

Sustainable Development of the Chinese Copper Market

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Abstract

Copper is one of the earliest key metals used by humans. It is ubiquitous across the power, transportation, building and construction, aerospace and related sectors due to its high electrical conductivity and heat transmission. Copper is also a staple constituent of power generators and electronic instruments, and is therefore integral to the development of modern high-tech industries.

With the rapid growth of the Chinese economy over the past decade, the demand for various raw materials, including copper, also has been increasing at a rapid pace. Chinese refined copper production reached 3.79 million tonnes in 2008, 2.8 times that of its production in 2000, and accounts for 20.5 per cent of total world output (18.48 million tonnes); as a result, China is now the largest refined copper producer in the world. Chinese consumption of refined copper in 2008 was 5.2 million tonnes, 2.6 times that of its consumption in 2000, accounting for 28.8 per cent of the world's total (18.02 million tonnes); China has also been the world's largest copper consumer for seven consecutive years. For more than ten years, China has experienced faster growth in copper production and consumption than all other countries.

The rapid growth in production and consumption also has resulted in a series of challenges for the Chinese economy, including the depletion of Chinese copper reserves, increased imbalances in the Chinese industrial structure, and growing stresses on the international trading system.

The following analysis provides a basis for a more strategic development of the Chinese copper industry, in accordance with the basic principles of sustainable development. The purpose of the paper is to provide a reference for government authorities to draft macroeconomic policies to apply the model of economic growth and promote not only a rapid but a socially and environmentally sustainable development of the Chinese copper industry.

Table of Contents

Abstract	ii
1.0 Foreword	1
2.0 Analysis of the Framework of Supply Chain.....	3
3.0 Current Situation of Chinese Production of Copper Products and Development Trends.....	5
3.1 Current Situation of Chinese Copper Concentrate Production and Development Trend	5
3.2 Current Situation of Chinese Refined Copper Production and Development Trend	5
3.2.1 <i>Current Situation of Chinese Copper Blister Production</i>	5
3.2.2 <i>Current Situation of Chinese Refined Copper Production</i>	5
3.2.3 <i>Current Situation of Chinese SX-EW (Solvent Extraction/Electrowinning) Copper Production</i>	5
3.2.4 <i>Development Trend of Chinese Refined Copper Production</i>	6
3.3 Current Situation of Chinese Copper Semis Production and Development Trend.....	6
3.4 Current Situation of Recycling Copper Scrap in China and Development Market Trend	7
3.5 Current Situation of Chinese Import and Export of Copper Products and Development Trend	8
3.5.1 <i>Overview of Foreign Trade of Copper Products</i>	8
3.5.2 <i>Foreign Trade of Copper Raw Materials</i>	9
3.5.3 <i>Import and Export of Refined Copper and Copper Semis</i>	9
3.5.3.1 <i>Import and Export of Refined Copper and Copper Alloy</i>	9
3.5.3.2 <i>Import and Export of Copper Semis</i>	9
3.6 Chinese Copper Consumption Level and Development Trend	10
3.6.1 <i>Copper Consumption Status</i>	10
3.6.2 <i>Consumption Structure</i>	11
3.6.3 <i>Consumption Trends</i>	11
4.0 Chinese Copper Industry Chain Organization Analysis (Business Administration)	12
4.1 Copper Mine and Smelting Enterprise Conditions (output 2005–2008)	12
4.2 The Profiles of Copper Fabricators	12
4.3 Chinese Industrial Associations	13
5.0 The Social Influence of the Chinese Copper Products Chain.....	15
5.1 Economy development	15
5.1.1 <i>Contribution to the National Financial Revenue</i>	15

5.1.2	<i>The Copper Industrial Contribution to the Nation's Employment</i>	16
5.2	Occupational Environment	16
5.2.1	<i>Occupational Health and Safety Protection</i>	16
5.2.2	<i>Labour Intensity</i>	17
5.2.3	<i>Human Rights Protection and Labour Protection</i>	17
5.2.4	<i>The Fulfilment of the Social Responsibility of China's Multinational Corporations</i>	17
5.2.4.1	<i>Dependence on Advanced Technology to Protect the Local Environment</i>	17
5.2.4.2	<i>Chinese Enterprises: Aid and Assistance</i>	17
5.2.4.3	<i>Conscientious Measures and Compliance</i>	18
5.2.4.4	<i>Local Focus</i>	18
5.2.4.5	<i>Respect and Protection of Local Culture, Tradition, Rights and Interests of Employees</i>	18
5.3	Analysis Regarding Social Influence.....	18
5.3.1	<i>Public Safety and Health</i>	18
5.3.2	<i>Promoting Social and Economic Development</i>	19
5.4	Impact on International Society.....	19
5.5	Conclusion	20
6.0	Policy on Copper.....	21
6.1	Laws and Regulations Related to the Copper Industrial Chain or Copper Products	21
6.1.1	<i>Industrial Policy</i>	21
6.1.1.1	<i>Current Industrial Policy</i>	21
6.1.1.2	<i>Catalogue for the Guidance of Foreign Investment Industries (Amended in 2007)</i>	25
6.1.1.3	<i>Support Plan for Nonferrous Metals Industry (Announced by the State Council on 11 May 2009)</i>	25
6.1.2	<i>Policy on Imports and Exports</i>	26
6.1.3	<i>Future Copper Policy Considerations</i>	28
References	29

List of Tables

Table 3.1	Proportions of domestic raw materials in the refined copper output (kilotonnes).....	5
Table 3.2	Chinese solvent extraction/electrowinning (SX-EW) copper output, 2001–2009 (kilotonnes).....	6
Table 3.3	Foreign trade of copper products, 2005–2008 (US\$ million).....	8
Table 3.4	Import and export weights of copper products, 2003–2008 (kilotonnes).....	8
Table 3.5	Chinese copper import, 2008 (tonnes). H1=first half of year, H2=second half of year.	9
Table 3.6	Import and export of copper semis (all kinds), 2008 (tonnes).....	10
Table 3.7	Apparent consumption of copper, 2001–2008 (kilotonnes).....	11
Table 3.8	Chinese copper consumption, 2007 and 2008 (kilotonnes).....	11
Table 4.1	Output of top five Chinese refined copper producers, 2005–2008 (kilotonnes).....	12
Table 4.2	Output of China’s copper fabricators, 2005–2008 (tonnes).....	13

List of Figures

Figure 2.1	Framework of the copper supply chain.....	4
Figure 3.1	Recycled copper production, 2002–2008.....	7
Figure 5.1	Pretax profit in copper industry.....	16

1.0 Foreword

Chinese refined copper production reached 3.79 million tonnes in 2008, accounting for 20.5 per cent of the world's total and making China the single largest copper producer globally. During the same year, the sales revenue of the refined copper industry in China was US\$295.7 billion, accounting for 29.6 per cent of the country's total nonferrous smelting industry, reflecting the overall importance of refined copper to the Chinese economy. In addition, the import and export of copper products has been highly dynamic in recent years. Statistics from China Customs show the import and export value of copper products in 2008 was US\$40.75 billion, accounting for a 46.6 per cent trading surplus of nonferrous metals. Since China has become the largest global producer and consumer of refined copper and the biggest importer of raw materials, the eyes of the world have been upon the Chinese copper industry.

Box 1: Research scope.

Copper products are becoming an increasingly important part of the Chinese economy and come in a wide range of formats and products, including:

- Copper products: refined copper, copper alloys, copper fabricated products;
- Copper making raw materials: copper concentrate, copper scrap;
- Copper metal: refined copper, copper alloys; and
- Copper fabricated products: tube, rod, bar, wire, sheet, strip, plate, foil.

This report, which draws from a partial life cycle analysis of the Chinese copper supply chain covering the extraction, processing and disposal phases of the copper life cycle, seeks to identify key sustainability hotspots for the Chinese copper supply chain from a Chinese perspective. It also seeks to summarize existing policy strategies for addressing systemic sustainability challenges within the supply chain as a basis for further policy and industrial development.

As environmental sensitivities and pressures increase around the planet, the sustainability impacts of the expanding copper sector and China's role in the global copper supply chain are becoming increasingly important factors in analysis and policy development. Already these pressures have stimulated the phasing out of outdated technology within the sector. And yet, at the same time, the growth of the copper industry within China that is needed to meet economic demand is generating major resource and environmental challenges for the sector. The purpose of this study is to analyze the structure of the Chinese copper supply chain, identify key challenges for sustainable development within the Chinese copper industry, and summarize current policy strategies as a basis for further policy and industrial development.

IISD's Global Commodity Chain Sustainability Analysis (GCCSA) has been used as a reference for this study; The GCCSA is a methodology for deriving suggestions on policy and strategic development within the special conditions of global supply chains and international markets. The basic features of the GCCSA include a combined analysis of global market structure and market trends, social and environmental impacts along the global supply chain, and an analysis of the supply chain management and policy framework as a basis for identifying practical policy recommendations that address major sustainability hotspots. Analysis of the life cycle, impacts on sustainable development and decision-makers in the supply chain, and actual supply chain decision-making structures are all combined in the GCCSA to provide a realistic and market-based approach to sustainable policy development.

Our analysis is also unique in the manner in which it has been designed to feed into a broader global discussion—one that includes Chinese and international experts alike—on copper sustainability. This is a critical feature of the research and policy development approach that must, at its heart, recognize the mutual responsibilities of the international and Chinese communities in addressing the *global* sustainability challenges of the *global* copper supply chain. We begin below with a review of the structure of the copper product chain, from a Chinese perspective.

2.0 Analysis of the Framework of Supply Chain

The copper industry is a basic raw material sector; copper is one of the most widely traded metals in the world. For the purposes of this analysis, copper is divided into four stages: raw materials supply, manufacturing, consumption, and recycling and reutilization (see Figure 2.1). The entire chain includes mining, smelting, fabricating, consumption, recycling and reutilization. The copper supply chains in China and the rest of the world are closely related, with new and used product moving in and out of the Chinese supply chain along the way.

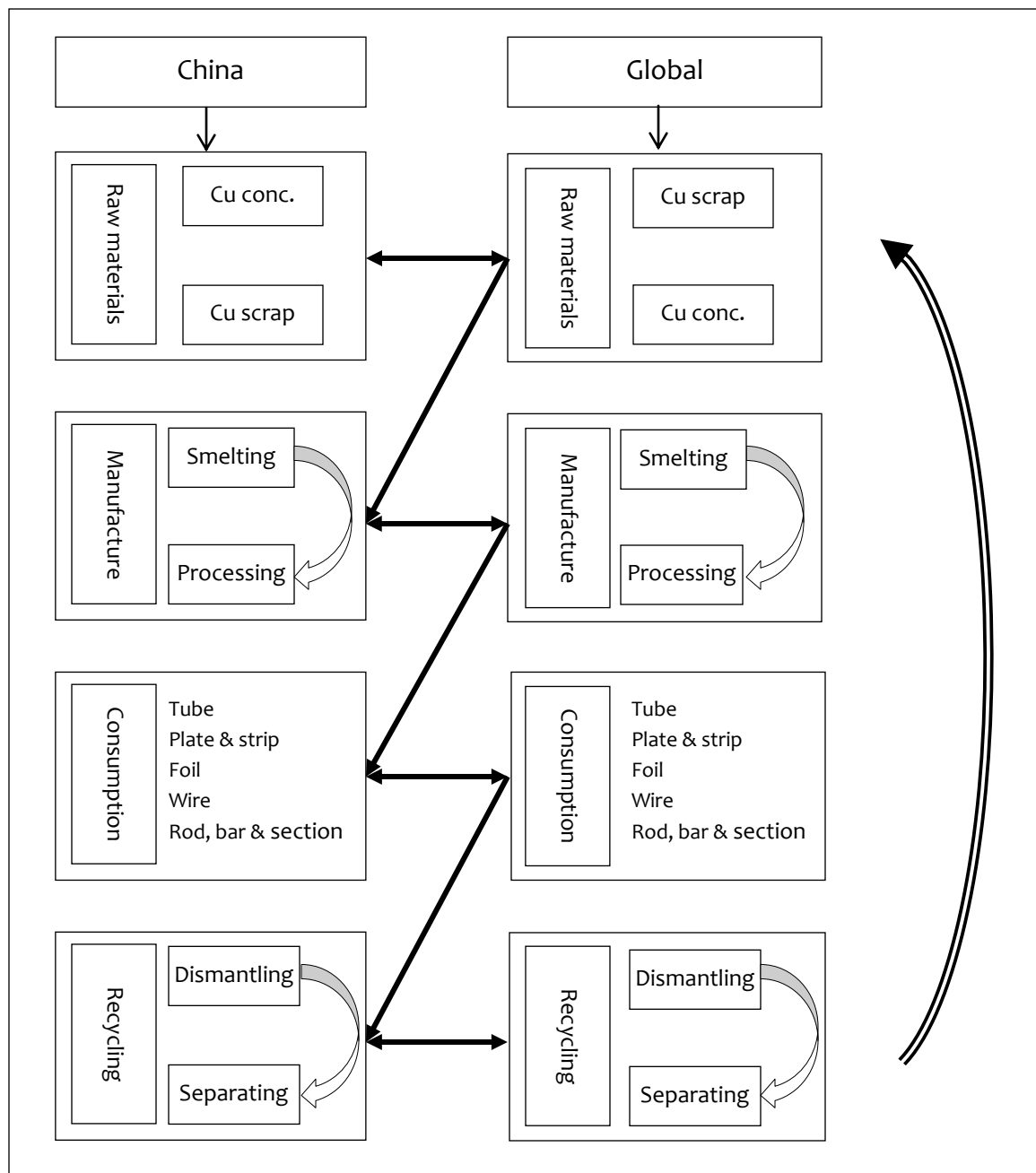


Figure 2.1: Framework of the copper supply chain.

3.0 Current Situation of Chinese Production of Copper Products and Development Trends

3.1 Current Situation of Chinese Copper Concentrate Production and Development Trend

With limited copper reserves, China has no significant comparative advantage in the production of copper ores. As a result, its output of copper concentrates historically has been relatively flat. More recently and fuelled by the intensive demand for copper, this has changed somewhat with an average annual growth rate of 6.68 per cent between 2000 and 2008. This growth rate is still significantly lower than the growth of China's production of refined copper over the same period. Copper extraction occurs mainly in Jiangxi, Yunnan, Anhui, Inner Mongolia, Gansu and Hubei.

Table 3.1: Proportions of domestic raw materials in the refined copper output (kilotonnes).

Products	2006	2007	2008	2009
Output of copper in concentrate	872.9	928.0	1,076.0	1,000.0
Output of refined copper	3,003.2	3,496.9	3,794.6	4,050.0
Self-sufficient rate (%)	29.07	26.54	28.35	24.69

3.2 Current Situation of Chinese Refined Copper Production and Development Trend

3.2.1 Current Situation of Chinese Copper Blister Production

There are more than 30 copper smelters in China at present, mainly based in Jiangxi, Anhui, Gansu, Yunnan, Shandong and Hubei. Chinese copper blister output was 2.45 million tonnes in 2008.

3.2.2 Current Situation of Chinese Refined Copper Production

There are over 100 copper refineries in China at present, mostly located in Jiangxi, Anhui, Shandong, Gansu and Yunnan. Chinese copper cathode output was 3.79 million tonnes in 2008.

3.2.3 Current Situation of Chinese SX-EW (Solvent Extraction/Electrowinning) Copper Production

In recent years, Chinese SX-EW copper output has increased quickly, growing to approximately 95 kilotonnes in 2008. In terms of the SX-EW copper production structure, the proportion from

copper mines is relatively low because most of the SX-EW copper is a by-product of gold smelters within China.

One of the clear conclusions to be drawn from the production and consumption trends within China is that Chinese copper resources cannot completely meet the country's demand as economic development continues to grow. So, using the low-grade copper ores, hard-processed mixed ores and ultra-low copper-grade waste ores is an important direction in developing copper resources. The SX-EW copper technology has the advantage of requiring a relatively small investment, with relatively low levels of pollution to the environment and low operation cost. These features give SX-EW a bright future within the Chinese copper industry.

Table 3.2: Chinese solvent extraction/electrowinning (SX-EW) copper output, 2001–2009 (kilotonnes).

	2001	2002	2003	2004	2005	2006	2007	2008	2009
SX-EW copper output	15	20	25	25	35	51	76	95	100
Proportion of Chinese SX-EW copper output to copper in concentrate output (%)	1.35	1.70	1.80	1.56	1.77	2.48	3.53	4.17	3.72
Proportion of Chinese SX-EW copper output to Chinese refined copper output (%)	0.98	1.25	1.38	1.15	1.33	1.68	2.37	2.75	2.53

Source: Beijing Research Institute of Mining & Metallurgy.

3.2.4 Development Trend of Chinese Refined Copper Production

In the next 5 to 10 years, it is expected that production scale of Chinese copper smelting enterprises will continue to increase as industrial concentration grows and outdated technologies are phased out of the market. The expansion of capacity and output of the copper smelting enterprises will assist in satisfying growing domestic demand to some extent and also help to enhance the competitiveness of the whole copper industry.

3.3 Current Situation of Chinese Copper Semis Production and Development Trend

According to incomplete statistics, in 2008 there were more than 2,000 copper fabrication enterprises with a slightly enhanced industrial concentration compared with that found in 2000. The distribution of Chinese copper semis production is relatively concentrated in the Pearl River Delta, Yangtze River Delta, Bohai Ring and other developed regions, along with distribution associated with the electric, electronic, instrument and metre, household electric appliances, hardware and light industries. Chinese copper semis output was 8.36 million tonnes in 2008.

3.4 Current Situation of Recycling Copper Scrap in China and Development Market Trend

The secondary copper sector is an important part of both the Chinese copper industrial chain and building of the self-sufficient economy and energy-efficient society. The Chinese secondary copper industry has grown rapidly in recent years in terms of industrial scale, structure, technology and facility, as well as in terms of environmental protection. Because the supply of copper raw materials remains limited worldwide, Chinese secondary copper output has expanded quickly in recent years, up to 1.90 million tonnes in 2008 from 880 kilotonnes in 2002 and accounting for 37.8 per cent of total output of secondary nonferrous metals in China in 2008. The secondary copper sector has been one of the most dynamic sectors in the Chinese nonferrous metals industry.

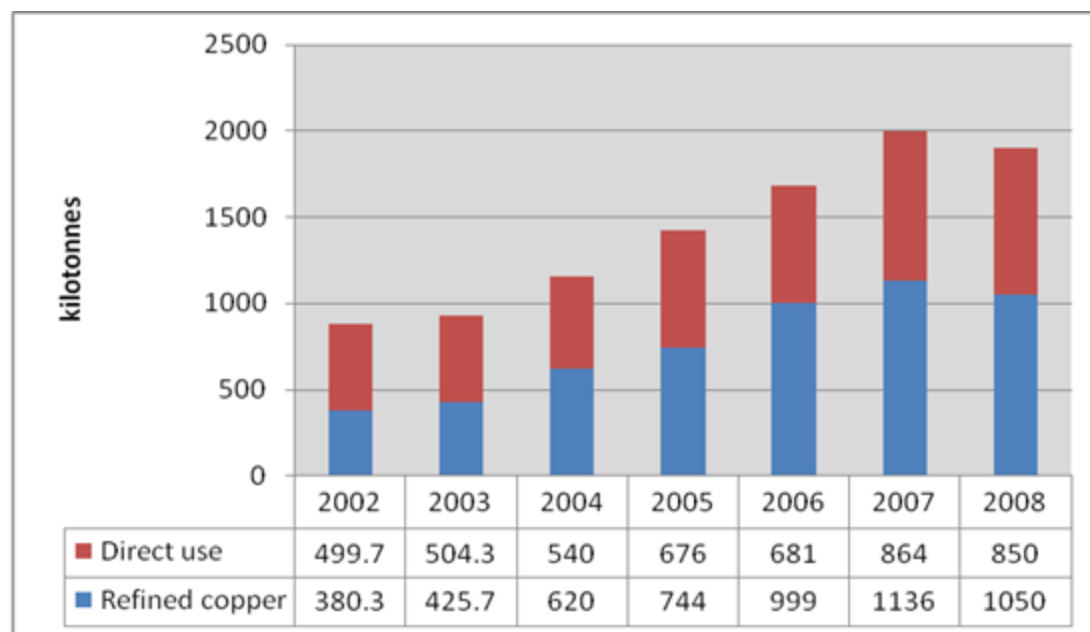


Figure 3.1: Recycled copper production, 2002–2008.

Copper scraps play a key role in the supply of copper raw materials in China. In 2008, China imported 5.57 million tonnes of copper scraps, containing around 1.12 million tonnes of copper metal. In 2008, the nation recycled about 780 kilotonnes of copper (metal contained). Importantly, secondary copper supply represented around 30 per cent of Chinese total copper consumption.

3.5 Current Situation of Chinese Import and Export of Copper Products and Development Trend

3.5.1 Overview of Foreign Trade of Copper Products

Along with the increasing demand for copper products and growing production capacity of copper smelting and fabrication in China, domestic demand for copper raw materials will continue to rise as a result of its own internal economic and industrial development. Therefore, foreign trade of copper products also will continue to rise at a rapid pace for the foreseeable future. The foreign trade deficit of copper products continued to increase in 2008; this can be seen in Table 3.3. The foreign trade deficit of copper products was US\$30.686 billion, which accounted for 86.34 per cent of the total foreign trade deficit of nonferrous metals. It is expected that the copper supply chain will generate a foreign trade deficit for the foreseeable future as well.

Table 3.3: Foreign trade of copper products, 2005–2008 (US\$ million).

Copper products	2005	2006	2007	2008
Total foreign trade value	18,843.12	27,784.69	39,645.81	40,752.87
Export value	2,632.78	5,210.63	4,775.31	5,033.26
Import value	16,210.34	22,574.06	34,870.50	35,719.52
Foreign trade deficit	13,577.56	17,363.43	30,095.19	30,686.26

As to the foreign trade structure, copper raw material import has showed a growing trend year after year.

Table 3.4: Import and export weights of copper products, 2003–2008 (kilotonnes).

	2005		2006		2007		2008	
	Import	Export	Import	Export	Import	Export	Import	Export
Refined copper	1,283.0	140.0	880.0	243	1,552.6	126.1	1,504.0	96.4
Copper semis	1,118.0	464.0	1,092.0	559	1,053.8	499.7	934.9	517.6
Copper blister	129.0	3.7	88.0	2.7	172.8	0	197.5	6.1
Copper concentrate	4,059.0	0.9	3,612.0	0.1	4,516.1	0.6	5,192.0	2.4
Copper scrap	4,821.0	6.4	4,942.0	6.7	5,584.6	5.0	5,576.9	3.3

As to the foreign trade partners of copper products, the key import origins and export destinations changed little in 2008, compared with 2007. Chile, Japan and Taiwan remained in the leading positions in the list of Chinese import value of copper products by origin, and the Hong Kong region, South Korea and the United States were in the leading positions in the list of Chinese export value of copper products by destination.

3.5.2 Foreign Trade of Copper Raw Materials

Because China is lacking in copper resources, its imports of copper concentrate and copper scrap have been significant in recent years. The Chinese import of copper concentrate was 5.19 million tonnes in 2008, making China the single largest importer of copper concentrate in the world.

The primary suppliers of mined copper ore in 2008 were Chile, Peru and Mongolia. There are more than 120 overseas suppliers of copper scraps for China, but a small number of western countries provide the vast majority of copper scraps. The major origins of imported copper scrap are Japan, Spain, the United States and the Hong Kong region, of which the import of copper scrap from Japan accounted for 36.93 per cent of the Chinese total in 2008.

3.5.3 Import and Export of Refined Copper and Copper Semis

3.5.3.1 Import and Export of Refined Copper and Copper Alloy

Chinese refined copper and copper alloy imports and exports held stable at 1.2 million tonnes during 2002–2005. Refined copper imports slid to 880 kilotonnes, due to soaring copper prices in 2006. Copper imports increased to 1.55 million tonnes per year in 2007–2008, promoting domestic demand.

Table 3.5: Chinese copper import, 2008 (tonnes). H1=first half of year, H2=second half of year.

Product		2007	2008					
			H1	% H1 growth from 2007	H2	% growth from H1 to H2	Year total	% yearly growth from 2007
Refined copper	Import	1,493,701	687,013	-23.20	769,362	11.99	1,456,375	-2.50
	Export	125,914	61,516	47.50	34,599	-43.76	96,115	-23.67
Copper alloy	Import	59,663	28,880	-1.16	19,216	-33.46	48,096	-19.39
	Export	663	189	-42.90	273	44.44	462	-30.32

China refined copper imports have come primarily from Chile, Japan and Kazakhstan; 738.5 kilotonnes of refined copper were imported from Chile in 2008, which accounted for 51 per cent of total imports to China that year. Copper alloy imports are very small each year, approximately 50 kilotonnes.

3.5.3.2 Import and Export of Copper Semis

Chinese copper semis imports have decreased while exports have increased year by year. Affected by the financial crisis in 2008, copper semis imports dropped 11.27 per cent year to year to 935 kilotonnes. Export was 517.6 kilotonnes, up by 3.56 per cent year to year.

Domestic copper semis producers primarily supply domestic demand. Copper semis import enterprises, on the other hand, are primarily foreign-owned enterprises, accounting for 57.58 per cent. Joint venture exports accounted for 38.72 per cent and foreign enterprises accounted for 22.61 per cent of semis exports in 2008.

Table 3.6: Import and export of copper semis (all kinds), 2008 (tonnes).

Product		2007	2008	% Y/y
Profile	Import	112,898	91,074	-19.33
	Export	9,879	8,331	-15.67
PSS	Import	243,529	200,082	-17.84
	Export	38,900	38,632	-0.69
Foil	Import	329,616	288,708	-12.41
	Export	167,069	146,051	-12.58
Tubes and pipes	Import	36,641	33,931	-7.4
	Export	264,323	303,908	14.98
Wire	Import	326,215	317,105	-2.79
	Export	17,011	17,524	3.02
Powder	Import	4,911	4,083	-16.86
	Export	2,496	3,104	24.36

3.6 Chinese Copper Consumption Level and Development Trend

3.6.1 Copper Consumption Status

China has been the largest consumer of refined copper for the better part of the last decade. Chinese refined copper consumption ranked first globally (2.78 million tonnes) in 2002. In 2008, Chinese refined copper consumption reached 5.2 million tonnes, maintaining China's place as the largest global consumer.

Industries with long-term growth opportunities, e.g., electricity, home appliance, real estate, automobile and so forth will provide great support to domestic copper demand. However, high copper prices create uncertainty regarding the future demand for copper. From the end consumption side, the copper market still has great potential; copper consumption in electric power construction especially will promote a future growth in demand.

Table 3.7: Apparent consumption of copper, 2001–2008 (kilotonnes).

	2001	2002	2003	2004	2005	2006	2007	2008
Apparent consumption ¹	2,340	2,780	3,210	3,340	3,740	3,640	4,920	5,200
Full aperture consumption ²	3,190	3,710	4,210	4,410	4,790	4,610	5,980	6,560

1. Apparent refined copper consumption = refined copper production + net import volume of refined copper.

2. Full copper consumption = apparent refined consumption + net import volume of copper semis* 80% + net import volume of copper scrap*11%.

3.6.2 Consumption Structure

Chinese refined copper consumption mainly comes from the electric power industry, electronics and communication, construction, the machinery and equipment industry, consumable and other commodities, the transportation industry, and so forth.

Table 3.8: Chinese copper consumption, 2007 and 2008 (kilotonnes).

	2007	2008	Growth rate
Electric power	2,481.7	2,684.4	8.17
Consumer goods	920.9	991.2	7.63
Transportation	392.9	411.3	4.69
Electronics	898.2	1,042.4	16.05
Construction	205.1	216.5	5.54
Machinery and equipment	580.7	671.1	15.57
Others	500.5	543.2	8.52

3.6.3 Consumption Trends

Compared with developed countries, Chinese copper consumption figures for the construction and transportation sectors form a lower percentage of overall consumption. However, consumption in these two sectors is expected to increase as industrial development expands. Also, with the development of other copper-intensive industries, the Chinese demand for copper is estimated to be more than 7.3 million tonnes in 2010 and will continue to increase.

4.0 Chinese Copper Industry Chain Organization Analysis (Business Administration)

4.1 Copper Mine and Smelting Enterprise Conditions (output 2005–2008)

Chinese refined copper and copper blister producers are mostly located in copper-rich resource areas such as Jiangxi, Anhui, Yunnan, Shanxi, Gansu and Hubei. The copper resource reserves of these six provinces account for 60 per cent of Chinese total volume. With respect to production enterprises, refined copper output of the top five enterprises accounts for 60 per cent of Chinese total output. With respect to enterprise property, almost all of the large-scale smelters are state-owned enterprises.

Table 4.1: Output of top five Chinese refined copper producers, 2005–2008 (kilotonnes).

	2005	2006	2007	2008
Jiangxi Copper Group Corporation	422	443	554	702
Tongling Nonferrous Metals Group Holdings Co., Ltd	326	545	624	647
Yunnan Copper Corporation	323	360	452	358
Jinchuan Nonferrous Metals Company	156	205	244	284
Daye Nonferrous Metals Company	178	204	250	264
Total of all Chinese companies	2,600	3,006	3,497	3,795
Top five companies: percentage of national total	54.04%	58.45%	60.74%	59.43%

4.2 The Profiles of Copper Fabricators

The production of Chinese domestic copper semis is mainly centered in the Pearl River Delta and Yangtze River Delta, which includes Zhejiang, Jiangsu, Guangdong, Anhui and Jiangxi Provinces. With copper smelters extending to copper fabricators, the copper semis development of Anhui and Jiangxi Provinces have seen fast growth.

In contrast with refined copper producers, copper semis enterprises feature large amounts and a wide variety of locations and most of them are private enterprise. The degree of concentration is not high and the competition in the industry is intense.

Table 4.2: Output of China's copper fabricators, 2005–2008 (tonnes).

	2005	2006	2007	2008
Ningbo Jintian Copper (Group) Co., Ltd	26,400	28,100	30,400	24,000
Golden Dragon Group Co., Ltd	14,900	18,800	20,200	21,000
China Hailiang Group Co., Ltd	16,400	15,100	13,500	14,700
Chalco Luoyang Copper Co., Ltd	7,800	8,300	9,200	10,400
Jiangxi Copper Group Corporation (Jiangxi Copper)*	18,400	32,000	42,800	43,900
Jiangxi Copper's copper wire rods*	(15,400)	(25,500)	(36,000)	(35,000)
Total of all Chinese companies	502,500	532,400	630,200	836,000
Top five companies: percentage of national total*	13.6%	14.4%	12.7%	9.4%

* Jiangxi Copper Group Corporation's production includes fabricators and wire rods; however, the top five companies' percentage of national total does not include Jiangxi Copper's wire rods production (which is why the wire rods' row appears as a subtraction).

4.3 Chinese Industrial Associations

China Nonferrous Metals Industrial Association (CNIA)

CNIA was approved by the State Council and registered in April 2001. The association is a nationwide, non-profit, and industrial organization. The functions of the association include: (1) promoting compliance with national policies, laws and regulations, drafting and overseeing guide regulations as well as coordinating prices and maintaining fair competition; (2) the drafting of industrial developing programs and policies and offering suggestions to the government; (3) assisting the related governmental departments with drafting and revising the industrial national-class standards and supervising their conduction; (4) with the approval of the government, carrying on the industrial survey and collecting, generating and releasing the statistics; (5) with the commission and approval of the related departments, performing the feasibility demonstration on the infrastructure construction, technology upgrading projects, technical introduction, investment and development of projects; (6) with the commission and approval of the related departments, carrying out managerial supervision and qualification examinations; (7) organizing the technical achievement evaluation, award and popularization, professional title evaluation, staff communication and training, issuing publications, performing consultations, and organizing commodities fairs and exhibitions; (8) organizing the economic and technical communication and cooperation with abroad and domestic-abroad bilateral or multilateral consultations and joining in international industrial conferences; (9) reflecting the members' requests and coordinating the relationships among the members; and (10) affording other works that the government requires.

China Nonferrous Metals Fabrication Industry Association (CNFA)

CNFA was established on 4 November 1981 and is approved by the state authority and registered as a legal person of social association with the Ministry of Civil Affairs. CNFA's activities are under the leadership of the State Owned Assets Supervision Committee of the State Council and the supervision of the Ministry of Civil Affairs. CNFA is one of the oldest of the ten nationwide industrial associations. There are nearly 500 member units, 55 person members and 6 branches: Heavy nonferrous metals, Light metals, Lead and zinc fabrication industry, Powder metallurgy, Semiconductor materials, and Equipment. For 26 years and especially recently, CNFA has developed numerous services for enterprises to promote development of the trade. CNFA was honoured as 2002 Outstanding Trade Association and Outstanding National Industry Association by the National Economic and Trade Commission and China Industrial and Economic Union, respectively, in March and November 2003. The long-term goal of CNFA is to highlight service and actively develop ways to grow through a strong sense of unity and aspiration, as well as spearheading innovations.

5.0 The Social Influence of the Chinese Copper Products Chain

Copper, as a traditional metal, has been used and smelted in China for centuries. Its outstanding characteristics have made it ideal for wide use in modern power systems, construction, household appliances, technology, the environment protection field, and so forth. It is potentially 100 per cent recyclable. The wide adoption of the metal not only serves to promote Chinese economic and industrial development and upgrading of its technology, but also provides a solid foundation for further technological advancement. The copper products supply chain plays an important role in the larger national economy and is therefore an important contributor to improvements in the Chinese standard of living. The following details reflect the copper products chain's influence on the Chinese economy, environment and society.

5.1 Economy development

The copper industry is a key part of the nonferrous metals industry. Since 2000, along with the continuous and rapid growth of the national economy, domestic copper consumption also experienced a period of rapid expansion. The industrial structure, scale and technology all have risen to higher levels. In the copper products chain, the mid-sized to large copper smelters jointly achieved 32.2 billion yuan of gross industrial output value in 2000. The indicator increased to 278 billion yuan in 2008, 8.25 times that of the year 2000. Annual average growth has been around 31 per cent.

5.1.1 Contribution to the National Financial Revenue

The value of copper products is relatively high and generates a large volume of pretax profit. Therefore, the copper industry contributes a great deal to the national financial revenue. In specific regions, the copper sector is a local pillar to the economy. In 2004, the copper mining and dressing industry created 1.174 billion yuan of pretax profit; the copper smelting industry realized 5.144 billion yuan; the normal nonferrous metals rolling processing industry (including aluminum and copper) created 11.392 billion yuan. By 2008, the three sectors had created 9.138, 15.61 and 57.716 billion yuan of pretax profit, respectively.

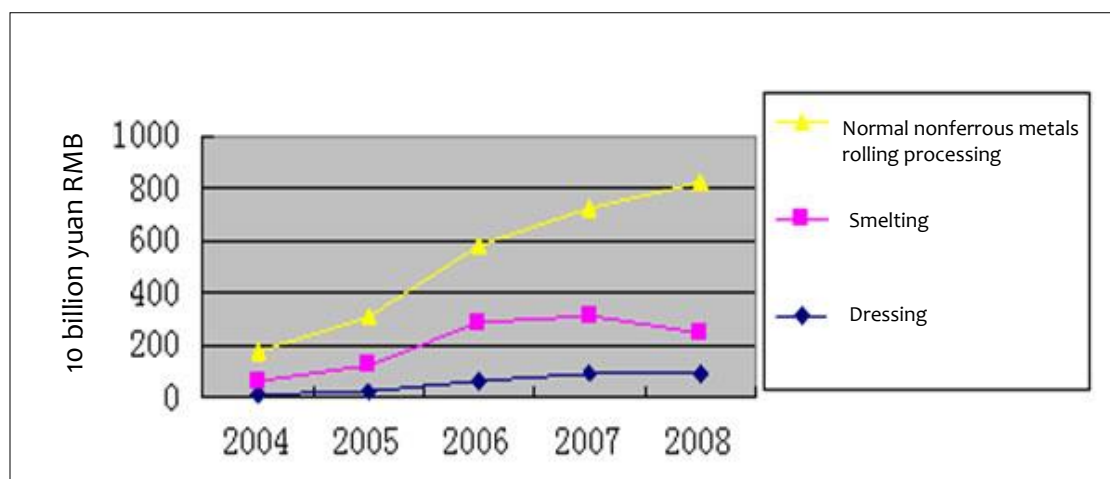


Figure 5.1: Pretax profit in copper industry.

5.1.2 The Copper Industrial Contribution to the Nation's Employment

The copper products chain involves exploration, mining, concentrating, smelting, processing and recycling. The entire industry significantly contributes toward the nation's overall employment. According to CNIA statistics, there are 116,600 employees in the copper mining and dressing sector, 139,700 in the smelting sector, 522,900 in the processing sector, and 200,000 in the secondary copper dismantling sector; the total number of people employed is close to one million. We estimate the number of employees in related fields to be even higher.

5.2 Occupational Environment

5.2.1 Occupational Health and Safety Protection

The copper sector is responsible for extracting useful metals from ores. The copper extraction process results in dust, off-gas, slag, wastewater, noise, and so forth. In order to address these issues, the copper supply chain requires more occupational health and safety protection than other non-extractive industries. However, through the conduction of a series of measures, occupational dangers can be effectively reduced and the health and safety of workers receives maximum attention, resulting in appropriate protection.

5.2.2 Labour Intensity

The labour intensity of copper production depends on the specific industry and working operations. Mining and smelting typically require continuous production, resulting in implementation of an eight-hour/three shifts system. The downstream procedure of copper smelting, e.g., fabrication, secondary copper production, and so forth implements an eight-hour/two shifts system. A three shifts system is implemented in the production peak season. If overtime work is needed, overtime pay will be granted in accordance with national regulations. Fabrication production has adopted automated equipment and secondary production combines machinery with manpower so that labour intensity is not as significant as in the production of copper products.

5.2.3 Human Rights Protection and Labour Protection

Individual interests and labour interests are fully protected by law. There are no obvious or reported violations of forced labour, child labour, discrimination, and so forth. Workers enjoy their own full rights. In addition, reform in the insurance system is implemented steadily and social insurance coverage continues to be expanded; basic endowment insurance, basic medical insurance, unemployment insurance, industrial injury insurance, maternity insurance, and other safeguard measures are widely accessible.

5.2.4 The Fulfilment of the Social Responsibility of China's Multinational Corporations

Due to the impact of Western culture, Chinese enterprises investing abroad also increasingly emphasize the importance of the fulfillment of corporate social responsibility as one part of business management.

5.2.4.1 Dependence on Advanced Technology to Protect the Local Environment

As a result of technology improvements and strict management of the production process, Chinese copper enterprises abroad tend to exceed local, environmental, safety and occupational health standards. This is generally a result of the fact that Chinese technologies and processes tend to be newer than those applied in other countries.

5.2.4.2 Chinese Enterprises: Aid and Assistance

Chinese enterprises continuously assist local residents suffering from drought or flood to return to a life of normalcy by donating money, drugs and support work. In addition, Chinese enterprises support local businesses to develop aquaculture, animal husbandry and manufacturing, via investment or cooperation. Moreover, Chinese enterprises give local residents support by improving transport, building farmers markets, repairing houses, digging wells, and so forth. At the same time,

Chinese enterprises improve local health care, education and other services by building hospitals and clinics, donating books or money to local schools, and other various enterprises.

5.2.4.3 Conscientious Measures and Compliance

Consistently complying with local laws and regulations and conscientiously performing their duties and obligations to pay taxes, Chinese enterprises get a good business reputation. Chinese enterprises actively take measures for improving and maintaining good relationships of cooperation with local enterprises, adhere to the principle of good faith during project constructions, and give local enterprises the benefit of the doubt if they have to break the contract.

5.2.4.4 Local Focus

By providing local staff with the training, Chinese enterprises promote the improvement of the local employment environment. These companies offer many positions for local staff and gradually realize the localization of employees through continuous training to strengthen and improve the workers' skills. Moreover, Chinese enterprises expend great effort to improve staff wages and benefits and follow the standards of developed countries.

5.2.4.5 Respect and Protection of Local Culture, Tradition, Rights and Interests of Employees

Although different from Western culture (which involves good communication), Chinese enterprises also work to integrate into the local culture, overcome cultural differences, and search for common ground.

5.3 Analysis Regarding Social Influence

5.3.1 Public Safety and Health

Copper mining influences the environment in the following ways, among others: water pollution, destruction of vegetation, geological disasters, heavy metal pollution in soil, and solid waste pollution. Mining usually disturbs land, causing serious soil erosion and land desertification. There are two causes of heavy metal pollution in soil. First, underground waste water, mineral processing waste water and refinery waste water, etc. contain numerous heavy metals. Secondly, copper industry brownfields generally contain large quantities of heavy metals—among these, the tailings and abandoned low-grade ores contain more heavy metals. These outdoor wastes quickly weather and spread out through rainfall and acidification. Heavy metals cannot degrade, so they accumulate in the ecosystem.

Environmental impacts brought about by copper smelting include toxic gas emissions and wastewater pollution. Sulphur dioxide (SO₂) is the main toxic gas released into the air and is a major source of acid rain. Wastewater emissions pollute surface water so as to affect the safety of drinking water.

Environmental influences brought about by secondary copper production are closely related to the recycling of metal scrap and cause heavy metal pollution in soil and pollution in surface and ground water.

In conclusion, copper production can have a huge impact on public safety and health. China now attaches great importance to environmental protection. Relevant laws and regulations are sound and effective. Examples include the implementation of environmental impact evaluation before mine exploitation and construction of smelters; strictly controlled emissions of waste gas, waste water and industrial residue; adoption of appropriate measures to repair environmental pollution, e.g., land reclamation and afforestation on mine exploitation areas; and so forth. The SO₂ recovery rate of Chinese copper enterprises is currently above 96 per cent and the solidification ratio is above 98 per cent. China and Australia have cooperated in researching land reclamation for farmland in tailing areas. The research has been implemented by Zhongtiaoshan Nonferrous Metals Co., Ltd and Tongling Nonferrous Metals Co., Ltd, among others.

5.3.2 Promoting Social and Economic Development

As a basic raw material, copper is widely used in construction, electrical power, home appliances, electronic information, and so forth. It plays an import role in improving the quality of life. The production of copper products promotes local economic growth and increases employment so that general welfare is improved. The copper products supply chain plays an important role in promoting social and economic development.

5.4 Impact on International Society

Chinese refined copper and copper semis production ranked number one globally for a few consecutive years. Refined copper production reached 3.77 million tonnes in 2008, occupying 20 per cent of global production; Chinese copper semis production reached 7.49 million tonnes, occupying 50 per cent of global production. Meanwhile, China is one of the largest importers of copper scrap; it can save copper resources and reduce emissions by recycling copper scrap. China is not only the main supplier of high quality copper products but also a recycler of copper scrap. China plays an important role in promoting sustainable development in the global copper industry.

5.5 Conclusion

The Chinese copper products supply chain plays an important role in promoting social progress, economic development and improvement of people's living standards within China and in Chinese copper source countries. Problems such as occupational health and safety and environmental impacts are globally common within the industry and these hazards need to be continually monitored and minimized. Enhanced management, supervision, and technological innovation and eco-design are all necessary steps for ensuring that the negative impacts of global copper production are minimized in a manner in accordance with the demands of sustainable development.

6.0 Policy on Copper

6.1 Laws and Regulations Related to the Copper Industrial Chain or Copper Products

In recent years, legislation has improved in China. As part of the real economy, copper is governed by the following categories of law, among others: Labour Law, Environmental Protection Law, Enterprise Income Tax Law, Law on Import and Export Commodity Inspection, Labour Dispute Mediation and Arbitration Law, Property Law, Law on Prevention and Control of Water Pollution, Law on Conserving Energy, Antitrust Law, Security Law of Women's Rights and Interests, Product Quality Law, Mineral Resources Law, Soil and Water Conservation Law, Solid Waste Pollution Prevention Law, Law on Mine Safety, and Law on Safety Production. Simultaneously, regulations and policies are promulgated on the copper industry based on its characteristics and development, which will be illustrated in the following paragraphs.

The policies on copper include that regarding industry, import and export, and so forth.

6.1.1 Industrial Policy

The industrial policy is promulgated in order to promote efficient competition, coordinate the conflicts of competition and scale economy, and protect and improve market order. In China, the main industrial policies for the copper sector were promulgated in the 1980s. In light of the rapid development of the Chinese economy over the past decade, a series of amendments to the existing industrial policies have been made including, inter alia: the drafting of a special development program, the identification of the appropriate development trend and geological distribution, mapping out a threshold entrance, regulation of the greenfield projects of copper smelting, regulation of the production activities of copper smelters, strengthening adjustments on industrial structure and the phasing out of backward capacities, and curtailing blind investment and illegal investment in copper with economic and legal measures designed to guide the Chinese copper industry toward healthy development.

6.1.1.1 Current Industrial Policy

The industrial policy now being implemented is Admittance Qualification of Chinese Copper Smelting Industry, issued by the National Development and Reform Commission (NDRC) on 30 June 2006. Below is a listing of specific requirements contained within this policy.

Overall Layout, Production Capacity and External Condition:

Copper smelting projects or equipment shall not be built or installed in the following regions: drinking water source protection zone, natural preservation zone, tourist sites, ecological function protected zone, middle and large cities and outskirts, 1.0 km from the civil concentrated area, health resorts, hospitals, medicine producers, or electronic producers and so on that require high-quality environment.

The copper smelting projects should be in line with the laws and regulations of environment protection, energy conservation, resources management, etc. They also should meet the regulations of industrial policies and roadmaps, land using plans, land supplying policies and land using standards.

A single copper smelting capacity should stand at over 100 ktpy; own suitable external conditions (copper concentrate supply, transportation, etc); realize self-sufficiency of copper concentrate more than 25 per cent or gross raw materials from self-owned mines and the mines jointly owned with partners (over 5 years contracts) more than 40 per cent; achieve the registered capital proportion not less than 35 per cent of the total investment.

Process and Equipment:

Use advanced flash smelting, ISA, Noranda or Baiyin furnaces, integrated furnaces, or bottom blowing smelting furnaces that owns intellectual property. Those processes are highly efficient, environmentally friendly, low energy consuming and have a high utilization rate of resources.

Sulphuric acid making, comprehensive resources utilization and energy conservation equipment are required. Acid making, dust collecting, and waste heat recycling facilities shall be installed alongside the fire smelting. The acid making process shall adopt weak acid-scrubbing cleaning, double contacts, or even triple contacts. Hot strong acid-scrubbing cleaning is prohibited. The equipment for waste heat collecting and dust collecting shall meeting the requirements of the Energy Saving Law, the Clean Production Law, the Environmental Protection Law and other laws.

Other policies include prohibiting reverberatory furnaces directly burning coal in copper smelting, imperial blast furnaces with a size less than 1.5 m²; removing reverberatory furnaces and imperial blast furnaces with a size between 1.5 m² and 10 m² before the end of 2006; and removing all the blast furnaces before the end of 2007.

Energy Consumption:

As for expanded copper smelting projects, the comprehensive energy consumption should be lower than 550 kg coal equivalent per ton, and the comprehensive energy consumption of refining should be lower than coal equivalent per ton; the DC consumption should be lower than 285 kWh per ton.

Blister smelting energy consumption shall be lower than 900 kg coal equivalent per ton and DC consumption lower than 310 kWh per ton; existing smelters should meet the requirement within 2 years.

Resources Comprehensive Utilization:

Greenfield projects: gross recovery rate of copper more than 97 per cent; blister recovery rate more than 98 per cent; water recycle rate more than 95 per cent; water consumption in each ton of copper production lower than 25 tons; land usage lower than 4 m² per ton of copper; gross sulphur capture rate more than 98 per cent; sulphur recover rate more than 96 per cent.

Existing projects: gross recovery rate of copper more than 96 per cent; blister recovery rate more than 97 per cent; water recycle rate more than 90 per cent; water consumption in each ton of copper production lower than 28 tons; gross sulphur capture rate more than 98 per cent; sulphur recover rate more than 95 per cent. The energy consumption should be reduced by modernization within 2 years to reach the standard of the greenfield projects.

Environment Protection:

The Environmental Protection Law requires all the greenfield and brownfield projects shall be subject to the environment impact assessment system; pollutants discharge shall be subject to license administration (the regions where the license regime has not been implemented excluded). The environmental protection authorities shall monitor and inspect the copper smelters and release the blacklist of smelters that fail to meet the environmental protection requirements, periodically. The smelters or companies in the blacklist must undertake treatment within the prescribed limit of time; otherwise, they will be required to stop production or be closed by the local government.

The pollutants discharge of copper smelters should meet the Emission Standard of Air Pollutants for Industrial Kiln and Furnace (GB9078-1996) and Integrated Wastewater Discharge Standard (GB8978-1996) and other standards set by the local governments.

Safety and Health:

Work safety requirements are a must, besides the establishment of a responsibility system of work safety; the safety facilities shall be designed, constructed and commissioned along with the main project whether it is a greenfield or brownfield project. The acid making operation, oxygen making operation, and work safety facilities shall pass the examination of work safety inspection authorities before being put into operation. Labour protection and industrial health facilities should be built. Related regulations should be established and improved. Examination of the local administrative authorities is required.

Supervision and Administration:

The greenfield and brownfield copper smelting projects should abide by the above mentioned regulations. The procedures of investment, land use, financing, and appraisal of environmental impact should meet the threshold requirements. The engineering companies must prepare and submit the environmental impact report to the environmental protection bureaus and get approval level by level. The qualified old copper smelters should meet the threshold requirements of greenfield projects in aspects of comprehensive utilization of resources, energy consumption and environmental protection by technology upgrading.

Before commissioning of the projects, they should be examined by related government authorities including investment, land, environmental protection, work safety, labour protection, and quality inspection administrations. If the projects do not pass the examination, the investment administrative authorities should require the engineering company to improve the construction in a required time period. If the projects do not meeting the requirements of environmental protection, the smelter shall be fined and required to alter in a time period. If the land use is illegal, the smelter shall be fined and required to alter in a time period; the land administrative authorities shall not issue a land use license.

The greenfield smelter shall not operate or sell blister until it passes examinations of related authorities and gets the license of pollutants discharge. The acid making and oxygen making systems shall get the work safety license for dangerous good-producing companies. The same standards rest with the brownfield projects.

The local development and reform commission, industry office, industrial and commercial bureau, work safety, labour, health and other related administrations should inspect the implementation of threshold requirements. The China Nonferrous Metals Industry Association should help them to monitor and supervise the smelters.

The unqualified smelters shall not be filed by the investment administrative office, or issued land use licenses by the land use administrative office, or get approval from the environmental protection bureau, or get financing from banks, or get power supply from power grid companies. The smelters to be closed should go to the industrial and commercial bureau for cancellation of registration.

The National Development and Reform Commission shall announce the list of qualified smelters, which should be monitored by the society. A dynamic administration system should be established.

6.1.1.2 Catalogue for the Guidance of Foreign Investment Industries (Amended in 2007)

The Catalogue sets out rules and guidance for the prospecting and exploitation of copper ores, plumbum ores and zinc ores (equity joint ventures or contractual joint ventures only, wholly foreign-owned enterprises are permitted in west regions).

The following is subject to the catalogue on a guidance basis:

Technology for increasing the utilization of tailing ores and comprehensive using technology of ecological reclamation, super-thin copper strip, alloyed copper semis used in exchanger, high-performance copper-nickel strip and copper-iron strip, beryllium Copper strip, wire, tube and rod.

Copper refining is subject to the catalogue on a required basis.

6.1.1.3 Support Plan for Nonferrous Metals Industry (Announced by the State Council on 11 May 2009)

The copper sector is also influenced by the Chinese Support Plan for Nonferrous Metals Industry (2009). The Support Plan specifies that various measures should be adopted to stabilize and expand the domestic market. The gross capacity should be controlled, outdated technologies should be phased out, technology upgrades should be strengthened, and M&A should be promoted. Nonferrous metal industrial structure should be adjusted and improved. Both domestic and overseas resources should be fully utilized. Recycling and reutilization should be attached importance to. Circular economy should be developed to increase the resource supply and promote the sustainable development of the nonferrous metal industry.

Five principles are set to support the nonferrous metal industry in its development by the Support Plan: integrate the dealing with financial crisis and industrial support, integrate gross capacity and

improvement of industrial distribution, integrate self creation and technology upgrading, integrate M&A and institutional innovation, and integrated resource development and saving utilization.

Twelve detailed measures are set forth by the Support Plan, including the improvement of export tariff policy, establishment of state reverse system, increasing investment in technology innovation, promotion of direct power supply from power company to producer, improvement of policy on M&A, support of the enterprises exiting production, amendment of industrial policy, rational allocation of resources, continuation of the policy of Encouragements and Discouragements on financing, continuation of implementation of the accountability system in saving energy and phasing out outdated technology, establishment of a system of exchanging and disclosing information, and exertion of the function of industrial association.

6.1.2 Policy on Imports and Exports

The Chinese government has been making adjustments on copper foreign trade policies based on the development of the global economy and copper industry, foreign trade situation, forex reserve and so on over the past decade, which has affected copper imports and exports. In the meantime, market factors have also brought about major impacts to the foreign trade, for example, the consumption cycle in China and overseas, price differences in China and overseas, and the fluctuation of exchange rates. These factors, among others, influence the quantity and timing of copper imports and exports. Because the domestic market has been relatively aligned with international market development, both importers and exporters are continually adapting their methods of trading to deal with the changes in foreign trade policy.

The guiding principles for Chinese foreign trade are very clear:

- (1) Protect resources, control pollution (including control of the export of energy intensive, highly pollutive), and give support to utilize domestic and overseas resources and markets.
- (2) Promote the healthy development of the copper industry and copper enterprises, stop blind investment, include foreign trade policy to match the threshold requirements for copper smelters, lift VAT rebate on export of copper products with high added value, and give support to exporters when they are in difficulty.
- (3) Balance foreign exchange surpluses and reduce foreign trade frictions.

Major policies on copper-related imports include:

- (1) Catalogue of technology prohibited to be imported (the first batch), issued by the ministry of foreign trade and economy, and the National Trade and Economy Commission in 2001:

The import of closed blast furnace (with hearth area less than 1.5 square meters) to smelt copper, dry cleaning method in acid making and hot concentrated acid cleaning is prohibited.

- (2) Catalogue of wastes restricted to be imported as raw materials (the first batch) issued by the ministry of foreign trade and economy, the Chinese Customs, AQSIQ and the Ministry of Environmental Protection in 2001:

Copper precipitates and used motors for recycling copper purpose are subject to the restricted catalogue of import as raw materials.

- (3) Seven ministries including the National Development and Reform Commission (NDRC), the Ministry of Commerce (MOF), and the Ministry of Finance (MOF) jointly issued a Circular on 9 December 2005 regarding controlling the export of high-energy consumption, heavy pollution and resource products. The Notice points out the export of refined copper made of import copper scrap or concentrate is prohibited as of 1 January 2006. The processing trade of copper concentrate and scraps shall not be approved any longer.

- (4) Copper concentrate is subject to Automatic Import License Administration since 1 January 2006, according to a Circular issued by the Ministry of Commerce (MOC). The automatic import licenses shall be issued by the Quota License Affairs Bureau, the departments in charge of foreign trade of all provinces, autonomous regions, municipalities directly under the Central Government and cities directly under State planning, as well as the relevant State departments upon authorization by the MOC.

- (5) The Catalogue of Wastes as Raw Materials subject to the Automatic Import License Administration and Catalogue of wastes restricted to be imported as raw materials, issued by the Ministry of Environmental Protection in 2005:

Copper scraps (excluding hardware, used cable and used motors) are subject to the Automatic Import License Administration.

- (6) Catalogue of Prohibited Foreign Trade on Tolling Basis, issued by the Ministry of Commerce, the Chinese Customs and the Ministry of Environmental Protection in 2006:

The processing trade of copper matte, copper anode, copper cathode and anode profile, refined copper and sections of cathodes, refined copper wire-bars, refined copper billets, other refined copper, copper alloys, and copper powder are prohibited.

- (7) Notice on Limit Harmful Elements in Imported Copper Concentrates, issued by the AQSIQ, the Ministry of Commerce and the Ministry of Environmental Protection in 2006:

As of date 1 June 2006, the harmful elements in the imported copper concentrate (HS2603000010 and 2603000090) shall not be more than:

As, 0.50%, Pb, 6.0%, F, 0.10%, Cd, 0.05%, Hg, 0.01%.

- (8) The Ministry of Commerce and the Chinese Customs made adjustments on the Catalogue of Prohibited Processing Trade in 2008:

The products that are in accordance with industrial policy, not energy intensive or highly pollutive or with high added-value are deleted from the Catalogue of Prohibited Processing Trade. As of date 1 February 2009, some of the qualified enterprises are allowed to import copper concentrate on a tolling basis.

6.1.3 Future Copper Policy Considerations

Policies currently being (or to be) implemented by the Chinese government include opinions on speeding up the M&A, regulations on managing and acquiring listed companies, and regulations on phasing out backward capacity. They also include a catalogue for the guidance of industrial adjustment (2009 version), notice on adjusting the catalogue of processing trade, and regulation on authentication of overseas mineral resource companies as partners.

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