the long run, however, the quality of post-consumer copper may increase as manufacturers are required to eliminate other substances from their products. Furthermore, the ELV and WEEE Directives help to improve the flow of recoverable materials by impacting the opportunity cost of landfill or disposal without recycling.

In summary, the supply of post-consumer copper that feeds the manufacturing process is elastic; it is pushed and pulled by market forces. End-of-life regulatory drivers (e.g., the WEEE and ELV Directives) intercede in the normal push and pull, creating a steady flow of post-consumer copper for copper refiners and processors. This regulatory-driven supply of post-consumer copper is not subject to the typical market influences. Although globally, the present regulatory-driven supply of post-consumer copper is small in relation to the amount of copper consumed (less than 20 per cent<sup>90</sup>), it is growing and will continue to do so as end-of-life regulatory drivers expand their reaches across the globe.

## 7.2 Flow D: Copper Supply Chain Policies

This section describes regulatory and voluntary policies affecting primary copper production in Australia, Chile, and Zambia (Flow D). The research indicates that there are very few policies specifically aimed at copper mining; rather, they are aimed at the extractive industry or the mining industry as a whole.

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<sup>90</sup> Five Winds International, 2008.

The regulatory and voluntary initiatives affecting the sustainability performance of primary copper production are summarized in Table 7.2. (Refer to Appendix B for a more comprehensive description of each of these initiatives.) The initiatives include national legislations on tax, mine safety and environment; international treaties on climate change and labour; and a wide range of international voluntary initiatives covering various aspects of corporate social responsibility (CSR).

**Table 7.2 Summary of regulatory and voluntary drivers—Flow D.**

	Region(s)/ parties affected	Summary of intent of driver
<b>National Legislation</b>		
Tax Legislation	Country of operation	Collects a return to the state from firms operating in the mining/extractive sector.
Mine Safety Legislation	Country of operation	Sets rules on occupational health and safety issues that are specific to the mining industry.
Environmental Legislation	Country of operation	Sets requirements for assessing and mitigating impacts to the environment in the planning, construction, operation and closure of mining operations.
<b>International Treaties</b>		
UNFCCC	Signatory countries	Sets targets for reducing greenhouse gas emissions.
ILO Core Conventions	Signatory countries	Sets minimum standards on labour rights related to child labour, forced labour, minimum age, unions, equal remuneration, and discrimination.
<b>International Voluntary Initiatives</b>		
EITI	Signatory countries	Reduces government corruption and increases transparency regarding the payment of taxes and royalties by resource extraction companies.
Voluntary Principles	Signatory countries	Provides guidance to extractive companies on ensuring the safety of their personnel and the security of their installations in insecure environments whilst at the same time respecting human rights.
OECD Guidelines	OECD countries	Provides recommendations addressed by governments to multinational enterprises operating in or from OECD countries.
ISO 26000	All	Offers guidance on ways to integrate socially responsible behaviour into existing organizational strategies, systems, practices and processes.
IFC Performance Standards	Borrowing companies	Establishes standards for determining, assessing and managing social and environmental risk in IFC project financing.
Equator Principles	Borrowing companies	Establishes standards for determining, assessing and managing social and environmental risk in project financing by signatory lending institutions.
GRI	All	Sets out the principles and indicators that organizations can use to measure and report their economic, environmental and social performance.

	<b>Region(s)/ parties affected</b>	<b>Summary of intent of driver</b>
ICMM SD Framework	ICMM member companies	Sets out the principles, reporting and assurance on sustainable development for ICMM's 19 corporate members.
ICA Copper Stewardship	ICA member companies	Promotes stewardship of copper throughout the copper value chain, with particular emphasis on copper's major end uses.

### **7.2.1 Impacts to Copper Supply Chains**

This section examines the impact of the above mentioned regulatory and voluntary policies on the copper supply chain, including the effects on financing, social licence to operate, copper prices, producing countries, other materials, secondary production and downstream customers.

#### **7.2.1.1 Financing**

For companies looking to develop a new copper mine or smelter, the International Finance Corporation's (IFC's) Performance Standards and the Equator Principles can have a significant impact on their ability to secure financing. EP-signatory finance providers want to minimize the reputational risks associated with NGO and media campaigns against financiers of extractive industries projects. Media attention generates uncertainty and can drive down share prices. These lenders are also wary of conflicts with local stakeholders, which may lead to withdrawal of concessions, operational disruption or other risks to project viability and future capital returns.

#### **7.2.1.2 Social Licence to Operate**

In effect, the regulatory and voluntary policies described above define the measures required for a mining company to obtain its "social licence to operate" (i.e., to maintain community and government relations and access to the mineral in the ground). Many mining companies are concerned about their own reputational and operational risks, and abiding by voluntary measures beyond what is required by law—such as those espoused in the Equator Principles or ICMM's Sustainable Development Principles—can be seen as a way to mitigate these risks.

#### **7.2.1.3 Copper Prices**

Copper prices are established on the metal exchanges; the most recognized is the London Metals Exchange. Present or "spot" prices are partly based on market tightness between supply and demand. London Metals Exchange spot prices are used as reference prices by copper producers and fabricators when negotiating contracts. Alongside the fundamental commodity price discovery

process on the metal exchanges, traders set location premiums, which depend on local supply–demand and distribution factors.<sup>91, 92</sup>

For copper mining and producing firms, the costs of compliance are added to the cost of production. As a result, increased regulatory and voluntary measures are associated with an increase in overall production costs. These increased production costs have the effect of taking out the production at the top end of the cost curve, contributing over the long term to the market price of copper.

#### 7.2.1.4 *Competitiveness among Producing Countries*

Regulatory policies can alter the competitiveness among producing countries in two important ways. First, they influence the attractiveness of the investment climate in producing countries. However, government policies are just one of a number of variables affecting the abilities of mining countries to attract new investment and it is important not to exaggerate their overall significance. A country’s geologic potential and political stability, amongst other factors, are likely to be of equal or greater importance.<sup>93</sup> Second, government policies affect the competitiveness of producers by altering the costs of production of operating mines. Should the market price of copper fall, mines that are less competitive would be more vulnerable to closure.

#### 7.2.1.5 *Competitiveness with Other Materials*

The regulatory and voluntary policies described above affect the competitiveness among materials only to the extent that they alter their relative prices. In a few copper end uses, producers can quickly and easily substitute an alternative material in response to changes in relative prices. For example, in response to the rising cost of copper, it was common in the late 1960s to mid-1970s for electricians in North America to install aluminum wiring instead of copper wiring.<sup>94</sup> In the long run, however, material substitution often requires new production equipment and the retraining of personnel. Such changes take time and can be expensive, so they are undertaken only once it is clear that the new price levels are likely to continue. Higher prices also provide strong incentives to increase recycling and reduce the demand for the higher-cost materials in other ways, such as by thinning down or reducing the gauge of the materials.

<sup>91</sup> Simon Payton, copper industry expert, correspondence with ICMM, 2010.

<sup>92</sup> In the case of smelting and refining, the mines selling copper concentrates get paid a price related to the world price for refined copper, less the “treatment charges and refining charges” (TCRCs). TCRCs are important for the Chinese supply of concentrates; however, due to the topic’s complexity and peripheral link to sustainability, it is considered outside the scope of this report.

<sup>93</sup> World Bank, 2006.

<sup>94</sup> Wikipedia, 2010.

### 7.2.1.6 Competitiveness with Secondary Production

Because some policies (e.g., mineral royalties) increase the costs of primary but not secondary producers, one might expect an increase in the competitiveness of secondary producers at the expense of primary producers. However, as the demand for copper increases in emerging economies, the share of total copper production accounted for by primary production has not displayed a tendency to decline over time. This is largely because the pool of secondary copper generation is largely limited by availability rates (i.e., most copper is still in use and not yet available for recycling).

### 7.2.1.7 Impact on Downstream Customers

The above described policies can also have impacts on downstream customers of copper although, once again, this depends on the degree of price increase, the proportion of the copper component in the good, and the relative value of alternatives. If market prices are pushed up, product manufacturers can, in some situations, mitigate the adverse effects by substituting less expensive alternative materials. Where the demand for the copper is highly insensitive to changes in price (inelastic), product manufacturers can pass on the rise in costs to their customers in the form of higher prices.

## 7.3 Summary

As described above, there are numerous regulatory and voluntary drivers affecting primary and secondary copper production. While very few initiatives are specifically aimed at copper, most are aimed at the mining industry as a whole (for primary production) or aimed at one of four copper-containing product groups (for secondary production)—automobiles, building and construction, electrical and electronic equipment, and infrastructure.

For the analysis of regulatory and voluntary policies affecting secondary copper production (Flow C), we examined the policies of Europe, the United States and Japan. A key finding was that the majority of policies affecting recycling in these regions have been designed to minimize harm to humans and the environment, rather than to maximize the amount of recoverable materials that are available for recycling. Although some of these policies—such as Europe’s ELV and WEEE Directives—may have the indirect impact of improving the flow of recoverable materials, others such as the Basel Convention have had the indirect impact of reducing the flow of recoverable materials to China. Despite the Basel Convention and national law prohibiting the trade of e-waste into China, the recycling of e-waste (whether domestic scrap or illegal imports) continues to represent a significant source of secondary copper for China.

The regulatory drivers in Europe, the United States and Japan have prompted several automotive companies, such as Volkswagen and Toyota, to invest research and development resources into more effective techniques to separate non-ferrous metals from plastics. As such, there are an increasing number of opportunities for technology transfer between e-waste and post-consumer automobile recovery. The transfer of technology of highly automated processes, however, may have limited applicability in China with its abundant labour resources, and may be a topic for further investigation.

For the analysis of regulatory and voluntary policies affecting primary copper production (Flow D), we examined the policies of Australia, Chile and Zambia. The research (detailed in Appendix B) indicates that although there are no significant differences between the regulations of each of the three countries, there is a notable discrepancy in the capacity of the Zambian government to enforce these regulations. For example, while total effective tax rates were comparable in the three countries, NGO and lending institutions have expressed concern that in Zambia, there is insufficient capacity in government to validate that what mining companies pay is actually what they should pay in taxes and duties. The sustainable development impact of weak enforcement is that the local communities and national government may not receive an appropriate return from the harvesting of non-renewable resources and, as a result, these funds would not be available for important social services such as health and education.

Weak enforcement of regulations, on one hand, reduces the costs of compliance for copper mining and producing firms, which has the effect of keeping production costs low. On the other hand, companies want to minimize the reputational risks associated with conflicts with local stakeholders and any unwanted attention from NGO and media campaigns. Abiding by voluntary measures beyond what is required by law—such as those espoused in the Equator Principles or ICMM's Sustainable Development Principles—can be seen as a way to mitigate these risks and remain competitive.

## 8.0 Policy Recommendations

Based on the research conducted in this report, which was aimed at gathering information that will improve our understanding of how sustainable development outcomes from the copper supply chain can be improved, the following policy recommendations were derived.

### 8.1 Fill Data Gaps

Accurate and reliable statistics on post-consumer copper consumption have always been difficult to obtain, but as world trade in low-grade, post-consumer copper has increased, statisticians have found it even more difficult to obtain accurate data. Possible reasons for the discrepancy include the way that copper is measured for export in contrast to the way it is reported at the importing country (for example, post-consumer copper may be reported by weight as “white goods” instead of just the much smaller copper content in the end-of-life product). Because of the growing interest and scrutiny in monitoring and quantifying post-consumer metal exports from the United States and European Union, there are new customs requirements and better ways to track the quantities of post-consumer metals being exported. Improving the consistency of these requirements between exporting and importing countries would help to improve the quality of the data on the trade of post-consumer copper.

### 8.2 Allow the Import of E-Waste

Although national law prohibits the trade of e-waste into China, the illegal import of e-waste continues to represent a major source of negative social and environmental impact within China. At the same time, recycling of e-waste represents a significant source of secondary copper for China—with one tonne of e-waste containing up to 0.2 tonnes of copper.

While the negative impacts felt by China arise during the recycling process, recycling itself produces significant social and environmental benefits to the planet as a whole. In order to deal with the social and environmental problems associated with e-waste treatment in China, there is a need to forcefully monitor the trade in such products rather than forcing it underground, while simultaneously strictly enforcing safe handling standards over the treatment process.

(Note: For more information on e-waste recycling in China, refer to IISD (2008), “Sustainable Electronics and Electrical Equipment for China and the World: A Commodity Chain Sustainability Analysis of Key Chinese EEE Product Chains.”)



### 8.3 Support Extended Producer Responsibility (EPR) Policies

China has several existing and forthcoming EPR policies, including “China RoHS” (effective in 2007), standards for the recycling of end-of-life vehicles (effective in 2010) and “China WEEE” (effective in 2011). These initiatives present an opportunity for China to anticipate when the “in-stock” copper will become available, set recycling targets, write standards and technical specifications, and develop the infrastructure required for efficient recovery and recycling.

- **Develop better understanding of availability of “in-stock” copper.**

Based on consumption patterns and estimated residence times, China can anticipate when “in-stock” copper will become available for recycling. For example, Chen and Zhang (2009) estimated that three to six million vehicles should have reached the end of their useful lives in 2006, but 2006 data reveal that only 380,000 were dismantled. This discrepancy demonstrates the difficulty in estimating the availability of end-of-life products. Products can be reused and refurbished many times before they are recycled. Developing a better understanding of consumer behaviour in key product sectors will be important to more accurately predict recycling flows.

- **Set standards and technical specifications with copper recycling in mind.**

While standards and technical specifications should continue to focus on identifying hazardous substances in products such as electronics and automobiles, these specifications should also have the goal of maximizing the efficiency of recovering valuable materials such as copper. Such technical specifications could include methods for marking and coding copper-containing parts, guidelines for which parts and components should be directed toward remanufacturing (versus recycling), and best practices for the efficient separation of copper from other materials.

- **Learn from best practices in the development of recycling infrastructure.**

Recycling systems for end-of-life copper-containing products vary by product sector and region. For automobiles, a well-established recycling infrastructure (along with its network for reusing parts) exists in the United States, Japan and the developed economies of the European Union. Most recycling technology advancements in this sector focus on separating plastic components from non-ferrous metals. The transfer of such technology may be appropriate between regions and between different product groups (e.g., the automotive and e-waste sectors).

- **Work with industry on materials stewardship.**

The mining and metals industry, under the umbrella of ICMM, is actively implementing materials stewardship initiatives. In addition to company-level initiatives, the global commodity association for copper—the International Copper Association—has also initiated a commodity-wide Copper Stewardship initiative. In today’s global marketplace, the

credibility and effectiveness of Copper Stewardship initiatives, such as LCA and risk assessment studies of copper products, would be greatly enhanced with the participation of Chinese companies and other stakeholders.

#### **8.4 Extend CSR Policy to Chinese State-Owned Enterprises and Chinese Private Enterprises Operating Overseas**

In 2008, China issued guidance to its State-owned enterprises operating in China, recommending systems for corporate social responsibility (CSR) reporting and protection of labour rights.<sup>95</sup> The Government is also currently considering draft “Guidelines on Corporate Social Responsibility Compliance by Foreign Invested Enterprises”<sup>96</sup> operating in China. As China looks more and more to Africa and other developing regions as sources for raw materials, similar guidance may also be relevant for both State-owned and privately-owned Chinese enterprises operating overseas.

#### **8.5 Strengthen Government Capacity**

In the case of both environmental and social issues, the extent and magnitude of the negative impacts of mining depend largely on the governance systems that are in place in the given mining region. It is evident that effective governance in the mining sector is lacking in some developing countries, particularly in Africa. National governments have a central and unavoidable role to play in improving governance for sustainable development through a national policy framework, regulation and enforcement. But not all governments have the capacity to make the changes. It is therefore important that the international community focus on strengthening the capacity of national governments to design and enforce regulations such that they contribute to the country’s economic growth and human development.

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<sup>95</sup> State-Owned Asset Supervision and Administration Commission, 2008.

<sup>96</sup> DLA Piper, 2009.

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## 10.0 Appendix A: Copper Supply Chain Policies—Flow C

### 10.1 Foreign National Legislation

#### 10.1.1 Automotive Product Group

Various recycling regulations affect the automotive industry, both at the end-of-life stage and at the design stage.

##### *European Union*

In line with the European Union Waste Management Policy, the **End-of-Life Vehicle (ELV) Directive**<sup>97</sup> was released in 2000.<sup>98</sup> The ELV Directive applies to all vehicles manufactured or sold in Europe and establishes a “take back” system for end-of-life automobiles in the European Union.

Under the ELV Directive, operators must achieve a minimum of 95 per cent of reuse and recovery and a minimum of 85 per cent of reuse and recycling for all end-of-life vehicles by January 1, 2015.

##### *Japan*

Japan introduced the **End-of-Life Vehicle Recycling Law**,<sup>99</sup> effective in 2005, as part of its overarching 3R legislation, described in the previous section. The law requires car manufacturers and importers to take back and recycle automobile shredder residue (ASR), airbags and fluorocarbons used in air conditioners. The law also bans disposing of ASR in landfills, establishes post-consumer metal recycling, and sets staged ASR recycling target rates—2005: 30 per cent, 2010: 50 per cent, and 2015: 70 per cent recovery rates.<sup>100</sup>

##### *United States*

There is no national legislation in the United States that specifically addresses the collection and recycling of end-of-life automobiles. Only one piece of legislation has ever been introduced on a national level that specifically targets ELV management: the Automobile Recycling Study Act of 1991, proposed by the House of Representatives but not passed.<sup>101</sup> Instead, ELV activities have been mainly influenced by national and local laws addressing solid and hazardous waste disposal

<sup>97</sup> Official Journal of the European Union, 2000.

<sup>98</sup> Europa, 2010.

<sup>99</sup> Japanese Ministry of Economy, Trade and Industry, 2006a.

<sup>100</sup> Recovery rate = weight of material recycled / weight of ASR generated from collected ELVs.

<sup>101</sup> Davis, 1996.

practices. It is more likely that any future efforts in the United States would be targeted at restricting landfill disposal of ASR.<sup>102</sup>

### 10.1.2 Building and Construction Product Group

Very few recycling regulations are specifically aimed at post-consumer copper, and current regulatory requirements are not directly driving recycling of copper-containing products in the building and construction industry.

#### *European Union*

The European Commission has proposed a strategy to prevent and recycle waste, which is one of the seven thematic strategies programmed by the 6th Environmental Action Plan.<sup>103</sup> The proposed **Revision of the Waste Framework Directive** sets recycling standards and specific targets for waste recycling.<sup>104</sup> Several amendments include targets for construction waste. If these amendments are included in the final directive it could increase recycling of post-consumer metals from the building and construction industry.

#### *Japan*

Japan's **Construction Material Recycling Law**, adopted in 2000, requires contractors to sort and recycle wastes generated in demolition work.<sup>105</sup> The intent of this law is to ensure efficient use of resources in the construction industry. The law also includes numerical recycling targets that were to reach 95 per cent by 2010.<sup>106</sup> However, this law does not apply to metals—rather to wood, concrete and asphalt, because these materials were not being adequately recycled.<sup>107</sup>

#### *United States*

In the United States, scrap metals are generally exempt from the waste handling, treatment and disposal regulations of the **Resource Conservation and Recovery Act (RCRA)** to encourage recycling. There is an active, established scrap metal recycling network as part of the construction and demolition waste system that is primarily driven by the market supply and demand for copper.

<sup>102</sup> Staudinger & Keoleian, 2001.

<sup>103</sup> European Commission, 2010.

<sup>104</sup> European Commission, 2010.

<sup>105</sup> Japanese Ministry of the Environment, undated.

<sup>106</sup> Japanese Ministry of the Environment, undated.

<sup>107</sup> Japanese Ministry of the Environment, undated.

### 10.1.3 Electrical and Electronic Equipment Product Group

The global regulatory landscape for consumer electrical and electronic equipment (EEE) currently focuses on consumer electrical products (a smaller subset of all electrical uses of copper) and is dominated by two priority areas: substances of concern and waste streams.

#### European Union

The **Waste Electrical and Electronic Equipment (WEEE) Directive**<sup>108</sup> and the **Restriction of Hazardous Substances Directive**<sup>109</sup> (RoHS) have far-reaching effects on global markets because the requirements address products manufactured or imported to the European Union. The intent of the WEEE Directive is to mandate recycling of end-of-life electronics products. The intent of the RoHS is to reduce the amount of hazardous substances (lead, mercury, cadmium, chromium VI and flame retardants) in manufactured products; therefore, its effect on recycling is indirect.

**REACH (Regulation on Registration, Evaluation, Authorisation and Restriction of Chemical Substances)**,<sup>110</sup> which has a wider application than RoHS, will almost certainly have a global impact on EEE manufacturing. Under REACH, effective in 2007, manufacturers are required to systematically replace toxic chemicals with approved alternatives.

REACH requires companies that manufacture or import more than one tonne of a substance to register it in a database. REACH covers all substances, whether manufactured, imported, used as intermediates or placed on the market, either on their own, in preparations or in articles and divides them into phase-in and non-phase-in substances. Manufacturers and importers are responsible for managing the risks posed by the chemicals, and to provide, assess and document hazard and safety information. Substances of very high concern are subject to authorization to ensure that they are properly controlled and progressively replaced by suitable, safer alternative substances or technologies, where these are economically and technically viable.

#### Japan

Japan is one of the three Asian countries (besides Taiwan and South Korea) currently mandating electronics recycling. In 2000, Japan adopted **Basic Laws for Establishing a Recycling-Based Society**, which legislates recycling and more effective use of resources by the 3R principle (reduce, reuse, recycle). The framework law includes the **Home Appliance Recycling Law (HARL)**.<sup>111</sup> HARL covers just four products: televisions, refrigerators, washing machines and air conditioners, which make up the largest amount of post-consumer waste electronics in Japan. The law requires

<sup>108</sup> Official Journal of the European Union, 2003b.

<sup>109</sup> Official Journal of the European Union, 2003a.

<sup>110</sup> Official Journal of the European Union, 2006.

<sup>111</sup> Japanese Ministry of Economy, Trade and Industry, 2006b.

consumers to pay a recycling fee when disposing of home appliances, requires retailers to take back discarded products and requires manufacturers to recycle the discarded appliances.

HARL includes nationwide deployment of home appliance recycling plants in Japan. Japanese home appliance manufacturers have built recycling plants throughout Japan to receive and recycle used home appliances.

### *United States*

In the United States, the **Resource Conservation and Recovery Act (RCRA)**, passed in 1976, regulates the management, treatment and disposal of solid and hazardous wastes. Post-scrap metal is exempt from the hazardous waste regulations, and household wastes are conditionally exempt as well. RCRA does not mandate recycling of e-wastes and there is no federal mandate to legislate e-waste recycling in the United States; although congressional hearings were held in 2005, there are no proposed regulations. At the state level, however, over half the states have laws or are proposing legislation on EEE end-of-life management, with varying degrees of responsibility for producers.

One example of a state-level program is the **California Electronic Waste Recycling Act**,<sup>112</sup> which regulates the end-of-life handling of certain EEE discards and the reduction of hazardous substances used in certain electronic products sold in California. Products affected include electronic devices containing cathode ray tubes, such as televisions and computer and laptop monitors. To fund this program, retailers collect a recycling fee from their consumers at the first sale of the covered electronic devices. The variable fee is based on the screen size of the product when measured diagonally and covers the costs of electronic waste collection and recycling.<sup>113</sup>

## **10.2 Multilateral Treaties**

### **10.2.1 Basel Convention**

The **Basel Convention**<sup>114</sup> is an international treaty whose intent is to control the export of hazardous wastes and their disposal; it is the most comprehensive global environmental agreement on hazardous and other wastes. The Convention has 170 Parties (including China and most European Union countries, but not the United States) and seeks to protect human health and the environment from the generation, management, export and disposal of hazardous wastes.

The Basel Convention has identified electronic waste as hazardous and has developed a framework for controlling the transboundary movement of such waste.

<sup>112</sup> California Department of Resources Recycling and Recovery, 2010.

<sup>113</sup> Telecommunications Industry Association, 2010.

<sup>114</sup> Basel Convention, 2010.

The Basel Ban, an amendment to the Basel Convention that has not yet come into force, would go one step further by prohibiting the export of hazardous wastes from developed to developing economies that may not have the capacity or environmental standards to appropriately handle these types of wastes.

### **10.2.2 Kobe 3R Action Plan**

Agreed upon at the G-8 Environmental Minister Meeting in Kobe in 2008, the Kobe 3R Action Plan intends to improve resource productivity, to establish an international sound material-cycle society and to bring forward 3R capacity in developing countries.

## **10.3 Voluntary Initiatives**

### **10.3.1 Automotive Product Group**

Automobile manufacturers are challenged to comply with end-of-life regulations and recycling targets, and different strategies and approaches have emerged. The following are examples of voluntary industry initiatives under way:

#### *10.3.1.1 Recycling Initiatives (Co-operations and Partnerships)*

##### *Consortium for Automotive Recycling & Disposal<sup>115</sup>*

- A collaborative project involving main motor vehicle manufacturers and importers and vehicle dismantlers in the United Kingdom. The main objective is to research and technically improve materials for reuse and recycling processes and reduce the amount of vehicle waste destined for the landfill.

##### *Renault & Sita Recycling Joint Venture<sup>116</sup>*

- An example of automobile manufacturers partnering with waste management companies to develop a recycling program to achieve recovery rates of 95 per cent, as required by the European Union's ELV Directive.

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<sup>115</sup> CARE Group UK, 2008.

<sup>116</sup> Greenbiz, 2008.



### U.S. Council for Automotive Research

- A collaborative research centre for Chrysler LLC, Ford Motor Company and General Motors Corporation. Various working groups are in place, including the **Vehicle Recycling Partnership**—a joint research and development effort for recycling used parts and disposal of vehicles,<sup>117</sup> and Design for Recyclability; and **U.S. Automotive Material Partnership**—a partnership focused on developing materials and processes for high volume production of more recyclable vehicles.<sup>118</sup>

#### 10.3.1.2 Recycling Technologies

##### *Development of Dismantling Technologies*<sup>119</sup>

The Toyota Automobile Recycle Technical Center has improved the wire harness removal tool to reduce the removal time, using a chain instead of hook to avoid slippage.

##### *Wire harness recycling*<sup>120</sup>

Toyota has developed a high-precision sorter to separate wire harnesses. The plastic shield and connectors are removed, and the remaining copper (of 97 per cent purity) is recycled.

##### *ASR Recycling/Recovery*<sup>121</sup>

Together with Toyota Metal Company, Toyota built the ASR Recycling Plant in 1988, the world's first mass-production recycling plant with a recycling capacity of 15,000 vehicles per month. Toyota developed unique dry separation, sorting and recycling technologies to recover various materials from ASR, including non-ferrous metals sorting using vibrations. To advance ASR recycling and recovery technologies, the plant uses ASR as a fuel in electricity generation furnaces, and began verification testing of an ASR resin sorting method in 2007.

##### *VW SiCon Process*<sup>122</sup>

- The Volkswagen SiCon Process is a post-shredder technology that separates shredder residues into different fractions (non-ferrous metals, shredder granulate, shredder fluff, shredder sand, PVC fraction, and residues). The VW SiCon Process is currently the only method that separates copper out from other materials with silicate enriched sand.

<sup>117</sup> USCAR, 2006b.

<sup>118</sup> USCAR, 2006a.

<sup>119</sup> Toyota Motor Corporation, 2008.

<sup>120</sup> Toyota Motor Corporation, 2002.

<sup>121</sup> Toyota Motor Corporation, 2007.

<sup>122</sup> Volkswagen, 2007.

### 10.3.1.3 Design for Disassembly (DfD) and Design for Recycling (DfR) Initiatives

#### Improvement of wire harness layout<sup>123</sup>

- To achieve a 95 per cent recoverability rate for all new automobile models released in Japan, Nissan improved the layout of the wire harness for increased recoverability.<sup>124</sup>

#### OPERA Recycling Simulation System<sup>125</sup>

- This tool, developed by Nissan and Renault, conducts recycling simulations at the development stage to calculate the recycling rate and costs based on design data.

### 10.3.2 Building and Construction Product Group

In the building and construction industry, green building initiatives are the key driving force behind environmentally preferable material selection. These initiatives influence architects, engineers and other building professionals to select materials that are highly recyclable, contain increased recycled content or have other environmental benefits.

The **World Green Building Council**, an international association of various green building councils, created the emerging council membership category to “endorse, provide recognition, support and establish a formal relationship to organisations that are in the process of forming a council.”<sup>126</sup> Green building initiatives vary by region, but are quickly gaining acceptance on a global scale. Green building initiatives and councils have started up throughout the world, with some modelling themselves after the U.S. LEED process while others model themselves after the life cycle approach used in the U.K.’s BREEAM process.

### 10.3.3 Electrical and Electronic Equipment Product Group

Our research identified numerous voluntary EEE initiatives. Below we have provided a listing of some of the more important international efforts.

**Solving the E-Waste Problem (StEP)**,<sup>127</sup> a global partnership involving the United Nations, industry, governments, NGOs and academia, aims to harmonize policy and legislative approaches to

<sup>123</sup> Nissan Motor Company, 2006a.

<sup>124</sup> Nissan Motor Company, 2006c.

<sup>125</sup> Nissan Motor Company, 2006b.

<sup>126</sup> World Green Building Council, 2010.

<sup>127</sup> StEP, 2010.

electronic recycling and to standardize recycling processes. Five task forces work to find feasible and environmentally safe solutions for e-waste through analysis, planning and pilot projects.

The **Mobile Phone Partnership Initiative (MPPI)**<sup>128</sup> was launched in 2002 as a pilot project for future partnerships between the Basel Convention and industry.<sup>129</sup> Leading mobile phone manufacturers signed the declaration of Basel Convention MPPI to promote environmentally sound management of used and end-of-life mobile phones. Additional goals included promoting changes in public behaviour; promoting state of the art repair, refurbishment and recycling; implementing extended producer responsibility; and raising awareness and providing training on environmentally sound management.

More recently, the Basel Convention developed the **PACE** program to deal with e-waste issues associated with personal computers. The initiative is structured in a similar way to MPPI, with task forces to promote best practices around recycling end-of-life computers.

Product-specific recycling schemes also exist on national levels, such as the **U.S. Call2Recycle**<sup>130</sup> program for cell phones and rechargeable batteries, or the **Electronics Take-Back Campaign**.<sup>131</sup>

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<sup>128</sup> INFORM, 2003.

<sup>129</sup> Basel Convention, 2010.

<sup>130</sup> Call2Recycle, 2010.

<sup>131</sup> Electronics Take Back Coalition, 2010.

## 11.0 Appendix B: Copper Supply Chain Policies—Flow D

### 11.1 Foreign National Legislation

#### 11.1.1 Tax Legislation

Tax legislation was perhaps the most talked about policy within the mining sector in 2010 as a result of the Australian government's proposed Resource Super Profits Tax (RSPT). The intention of the new tax, at a rate of 40 per cent on profits, was to provide a more appropriate return to the Australian community from the exploitation of its non-renewable resources. According to the Australian government, the previous resource charging arrangements failed to collect an appropriate return for the community from private firms, largely due to those arrangements not responding to changes in profits.<sup>132</sup> After much opposition from mining companies, the Australian government reduced the rate to 30 per cent on profits in a proposed Minerals Resource Rent Tax. Nonetheless, Australia's tax proposals highlight current international trends in resource charging toward profit-based royalties.

A meaningful comparison of profit-based tax rates among countries is difficult to make due to variability across jurisdictions in the measurement of the tax base. However, one way to do it is to develop a financial model. A 2006 World Bank publication<sup>133</sup> presents the results of a copper mine financial model applied to the tax systems in over 20 nations (see Table 11.1 for results in selected jurisdictions). Measures of the effective tax rate in each nation were calculated based on all major taxes and fees paid to government, including royalties. Such models are particularly useful for looking at the impact of a mix of taxes and incentives on international competitiveness.

**Table 11.1 Comparative tax rates for a model copper mine in selected jurisdictions.**

Country	Foreign Investor's Internal Rate of Return (%)	Total Effective Tax Rate (%)
<b>Lowest taxing quartile</b>		
Western Australia	12.7	36.4
Chile	15.0	36.6
Zimbabwe	13.5	39.8
China	12.7	41.7
<b>Second lowest taxing quartile</b>		
South Africa	13.5	45.0
Philippines	13.5	45.3

<sup>132</sup> Australian Government, 2010.

<sup>133</sup> World Bank, 2006.

Indonesia	12.5	46.1
<b>Second highest taxing quartile</b>		
Peru	11.7	46.5
Tanzania	12.4	47.8
Arizona (United States)	11.0	49.9
Mexico	11.3	49.9
<b>Highest taxing quartile</b>		
Ghana	11.9	54.4
Mongolia	10.6	55.0
Cote d'Ivoire	8.9	62.4
Ontario (Canada)	10.1	63.8

To obtain any target level of taxation or revenue, governments have a wide variety of options from which to choose. Most nations may have little or no flexibility with regard to some types of tax rates, for example, the income tax rate or the withholding tax rate. An exception to rate inflexibility is often royalty or sector-specific tax. Because it is unique to the mining sector, such mineral royalties are perhaps politically easier to modify from time to time than taxes that apply to all sectors.

In nations without royalty tax, there is from time to time pressure to impose them (such as the recent situation in Australia). In 2000, the mineral-producing nations of Chile, Greenland, Mexico, Peru, South Africa, Sweden and the United States did not impose any royalty taxes. Since then, Peru, South Africa and Chile have all introduced royalties, and in the United States, calls for federal-level royalties have intensified. In 2010, Chilean President Sebastián Piñera proposed a reform to mineral royalties aimed at raising up to \$1 billion to help pay for rebuilding after a massive earthquake. In most nations where minerals are the property of the state or of the people collectively, some sort of royalty is imposed.

Although Zambia was not one of the countries included in the 2006 World Bank financial model, several sources suggest that it would likely fall in the second lowest taxing quartile,<sup>134,135</sup> with a slightly higher total effective tax rate than South Africa. The Zambian Ministry of Mines and Minerals Development states on its website that “surcharges on mineral production compare very favourably with most countries in terms of royalties and taxes, and a number of financial incentives have been created specifically to encourage investment in the mining industry.”

As with any legislation, it is not just the law but also the capacity of the government to enforce the law that matters. NGOs and lending institutions have expressed concern that in Zambia, there is

<sup>134</sup> Regional Program on Enterprise Development, 2003.

<sup>135</sup> Fraser Institute, 2010.

insufficient capacity in government to validate that what mining companies pay is actually what they should pay in taxes and duties.<sup>136</sup>

### 11.1.2 Labour Legislation

The type of labour legislation that is most relevant to primary copper industry is mine safety regulation. Mine safety regulation varies from country to country, particularly with respect to inspection and enforcement.

In **Australia**, each of the mining states has an independent mines inspectorate. There have been major reforms over the last few years to the legislation of Australia's mining states. Queensland made major changes to its mine safety legislation in 1999. New South Wales enacted occupational health and safety legislation in 2000 and mine-specific statutes came into force in 2006–2007. Western Australia amended its mine-specific legislation in 2009. Despite this patchwork approach, mine safety regulations in Australia have clearly driven improved performance. According to a 2004 study, the majority of Australian mining companies are aware of serious punitive consequences being imposed on organisations in their sector and this knowledge impacts their own risk management.<sup>137</sup>

In **Chile**, mine safety regulations are enforced at the federal level by the National Geology and Mining Service. Applicable provisions are contained in the Mine Safety Regulations and the National Geology and Mining Service Act. According to the U.S. Department of State, the Chilean government effectively enforces such labour standards.<sup>138</sup>

In **Zambia**, however, the effectiveness of mining sector regulation is hampered by a shortage of skilled inspectors and resources to physically inspect the mining sector. Haglund (2008) points out that the Mines Safety Department is particularly suffering from chronic underfunding.<sup>139</sup>

### 11.1.3 Environmental Legislation

Environmental legislation affecting the primary copper industry may be divided into two major areas: (1) pollution control, and (2) resource conservation and management. Laws dealing with pollution are often limited to a single environmental medium (e.g., air, water, soil) and control emissions into the medium as well as liability for exceeding permitted emissions and cleaning up any resultant pollution. The principal air pollutants emitted from copper smelting are sulphur dioxide

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<sup>136</sup> Haglund, 2008.

<sup>137</sup> Gunningham, 2007.

<sup>138</sup> United States Bureau of Democracy, Human Rights, and Labor, 2007.

<sup>139</sup> Haglund, 2008.

and particulate matter (and in some cases, arsenic). The following discussion focuses on measures to reduce sulphur dioxide emissions as a proxy for other pollutants.

There are no internationally agreed upon standards for emissions of sulphur dioxide. Such a target would be controversial because ecosystems exhibit different levels of sensitivity to sulphur dioxide and so a uniform emissions target can be too stringent for some localities and too lax for others. As such, emission limits for sulphur dioxide not only vary from country to country, but can also vary from state to state and even from municipality to municipality.

In **Australia**, for example, the national, state and territory governments have agreed on a National Environment Protection Measure for Ambient Air Quality. The Measure includes national standards for six key pollutants, including sulphur dioxide.<sup>140</sup> To meet this goal, state and territory governments grant industrial emitters such as copper smelters a licence to emit a certain level of sulphur dioxide, depending on factors such as meteorological conditions and proximity to populated areas.

In **Chile**, the approach to air pollution control in the mining industry also relies on meeting ambient air quality objectives rather than imposing uniform emission standards based on best available technology. To enforce compliance with air quality standards in areas where limits have been exceeded, the 1994 General Environmental Framework Law requires that an air clean-up plan be developed. Since the early 1990s, air clean-up plans have set sulphur dioxide emission reduction targets for each of the five state-owned copper smelters. As a result, sulphur dioxide emissions were reduced by more than 70 per cent in 1990–2002. In 1998, an emission reduction timetable for arsenic in particulate matter was set for the country's seven copper smelters.<sup>141</sup>

In **Zambia**, a National Conservation Strategy (NCS) was formulated in 1985 to address environmental problems facing the country. The NCS led to the Environmental Protection and Pollution Control Act (EPPCA) in 1990.<sup>142</sup> The Act includes guideline limits for ambient air pollutants, including sulphur dioxide. The Environmental Council of Zambia (ECZ, one of Zambia's regulatory bodies) is responsible for granting copper producers a licence to emit air pollutants. ECZ is allowed to prescribe intermediate limits that are higher than long-term emission limits. Some NGOs argue that the intermediate limits have been too lax.<sup>143</sup> Haglund (2008) explains that during privatisation in the late 1990s, the Zambian government was advised that it would be prohibitively expensive for incoming firms, who mostly inherited old and poorly maintained technology, to immediately upgrade their systems to achieve compliance with Zambia's statutory

<sup>140</sup> Australian Government, 2005.

<sup>141</sup> Organisation for Economic Co-operation and Development (OECD), 2005.

<sup>142</sup> Kanduza, 2005.

<sup>143</sup> Dymond, 2007.

standards. Consequently, environmental standards that apply to privatized mining companies were set in negotiation with incoming investors and vary among firms: concessions are asset-specific. For example, the Chambishi Metals were given 15 years to comply with environmental regulations and the Konkola Copper Mines were given 20 years to comply.<sup>144</sup>

Laws regarding resource conservation and management generally focus on natural resources such as mineral deposits, forests, animal species or more intangible resources such as especially scenic areas or sites of high cultural value—and the laws provide guidelines for and limitations on the conservation, disturbance and use of those resources.

In **Australia**, there is resource conservation regulation at the federal level (1999 Environment Protection and Biodiversity Conservation Act) requiring that most mine sites submit environmental impact statements when they are in the planning and construction phase of mine operations. Australia also has comprehensive policy and legislation that provides for comprehensive mine closure and for post-mining sustainable development.<sup>145</sup>

The **Chilean** legal framework regarding environmental impact assessment (EIA) was enacted in 1997. Under the law, mining companies wishing to operate in Chile are required to submit mining projects to an EIA, including a phase of public participation through public hearings and comments made by those who may be affected by mining projects.<sup>146</sup> Chile's mining regulations also include closure requirements and provide general guidelines for mine closure, but no detailed legislation on closure guidelines. There is a closure law that was proposed several years ago, but it is still pending approval.<sup>147</sup>

**Zambia** has an Environmental Protection and Pollution Control Act and a number of sectoral laws and regulations. A framework for responsible development has been created through the publication of the Environmental Protection and Pollution Control (EIA) Regulations in 1997. According to Clark (2008), Zambia can be said to have comprehensive policy and legislation that provides for comprehensive mine closure and for post-mining sustainable development.<sup>148</sup>

#### 11.1.4 Trade Legislation

China signed its first-ever free trade agreement with a non-Asian country in 2005, with **Chile**. **Australia** is also currently exploring the possibilities of a free trade agreement with China.

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<sup>144</sup> Kanduzi, 2005.

<sup>145</sup> Clark, 2008.

<sup>146</sup> Bastida et al., 2005.

<sup>147</sup> Garcia, 2008.

<sup>148</sup> Clark, 2008.



## 11.2 Multilateral Treaties

### 11.2.1 United Nations Framework Convention on Climate Change (UNFCCC)

The **Kyoto Protocol** entered into force on February 16, 2005, with the first four-year commitment period commencing in 2008. Under the Protocol, 34 industrialized countries have committed themselves to a reduction of greenhouse gases, to targets that are set in relation to their 1990 emission levels. The treaty permits emission increases of 8 per cent for Australia from its 1990 levels. As non-Annex I Parties (i.e., developing countries), China, Chile and Zambia are not obliged to reduce their greenhouse gas emissions.

The **Copenhagen Accord** was drafted by the United States, China, India, Brazil and South Africa on December 18, 2009. It was “taken note of,” but not “adopted,” in a debate of all the participating countries the next day. The document recognized that climate change is one of the greatest challenges of the present day and that actions should be taken to keep any temperature increases to below 2°C. The document is not legally binding and does not contain any legally binding commitments for reducing carbon dioxide emissions. Many countries and NGOs were opposed to this agreement but, as of July 15, 2010, 136 countries have signed the agreement, including Australia, China, Chile and Zambia.<sup>149</sup>

**Australia** committed to unconditionally reduce its emissions by 5 per cent below 2000 levels by 2020, to reduce its emissions by up to 25 per cent with a global agreement, and to reduce its emissions by up to 15 per cent without a global agreement under which major developing economies commit to substantially restrain emissions and advanced economies take on commitments comparable to Australia’s.<sup>150</sup>

As part of the Copenhagen Accord, developing countries were invited to submit nationally appropriate mitigation actions. **China** announced that it would endeavour to lower its carbon dioxide emissions per unit of GDP by 40–45 per cent by 2020, compared to the 2005 level.<sup>151</sup> At the time of writing, **Chile** and **Zambia** had not submitted commitments to UNFCCC on greenhouse gas emissions.

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<sup>149</sup> UNFCCC, 2009.

<sup>150</sup> UNFCCC, 2009.

<sup>151</sup> UNFCCC, 2009.

### 11.2.2 International Labour Organization (ILO) Core Conventions on Labour Rights

The ILO Declaration on Fundamental Principles and Rights at Work, adopted in June 1998, highlights a set of fundamental labour principles endorsed by the international community. These ILO Conventions are at times referred to as the core labour standards<sup>152</sup>:

- Freedom of Association and Protection of the Right to Organise Convention, 1948 (No. 87)
- Right to Organize and Collective Bargaining Convention, 1949 (No. 98)
- Forced Labour Convention, 1930 (No. 29)
- Abolition of Forced Labour Convention, 1957 (No. 105)
- Minimum Age Convention, 1973 (No. 138)
- Worst Forms of Child Labour Convention, 1999 (No. 182)
- Equal Remuneration Convention, 1951 (No. 100)
- Discrimination (Employment and Occupation) Convention, 1958 (No. 111)

The ILO standards are backed by a supervisory system that is unique at the international level and that helps to ensure that countries implement the conventions they ratify. The ILO regularly examines the application of standards in member states and points out areas where they could be better applied. If there are any problems in the application of standards, the ILO seeks to assist countries through social dialogue and technical assistance. As of 2009, there were 183 member states of the ILO, including China, Australia, Chile and Zambia.<sup>153</sup>

## 11.3 International Voluntary Initiatives

In addition to national legislation and multilateral treaties, there are a number of voluntary initiatives influencing the sustainability performance of the primary copper industry. These range from voluntary initiatives of governments to those of lending institutions and industry. We have provided a listing of some of the more important international efforts.

### 11.3.1 Voluntary Government Initiatives

The **Extractive Industries Transparency Initiative (EITI)** is a joint effort by governments, companies, civil society groups, investors and international organizations and is led and managed by the U.K. Government and the Department for International Development (DFID). The EITI mandate is to ensure that revenues from extractive industries contribute to sustainable development and poverty reduction, reduce government corruption in resource-rich countries, and increase

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<sup>152</sup> ILO, 2003.

<sup>153</sup> ILO, 2009.

transparency regarding the payment of taxes and royalties by resource extraction companies, especially in countries plagued by problems of bribery and corruption. As of May 2010, two countries had achieved EITI Compliant Country Status (Azerbaijan and Liberia). Another 29 countries had achieved EITI Candidate Status,<sup>154</sup> including Zambia but not Australia, Chile or China.

The **Voluntary Principles on Security and Human Rights** provide guidance to extractive companies on ensuring the safety of their personnel and the security of their installations in insecure environments while at the same time respecting human rights. The initiative provides practical guidance to companies on how to do this. By ensuring that human rights are upheld, the Voluntary Principles aim to mitigate potential tensions between extractive companies and the communities within which they work. The initiative is led by the governments of the United States, the United Kingdom, Norway, the Netherlands, Canada, Colombia and Switzerland, plus companies operating in the extractive and energy sectors, and NGOs.<sup>155</sup>

The **OECD Guidelines for Multinational Enterprises** are recommendations addressed by governments to multinational enterprises operating in or from adhering countries. They provide voluntary principles and standards for responsible business conduct in areas such as employment and industrial relations, human rights, environment, information disclosure, the combating of bribery, consumer interests, science and technology, competition and taxation. An update to the Guidelines is expected to be released in 2011, with the goal of clarifying or providing further guidance on the application of the Guidelines in the areas of supply chains, human rights, and environment and climate change.<sup>156</sup>

In 2008, **China** issued guidance to its State-owned enterprises, recommending systems for corporate social responsibility (CSR) reporting and protection of labour rights.<sup>157</sup> The government is also currently considering draft “Guidelines on Corporate Social Responsibility Compliance by Foreign Invested Enterprises.”<sup>158</sup> The draft Guidelines explain that CSR is relevant for all companies and comprises three levels: legal compliance; actively balancing stakeholders’ interests while pursuing growth; and voluntary acts that further social progress, economic growth and environmental protection. Among the expectations on companies regarding their employees are the elimination of child labour, forced labour and workplace discrimination. Companies are also recommended to

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<sup>154</sup> EITI, 2010.

<sup>155</sup> Voluntary Principles, 2010.

<sup>156</sup> OECD, 2010.

<sup>157</sup> “Guidelines to the State-Owned Enterprises Directly under the Central Government on Fulfilling Corporate Social Responsibilities,” issued by China’s State-Owned Asset Supervision and Administration Commission on January 4, 2008, available at <http://www.sasac.gov.cn/n2963340/n2964712/4891623.html>.

<sup>158</sup> The draft Guidelines were issued by the Chinese Academy of International Trade and Economic Cooperation, a subsidiary of the Ministry of Commerce. More information is available at [http://www.dlapiper.com/foreign\\_enterprises\\_csr\\_compliance](http://www.dlapiper.com/foreign_enterprises_csr_compliance).

establish a CSR reporting system and to use “reasonable influence to encourage and urge upstream and downstream enterprises to improve CSR standards.”

### 11.3.2 *Voluntary International Standards*

The **ISO 26000 Standard on Social Responsibility** (draft) offers guidance on socially responsible behaviour and possible actions. It does not contain requirements and, therefore, in contrast to ISO management system standards, is not certifiable. The ISO 26000 provides guidance on the underlying principles of social responsibility, on the core subjects and issues pertaining to social responsibility and on ways to integrate socially responsible behaviour into existing organizational strategies, systems, practices and processes. One key component is its guidance to organizations to discuss their social responsibility issues and possible actions with relevant stakeholders. It is expected that the final guidance document will be published in late 2010.<sup>159</sup>

### 11.3.3 *Voluntary Initiatives of Investing Organizations*

The International Finance Corporation’s (IFC’s) **Performance Standards on Social & Environmental Sustainability** defines clients’ roles and responsibilities for managing their projects and the requirements for receiving and retaining IFC support. The standards include requirements to disclose information.

Together, the eight Performance Standards establish standards that the client is to meet throughout the life of an investment by IFC or other relevant financial institution<sup>160</sup>:

- Performance Standard 1: Social and Environmental Assessment and Management System
- Performance Standard 2: Labour and Working Conditions
- Performance Standard 3: Pollution Prevention and Abatement
- Performance Standard 4: Community Health, Safety and Security
- Performance Standard 5: Land Acquisition and Involuntary Resettlement
- Performance Standard 6: Biodiversity Conservation and Sustainable Natural Resource Management
- Performance Standard 7: Indigenous Peoples
- Performance Standard 8: Cultural Heritage

The IFC’s Performance Standards are also commonly applied by other financial institutions electing to apply them to projects in emerging markets. For example, the Performance Standards are

<sup>159</sup> ISO, 2010.

<sup>160</sup> IFC, 2007.

referenced in the **Equator Principles**, a set of voluntary social and environmental standards adopted by 67 financial institutions as of July 2010.

The **Global Reporting Initiative (GRI)** reporting framework sets out the principles and indicators that organizations can use to measure and report their economic, environmental, and social performance. The cornerstone of the framework is the Sustainability Reporting Guidelines. The third version of the Guidelines—known as the G3 Guidelines—was published in 2006. Other components of the framework include Sector Supplements (unique indicators for industry sectors) and National Annexes (unique country-level information).

The GRI Mining & Metals Sector Supplement was developed with the ICMM as co-convenor. The most recent version of the supplement was released in March 2010 and is up to date with the G3 Guidelines. Reporting with the Supplement will be required for GRI Application level “A” reporters published after December 31, 2011.<sup>161</sup>

#### **11.3.4 Voluntary Industry Initiatives**

The ICMM was established in 2001 to act as a catalyst for performance improvement in the mining and metals industry. The organization brings together 19 mining and metals companies as well as 30 national and regional mining associations and global commodity associations to address the core sustainable development challenges faced by the industry.

ICMM member companies have committed to the **ICMM Sustainable Development Framework**. The Sustainable Development Framework comprises three elements—a set of 10 Principles (including a set of supporting position statements), public reporting and independent assurance—each approved by ICMM’s CEO-led Council. In 2010, for the first time, ICMM conducted an assessment of the progress that each member company is making against these performance commitments. The result is a member performance table that lists the achievements of all 19 corporate members and that will be updated on an annual basis.<sup>162</sup>

One of the global commodity association members of ICMM is the International Copper Association (ICA). ICA’s 37 member companies represent a majority of the world’s refined copper output and are among the largest copper producers, copper alloy fabricators, and wire and cable companies in the world.<sup>163</sup>

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<sup>161</sup> GRI, 2010.

<sup>162</sup> ICMM, 2010.

<sup>163</sup> ICA, 2010.

ICA's **Copper Stewardship** initiative, launched in 2005, is "a process for continuously increasing the value to society of copper and copper uses in a responsible, accountable and concerned manner." The voluntary initiative revolves around measuring industry impacts, communicating performance, monitoring improvements, enhancing the customer's value proposition, and promoting system innovation. ICA's programs are focused on copper's major end uses rather than on the mining side of the value chain. For example, ICA coordinates research to conduct LCA and risk assessment studies of copper products.