THE

WORLD COPPER FACTBOOK

2007

International Copper Study Group

World Copper Factbook – Contents

The International Copper Study Group

The International Copper Study Group (ICSG), established in 1992, is an intergovernmental organization that serves to increase copper market transparency and promote international discussions and cooperation on issues related to copper. The ICSG is the only forum solely dedicated to copper where industry, its associations and governments can meet and discuss common problems and objectives. The current members and observers of ICSG are Argentina, Belgium, Chile, China, the European Union, Finland, France, Germany, Greece, India, Italy, Japan, Luxembourg, Mexico, the Netherlands, Peru, Poland, Portugal, the Russian Federation, Serbia, Spain, the United States and Zambia.

In order to fulfill its mandate, the Study Group has three objectives:

- *Promote international cooperation* on matters related to copper, such as health and the environment, research, technology transfer, regulations and trade.
- *Provide a global forum* where industry and governments can meet and discuss common problems/objectives. The ICSG is the only inter-government forum solely dedicated to copper. The meetings of the Study Group are open to government members, their industry advisors and invited observers.
- *Increase market transparency* by promoting an exchange of information on production, consumption, stocks, trade, and prices of copper, by forecasting production and consumption, and by assessing the present and future capacities of copper mines, plants, smelters and refineries.

The International Copper Study Group maintains activities in four core areas: Statistics; Environment and Health; Economics; and serving as an International Commodity Body. The ICSG maintains one of the world's most complete historical and current database providing access to production, consumption and trade data for copper, copper products and secondary copper, price series, and information on copper mines and plants. ICSG publishes the Copper Bulletin (monthly), the Copper Bulletin Yearbook (annual), the Directory of Copper Mines and Plants (semi-annual), the Copper Mines and Plants Annual Service and the Directory of Copper and Copper Alloy Fabricators – First Use (annual).

The ICSG would like to thank the International Copper Association, the Copper Development Association, the International Wrought Copper Council, the U.S. National Park Service, the British Museum and Mr. Luis Hernán Herreros Infante for their contributions to the *Factbook*.

Chapter 1: Copper and Society

Of all the materials used by humans, copper has had one of the most profound effects on the development of civilization. From the dawn of civilization until today, copper has made, and continues to make, a vital contribution to sustaining and improving society. What makes copper and copper-based products so valuable to us, and why do societies depend on them? Copper's chemical, physical and aesthetic properties make it a material of choice in a wide range of domestic, industrial and high technology applications. Copper is ductile, corrosion resistant, malleable and an excellent conductor of heat and electricity. Alloyed with other metals, such as zinc (to form brass), aluminum or tin (to form bronzes), or nickel, for example, it can acquire new characteristics for use in highly specialized applications. In fact, society's infrastructure is based, in part, on copper. For instance, copper is used for:

- conducting electricity and heat;
- communications;
- transporting water and gas;
- roofing, gutters and downspouts;
- protecting plants and crops, and as a feed supplement; and
- making statues and other forms of art.

Copper has been in use for at least 10,000 years, yet, it is still a high technology material, as evidenced by the development of the copper chip by the semi-conductors industry.

Photo: Courtesy of National Park Service Digital Image Archives.

Copper in History

Archaeological evidence demonstrates that copper was one of the first metals used by humans and was used around 10,000 years ago for items such as coins and ornaments in western Asia. During the prehistoric Chalcolithic Period (derived from *chalkos*, the Greek word for copper), man discovered how to extract and use copper to produce ornaments and implements. As early as the 4th to 3rd millennium BC, workers extracted copper from Spain's Huelva region. The discovery that copper, when alloyed with tin, produces bronze, led to the Bronze Age, c. 2,500 BC. Israel's Timna Valley provided copper to the Pharaohs (an Egyptian papyrus records the use of copper to treat infections and to sterilize water). Cyprus supplied much of the Phoenician, Greek and Roman needs for copper. "Copper" is derived from the latin *Cyprium*, literally Cyprian metal. While the Greeks of Aristotle's era were familiar with brass, as a copper alloy, it was under Augustus' Imperial Rome that brass came into being. In South America, the pre-Columbian Maya, Aztec and Inca civilizations exploited copper, in addition to gold and silver. During the Middle Ages, copper and bronze works flourished in China, India and Japan. The discoveries and inventions relating to electricity and magnetism of the late 18th and early 19th centuries by scientists such as Ampere, Faraday and Ohm, and the products manufactured from copper, helped launch the Industrial Revolution and propel copper into a new era.

Today, copper continues to serve society's needs.

Photo: Copper manilla (or bracelet), courtesy of the British Museum. Prior to the arrival of European traders, copper bracelets were used for making payments in West Africa and, starting around the sixteenth century, became one of the standard trade currencies for traders in Africa and Europe (British Museum).

Copper: Natural, Recyclable and Essential

Copper occurs naturally in the Earth's crust in a variety of forms. It can be found in sulfide deposits[1] (as chalcopyrite, bornite, chalcocite, covellite), in carbonate deposits[2] (as azurite and malachite), in silicate deposits[3] (as chrysycolla and dioptase) and as pure "native" copper.

Copper is one of the most recycled of all metals. It is our ability to recycle metals over and over again that makes them a material of choice. Recycled copper (also known as secondary copper) cannot be distinguished from primary copper (copper originating from ores), once reprocessed. Recycling copper extends the efficiency of use of the metal, results in energy savings and contributes to ensuring that we have a sustainable source of metal for future generations.

Copper also occurs naturally in humans, animals and plants. Organic life forms have evolved in an environment containing copper. As a nutrient and essential element, copper is vital to maintaining health. Life sustaining functions depend on copper.

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[1] Bound with sulfur.
[2] Bound with carbon and oxygen.
[3] Bound with silicon and oxygen.
Photo: ICSG.

From Ores to Products

Geologists look for signs and/or anomalies that would indicate the presence of a mineral deposit. Under the right geological, economic, environmental and legal conditions, mining can proceed.

Primary copper production starts with the extraction of copper-bearing ores. There are three basic ways of copper mining: surface, underground mining and leaching. Open-pit mining is the predominant mining method in the world.

After the ore has been mined, it is crushed and ground followed by a concentration by flotation. The obtained copper concentrates typically contain around 30% of copper, but grades can range from 20 to 40 per cent. In the following smelting process, sometimes preceded by a roasting step, copper is transformed into a "matte" containing 50-70% copper. The molten matte is processed in a converter resulting in a so-called blister copper of 98.5-99.5% copper content. In the next step, the blister copper is fire refined in the traditional process route, or, increasingly, re-melted and cast into anodes for electro-refining.

The output of electro-refining is refined copper cathodes, assaying over 99.99% of copper.

Alternatively, in the hydrometallurgical route, copper is extracted from mainly low grade oxide ores and also some sulphide ores, through leaching (solvent extraction) and electrowinning (SX-EW process). The output is the same as through the electro-refining route - refined copper cathodes. ICSG estimates that in 2006, refined copper production from SX-EW represented 16% of total copper refined production, up from 11% ten years ago.

Refined copper production derived from mine production (either from metallurgical treatment of concentrates or SX-EW) is referred to as "primary copper production", as obtainable from a primary raw material source. However, there is another important source of raw material

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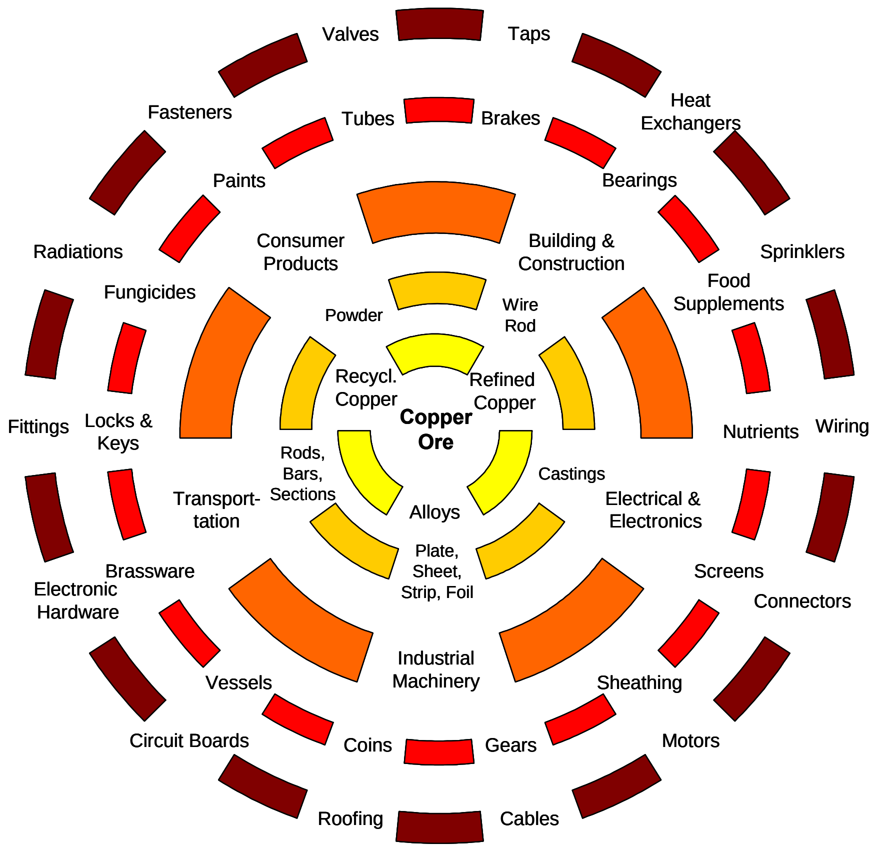
Photos: Luis Hernán Herreros from www.visnu.cl, © Copyright Anglo American (Faena Los Bronces y Matos Blancos – Chile).

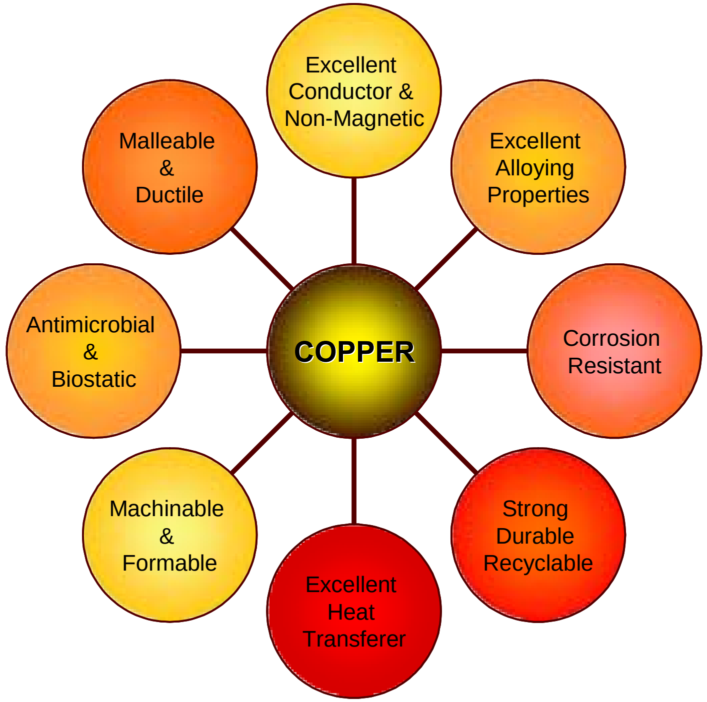
which is scrap. Copper scrap derives from either metals discarded in semis fabrication or finished product manufacturing processes (“new scrap”) or obsolete end-of-life products (“old scrap”). Refined copper production attributable to recycled scrap feed is classified as “secondary copper production”. Secondary producers use processes similar to those employed for primary production. ICSG estimates that in 2006, at the refinery level, secondary copper refined production may have reached around 15% of total copper refined production.

Copper is shipped to fabricators mainly as cathode, wire rod, billet, cake (slab) or ingot. Through extrusion, drawing, rolling, forging, melting, electrolysis or atomization, fabricators form wire, rod, tube, sheet, plate, strip, castings, powder and other shapes. These copper and copper-alloyed products are then shipped for final manufacturing, or distribution, to meet society's needs.



Properties of Copper

Chemical Symbol	Cu
Atomic number	29
Atomic weight	63.54
Density	8960 kg m^{-3}
Melting point	1356 K
Specific Heat c_p (at 293 K)	0.383 kJ kg^{-1} K^{-1}
Thermal conductivity	394 W m^{-1} K^{-1}
Coefficient of linear expansion	16.5 x 10^{-6} K^{-1}
Young's Modulus of Elasticity	110 x 10^{9} N m^{-2}
Electrical Conductivity (% IACS[1])	100 %
Electrical Resistivity	1.673 x 10^{-8} ohm-m
Crystal Structure	Face-Centered Cubic



[1] International Annealed Copper Standard.

Major Uses of Copper: Electrical

Copper is the best non-precious metal conductor of electricity as it encounters much less resistance compared with other commonly used metals. It sets the standard to which other conductors are compared.

Copper is also used in power cables, either insulated or uninsulated, for high, medium and low voltage applications.

In addition, copper's exceptional strength, ductility and resistance to creeping and corrosion makes it the preferred and safest conductor for commercial and residential building wiring.

Copper is an essential component of energy efficient generators, motors, transformers and renewable energy production systems.

ICSG, in partnership with the Common Fund for Commodities, the International Copper Association and the International Copper Promotion Council (India), is supervising the Transfer of Technology for High Pressure Copper Die Casting in India project. The project is designed to facilitate the transfer of technology related to the manufacture of rotors, motors and motor systems using more energy efficient high pressure copper die castings.

Photos: Courtesy of the International Copper Association.

Major Uses of Copper: Electronics and Communications

Copper plays a key role in worldwide information and communications technologies. ADSL (Digital Subscriber Line) technology allows for high-speed data transmission, including internet service, through the existing copper infrastructure of ordinary telephone wire.

Copper and copper alloy products are used in domestic subscriber lines, wide and local area networks, mobile phones and personal computers.

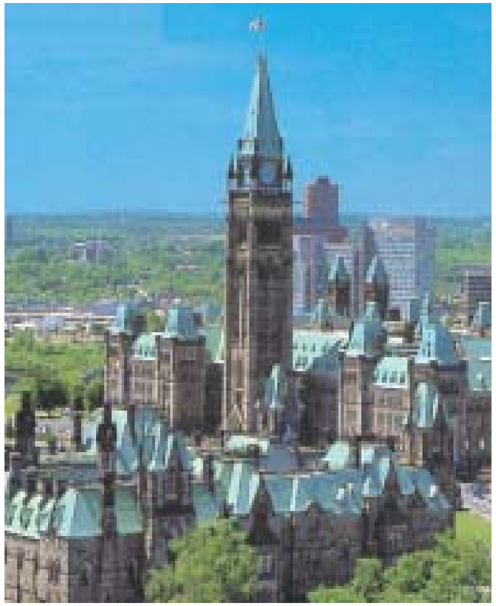
Semiconductor manufacturers have launched a revolutionary "copper chip." By using copper for circuitry in silicon chips, microprocessors are able to operate at higher speeds, using less energy. Copper heat sinks help remove heat from transistors and keep computer processors operating at peak efficiency. Copper is also used extensively in other electronic equipment in the form of wires, transformers, connectors and switches.

Photos: Courtesy of the Copper Development Association.

Major Uses of Copper: Construction

Copper and brass are the materials of choice for plumbing, taps, valves and fittings. Thanks in part to its aesthetic appeal, copper and its alloys, such as architectural bronze, is used in a variety of settings to build facades, canopies, doors and window frames.

Unlike plastic tubing, copper does not burn, melt or release noxious or toxic fumes in the event of a fire. Copper tubes also help protect water systems from potentially lethal bacteria such as legionella. Copper fire sprinkler systems are a valuable safety feature in buildings.



The use of copper doorknobs and plates exploits copper's biostatic properties to help prevent the transfer of disease and microbes.

Copper roofing, in addition to being attractive, is well known for its resistance to extreme weather conditions. Major public buildings, commercial buildings and homes use copper for their rainwater goods and roofing needs.

The telltale green patina finish, that gives copper the classic look of warmth and richness, is the result of natural weathering.

Photos: Courtesy of the Copper Development Association (left) and ICSG (right).

Major Uses of Copper: Transportation

All major forms of transportation depend on copper to perform critical functions.

Copper-nickel alloys are used on the hulls of boats and ships to reduce marine biofouling, thereby reducing drag and improving fuel consumption.

Automobiles and trucks rely on copper motors, wiring, radiators, connectors, brakes and bearings. The average automobile contains 2 km of copper and alloy cables, while the quantity of copper in cars can range from 20 kg for smaller cars to 45 kg for luxury and hybrid vehicles.[1] Copper's superior thermal conductivity, strength, corrosion resistance and recyclability make it ideal for automotive and truck radiators. New manufacturing technologies, processes and innovative designs are resulting in lighter, smaller and more efficient radiators.

Copper is also used extensively in new generation airplanes and trains. New high-speed trains can use anywhere from 2 to 4 tonnes of copper, significantly higher than the 1 to 2 tonnes used in traditional electric trains.

[1] Source: French Ministry of Industry.
Photos: Courtesy of the Copper Development Association (top) and International Copper Association (middle and bottom).

Major Uses of Copper: Industrial Machinery and Equipment

Wherever industrial machinery and equipment is found, it is a safe bet that copper and its alloys are present. Due to their durability, machinability, and ability to be cast with high precision and tolerances, copper alloys are ideal for making products such as gears, bearings and turbine blades.

Copper's superior heat transfer capabilities and ability to withstand extreme environments makes it an ideal choice for heat exchange equipment, pressure vessels and vats.

The corrosion resistant properties of copper and copper alloys (such as brass, bronze, and copper-nickel) make them especially suitable for use in marine and other demanding environments.

Vessels, tanks, and piping exposed to seawater, propellers, oil platforms and coastal power stations, all depend on copper's corrosion resistance for protection.

Photos: Courtesy of the Copper Development Association.

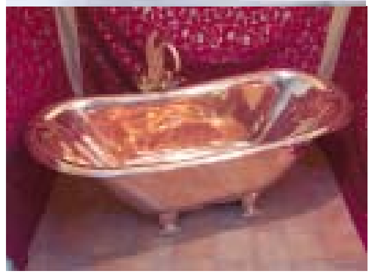
Major Uses of Copper: Consumer and General Products

From the beginning of civilization copper has been used by various societies to make coins for currency.

Today, countries are replacing lower denomination bills with copper-based coins, as these coins last 10, 20 and even 50 times longer.

In the United States, one cent coins and five cent coins contain 2.5% and 75% copper, respectively, while other U.S. coins contain a pure copper core and 75% copper face.[1] In the recently expanded European Union, the Euro coins, first introduced in 2002, also contain copper.

Copper and copper-based products are used in offices, households and workplaces. Computers, electrical appliances, decorative brassware, and locks and keys are just some of the products exploiting copper's advantages.

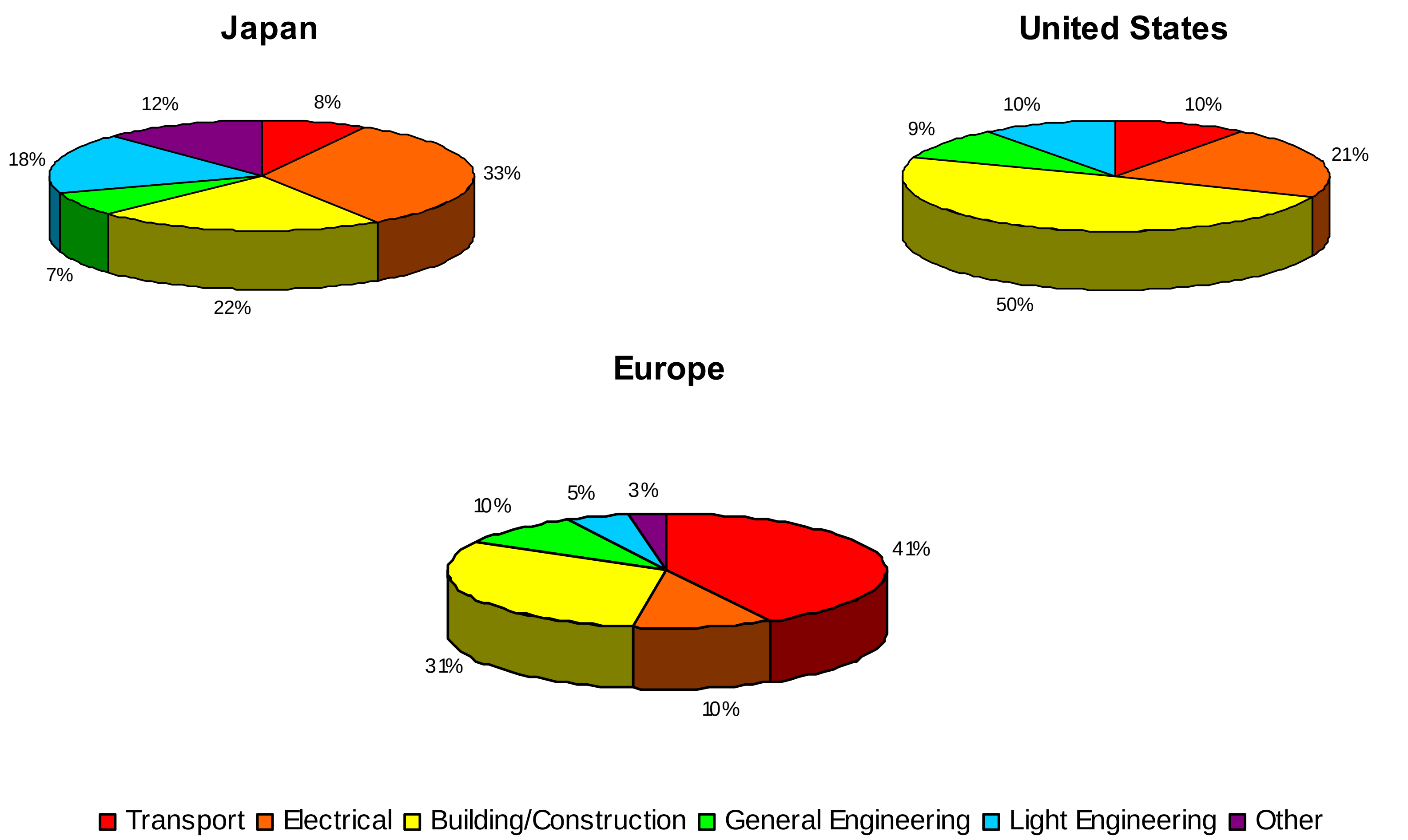


In addition, in areas known to be copper deficient, copper is used by farmers to supplement livestock and crop feed.

[1] Source: U.S. Department of the Treasury.
Photos: Print artist (top left), International Copper Association (bottom left), and the Copper Development Association (top and bottom right).

Major Uses of Copper: Usage by End-Use Sector, 2003

Thousand metric tonnes
Source: International Wrought Copper Council



Substitution: Copper vs its Competitors (by Major Use)

Sources: International Copper Association and copper industry.

Substitute goods are those goods which can be used interchangeably with relative ease. In different applications, copper and other metals, alloys and other products can serve as substitutes for each other for certain uses. Substitution can range from complete substitution from one good to another to reduced usage (or failure to increase usage) of a given good or product. With the relatively high volatility of copper prices over the last several years, increased attention has been paid to the issue of substitution. An overview of copper products and its competitors by major end use is provided below.

Copper-bearing product	Competing material/product	Estimated global market size (thousand metric tonnes)
Electrical wire and cable uses		
Telecom wire (last mile)	Wireless technology, optical fibre	800
Automotive wire/harness	Aluminium wire, optical fibre	700
Transformer winding wire	Aluminium wire	2,000
Motor winding wire in household appliances	Aluminium wire	(total winding wire)
Building construction		
Building wire	Aluminium wire	1,400
Roofing and guttering	Zinc sheet, aluminium sheet, composite copper sheet	500
Plumbing tube	Composite copper tube, plastic tube, stainless steel	1,000
Boilers	Stainless steel	200
ACR Tube (external tubes)	Aluminium tube	700 (150 external)
Other Uses		
Brass rod for machining (valves, fasteners, fittings)	Miniaturisation, lower copper alloys	1,800
Copper alloy sheet/strip for connectors, lead frames, buttons, decoration, furniture	Lower copper alloys, plated materials, steel, aluminium, plastic	1,200

Chapter 2: Copper and the Environment
Copper and Health

1. Copper is essential to plant, animal and human health. Deficiencies, as well as excesses, can be detrimental to health.
2. In 1996, a World Health Organization associated agency, the International Program on Chemical Safety, concluded that "there is greater risk of health effects from deficiency of copper intake than from excess copper intake."
3. Copper is important in: the maintenance of the immune function and bone strength; the development of red and white blood cells; cholesterol and glucose metabolism; homeostasis; protection against oxidative and inflammatory damage; maintaining a healthy heart; transport and adsorption of iron; and brain development.
4. Certain enzymes that are critical to the function of our body depend on copper.
5. Copper deficiency can cause problems. In children, copper deficiency can result in physical, metabolic and developmental problems.
6. Population groups particularly at risk of having a copper deficiency are those with poor diets.
7. People with rare genetic disorders such as Menke's Disease (where the body has difficulty absorbing copper it needs), Wilson's Disease (where the body has difficulty getting rid of copper it does not need) and Idiopathic Copper Toxicosis (similar to the effects of Wilson's Disease) are susceptible to copper deficiencies or excesses.
8. In areas that benefit from copper tubing as a means to transport water, copper may be introduced in safe and minuscule amounts into the water. This amount of copper can contribute to meeting dietary requirements.
9. Copper can kill or inhibit health threatening fungi, bacteria, and viruses, including water-borne organisms.

Photo: Courtesy of the International Copper Association.

Copper and the Environment

Copper is present naturally in the environment in a wide variety of forms and humans, animals and plants require copper for healthy development. However, the relationships between copper, copper production and the environment can be complex. An overview of some key environmental attributes of copper and issues related to copper production is provided below.

Pros:

- **Recycling**. Copper is one of the most recycled of all metals. Virtually all products made from copper can be recycled. Industry uses recycled copper (also known as secondary copper) as a major source of raw material. In some instances, recycled copper can be remelted and directly used without any further processing. In effect, copper can be considered as renewable since it can be recycled over and over again without losing any of its chemical or physical properties.

- **Energy Efficiency**. Copper can improve the efficiency of energy production and distribution systems. Electricity conducted by copper encounters much less resistance compared with any other commonly used metal. This is the reason why copper is found in wires and cables, as well as in generators, motors, transformers, and renewable energy production systems. Household electrical appliances, electronic and telecommunications devices also contain significant quantities of copper.

- **Antimicrobial Properties**. Due to copper's antimicrobial properties, numerous applications of copper and copper alloy products are currently being explored in the healthcare and public sanitation fields to eliminate pathogens, reduce the spread of diseases and produce clean water.

Cons:

- **Water pollution.** Water pollution from mine waste rock and tailings may need to be managed after mine closure. In particular, acid mine drainage is becoming a key issue in some areas. As new mining technologies are able to handle more rock and ore material, more solid and liquid waste is expected to be disposed of and treated properly.

- **Emissions.** Atmospheric emissions of sulphur dioxide and heavy metals on fine particles may occur in the smelting and refining processes. While there have been significant improvements in copper mining, smelting and refining procedures and practices in recent years, reducing the environmental impacts of copper production remains an important issue for the industry.

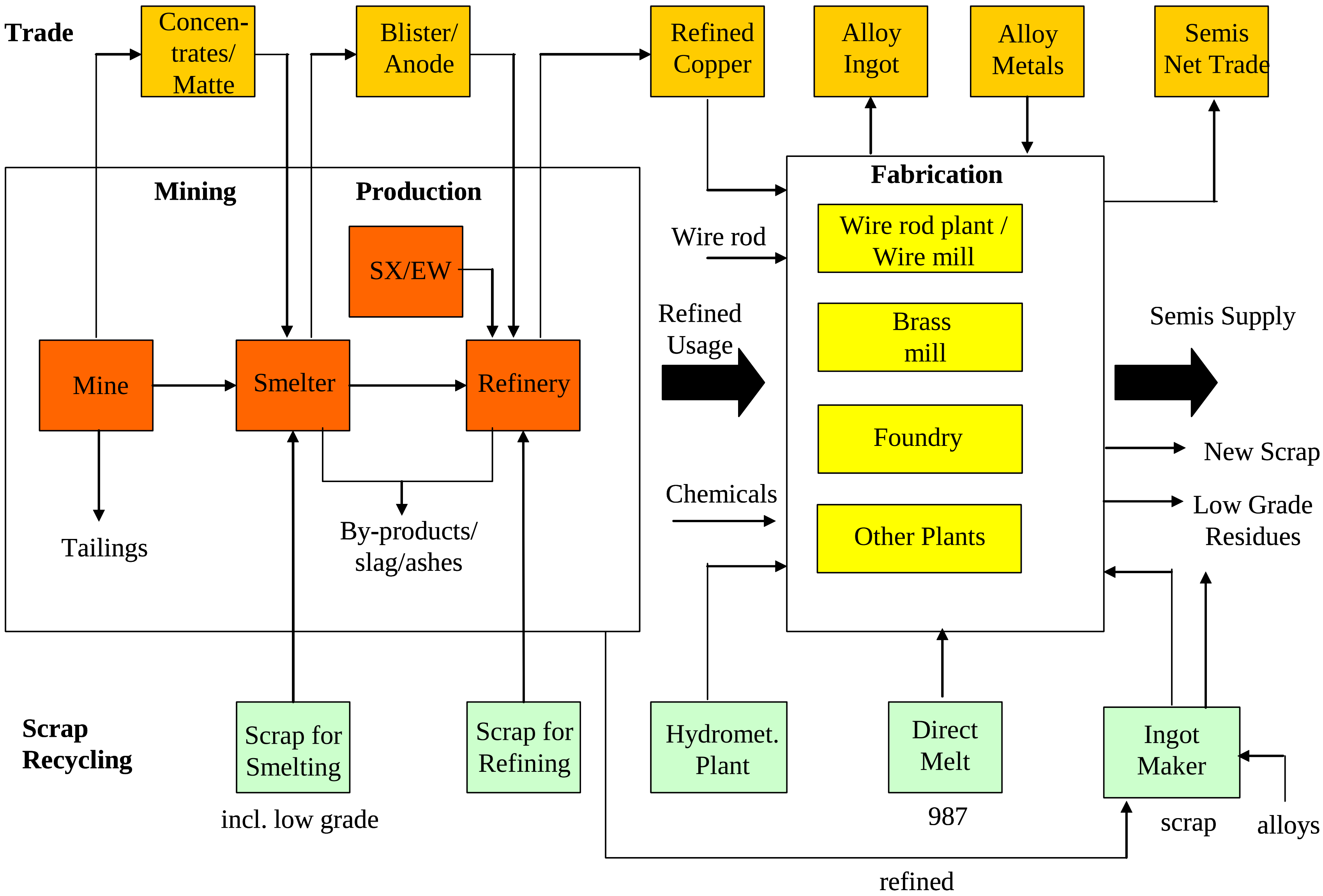
Copper Recycling

Copper is among the few materials that do not degrade or lose their chemical or physical properties in the recycling process. Considering this, the existing copper reservoir in use can well be considered a legitimate part of world copper reserves. In the recent decades, an increasing emphasis has been placed on the sustainability of material uses in which the concept of reuse and recycling of metals plays an important role in the material choice and acceptance of products. If appropriately managed, recycling has the potential to extend the use of resources, and to minimize energy use, some emissions, and waste disposal. Closing metal loops through increased reuse and recycling enhances the overall resource productivity and therefore represents one of the key elements of society's transition towards more sustainable production and consumption patterns. It is widely recognized that recycling is not in opposition to primary metal production, but is a necessary and beneficial complement.

> Copper-based products have a wide variety of life spans from a few years in electronic devices, to over a 100 years in architectural uses.
>
> Assuming an average life span of 30 years for most products, copper's truer recycling rate would be 85%.

In 2005, 34% of copper consumption came from recycled copper. Some countries' copper requirements greatly depend on recycled copper to meet internal demands. However, recycled copper alone cannot meet society's needs, so we also rely on copper produced from the processing of mineral ores.

Copper Recycling Flows



Copper Recycling Rate Definitions

The recycling performance of copper-bearing products can be measured and demonstrated in various ways – depending, among other things, on objectives, scope, data availability and target audience. The three International Non-Ferrous Metal Study Groups in conjunction with various metal industry associations agreed on the common definitions of the three following metal recycling rates:

- The **Recycling Input Rate** (RIR) measures the proportion of metal and metal products that are produced from scrap and other metal-bearing low-grade residues. The RIR is mainly a statistical measurement for raw material availability and supply rather than an indicator of recycling efficiency of processes or products. The RIR has been in use in the metals industry for a long time and is widely available from statistical sources. Major target audiences for this type of "metallurgical" indicator are the metal industry, metal traders and resource policy makers. However, given structural and process variables, it may have limited use as a policy tool.

- The **Overall Recycling Efficiency Rate** (Overall RER) indicates the efficiency with which end of life (EOL) scrap, new scrap, and other metal-bearing residues are collected and recycled by a network of collectors, processors, and metal recyclers. The key target audiences of this particular indicator are metal industry, scrap processors and scrap generators.

- The **EOL Recycling Efficiency Rate** (EOL RER) indicates the efficiency with which EOL scrap from obsolete products is recycled. This measure focuses on end-of-life management performance of products and provides important information to target audiences such as metal and recycling industries, product designers, life cycle analysts, and environmental policy makers.

Global Copper Recyclables Use, 2000-2005

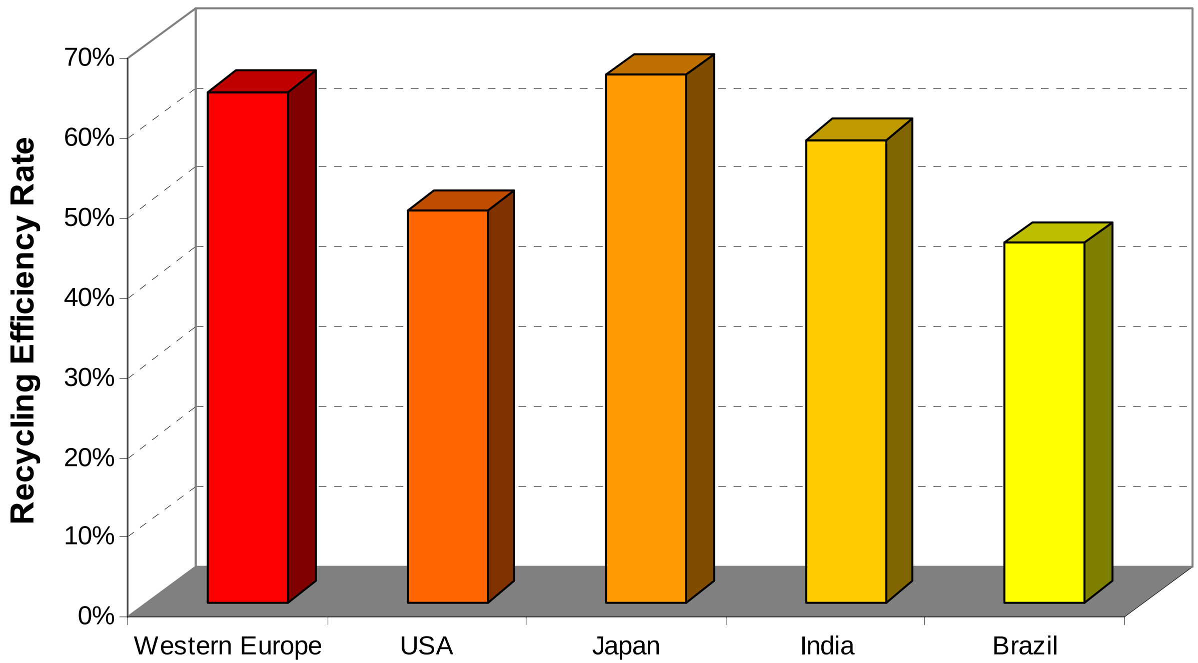
Thousand metric tonnes
Source: ICSG

	2000	**2001**	**2002**	**2003**	**2004**	**2005**
Americas	1,563	1,352	1,344	1,242	1,313	1,373
Asia	2,867	2,765	2,828	3,154	3,518	3,676
Middle East	143	172	208	215	190	184
Europe	3,189	2,752	2,652	2,452	2,582	2,459
Africa & Oceania	121	101	91	73	70	75
World Total	**7,744**	**6,975**	**6,921**	**6,926**	**7,488**	**7,591**
Total scrap use year-on-year		-10%	-1%	0%	8%	1%
Secondary refined production	2,090	1,846	1,862	1,759	2,037	2,130
Cu content of Direct Melt	5,654	5,129	5,059	5,167	5,451	5,461
Refined Usage	15,148	14,927	15,192	15,668	16,786	16,664
Total copper usage	20,802	20,056	20,251	20,836	22,237	22,125
Recycling Input Rate (RIR)	**37.2%**	**34.8%**	**34.2%**	**33.2%**	**33.7%**	**34.3%**

Recycling Input Rate by Region	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Asia	34.7%	33.0%	31.0%	31.9%	32.9%	33.5%
Europe	48.8%	43.8%	43.9%	40.9%	41.2%	41.4%
North America	29.3%	29.0%	29.8%	28.4%	27.7%	29.5%
Rest of the World	22.1%	18.2%	21.8%	19.6%	21.1%	21.8%
Total World	37.2%	34.8%	34.2%	33.2%	33.7%	34.3%

ICSG Copper Flow Model

The ICSG Secretariat developed the Copper Flow Model (CFM) as a key tool for understanding copper flows in a particular country and determining the efficiency of recycling of copper from end-of-life products. It was first applied for Western Europe and afterwards for the USA and Brazil. Comparable flow studies were published by other organizations in the context of projects commissioned by the ICSG and/or other governmental organizations (including China, India and Japan). The CFM aims to calculate balances at different stages of the copper flow and to cross check these with collected data. For instance, different approaches for estimating recycling efficiency of a particular product group can be applied and crosschecked. The chart below shows a comparison of the calculated Recycling Efficiency Rates for the different regions.



End-of-Life Management of Copper Products

Recycling is dependent on the efficiency of the scrap collection system of products at the end of their service life, technological and economic factors, product design, societal values, as well as the incentives and barriers introduced by society, including governments. Today, there are over 140 national and international laws, regulations, directives and guidelines that encourage responsible end-of-life management of copper-containing products by producers and consumers alike. These regulations provide a variety of requirements and incentives for products such as appliances, batteries, electronic equipment, telephones and motor vehicles, among others. In 2004, ICSG conducted a study on end-of-life vehicles that contained the following results:

Flow/Stock	European Union	Japan	USA
Copper stock in cars in use	~3.0 million tonnes	~0.8 million tonnes	~3.0 million tonnes
Copper available for recycling in one year	250,000 tonnes	75,000 tonnes	200,000 tonnes
Copper collected for domestic recovery	150,000 tonnes	65,000 tonnes	190,000 tonnes
Copper export in used end-of-life cars	50,000 tonnes	10,000 tonnes	n.a.

Copper and Sustainable Development

Copper and copper-based alloys are used in a variety of applications that are necessary for a reasonable standard of living. Its continued production and use is essential for society's development. How society exploits and uses its resources, while ensuring that tomorrow's needs are not compromised, is an important factor in ensuring society's sustainable development.

> Copper is distributed in the earth's crust and oceans in various forms and concentrations, which form the overall resource-base for copper.
>
> Often, there are references to "world reserves" of a metal. Reserves indicate the amount of material that can be economically extracted or produced at the time of determination. Improved extraction techniques and technologies, new discoveries, depletion and changes in economic conditions are some of the factors that alter reserve levels. For instance, world copper reserves have jumped from 90 million tonnes in 1950 to 280 and 480 million tonnes in 1970 and 2006, respectively.[1]

The demand for copper will continue to be met by the discovery of new deposits, technological improvements, efficient design, and by taking advantage of the renewable nature of copper through reuse and recycling. As well, competition between materials, and supply and demand principles, contribute to ensuring that materials are used efficiently and effectively.

Copper is an important contributor to the national economies of mature, newly developed and developing countries. Mining, processing, recycling and the transformation of metal into a multitude of products creates jobs and generates wealth. These activities contribute to building and maintaining a country's infrastructure, and create trade and investment opportunities. This is particularly important for lesser-developed countries seeking to improve their living standards.

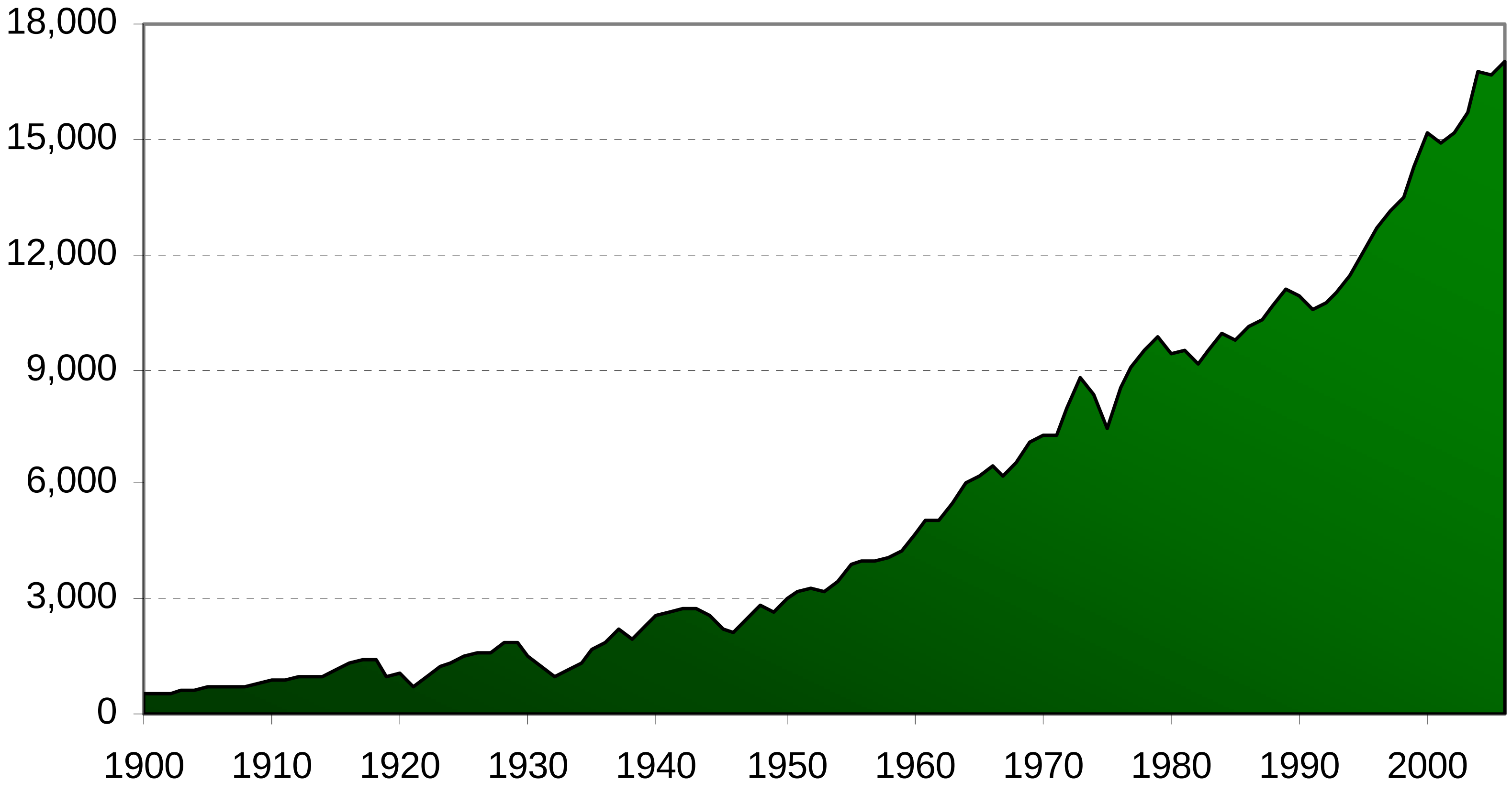
Copper will continue to contribute to society's development well into the future.

[1]Source: United States Geological Survey.

Chapter 3: World Copper Usage

World Copper Usage, 1900-2006

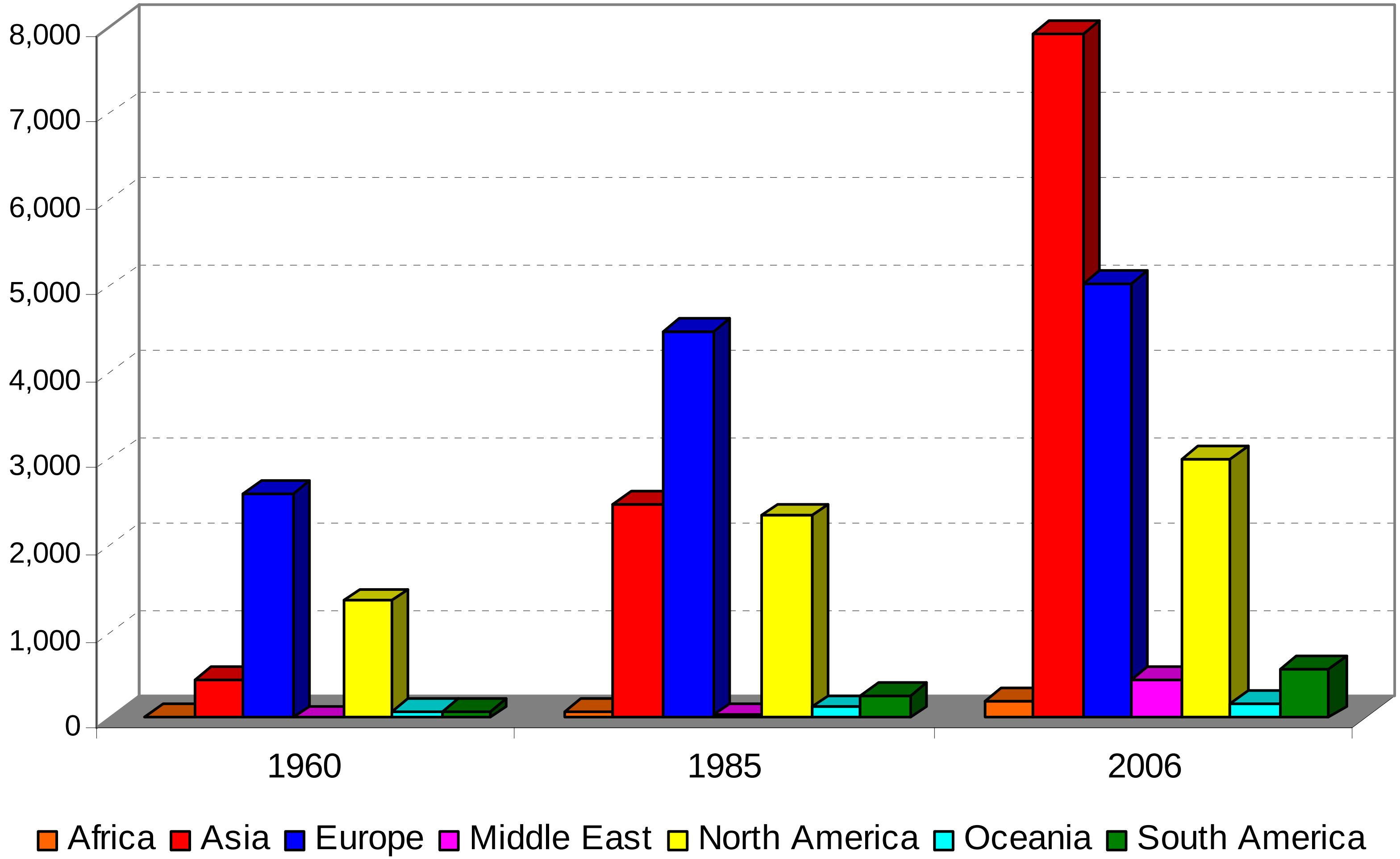
Thousand metric tonnes
Source: ICSG



Since 1900, demand for refined copper increased from 495 thousand metric tonnes to over 17 million metric tonnes in 2006 as demand over the period grew by an average of 4% per year.

Refined Copper Usage by Region

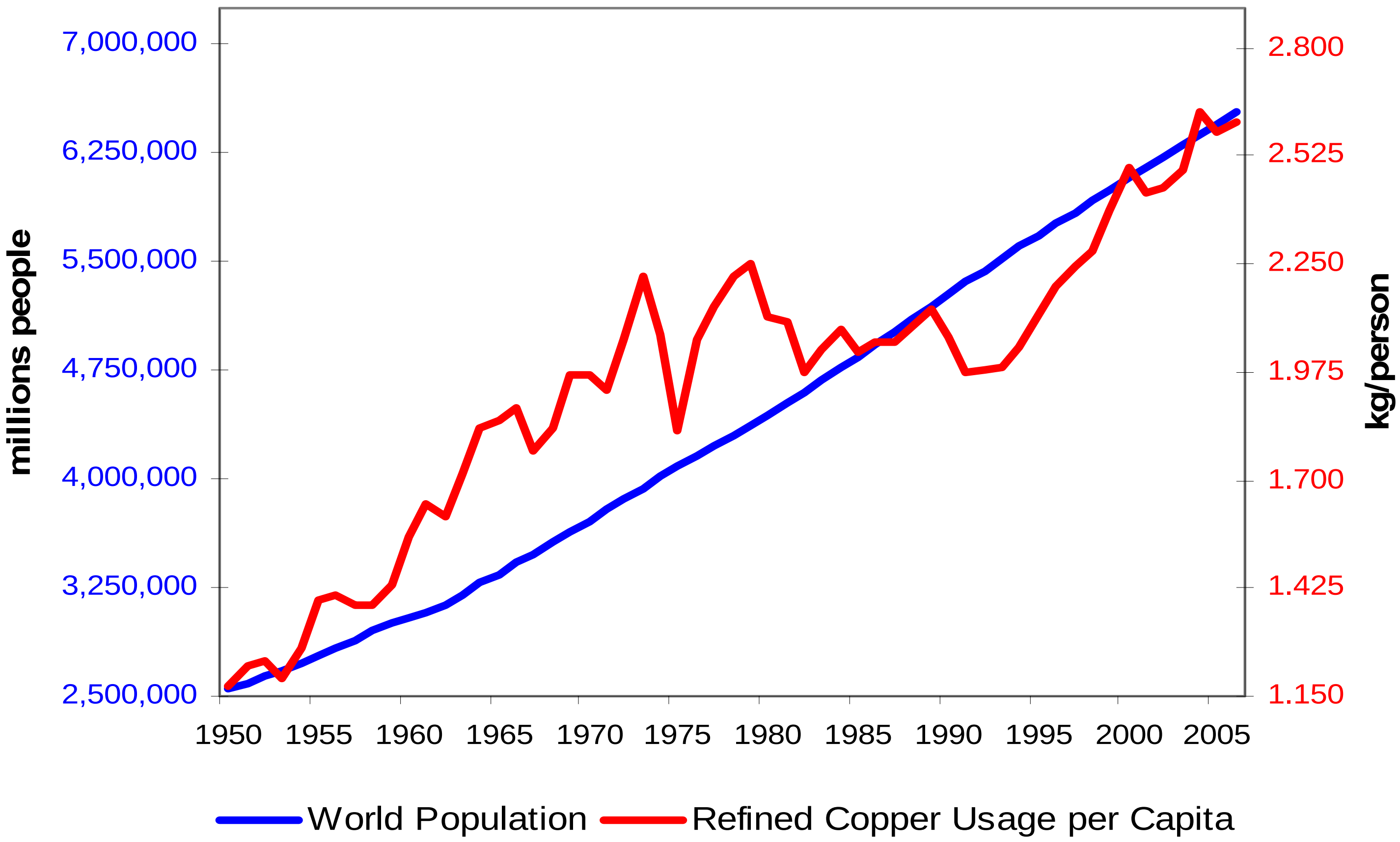
Thousand metric tonnes
Source: ICSG



From 1960 until 2006, demand for copper in Asia surged from 455 thousand metric tonnes to around 8,000 thousand metric tonnes.

Refined Usage per Capita, 1950-2006[1]

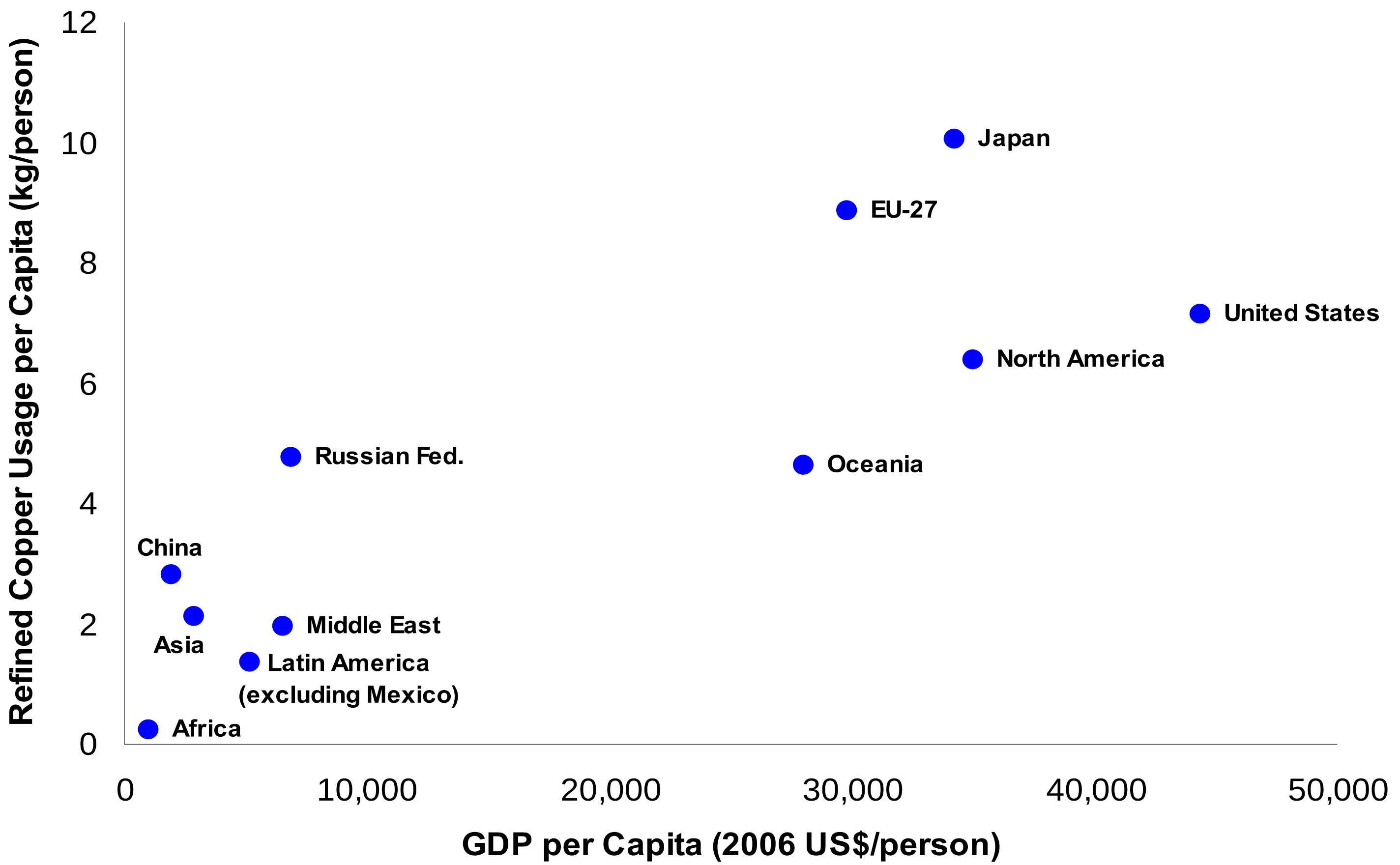
Sources: ICSG and U.S. Census Bureau



[1] Note: Refined copper is consumed by semis fabricators or the "first users" of refined copper, including ingot makers, master alloy plants, wire rod plants, brass mills, alloy wire mills, foundries and foil mills. As a result, per capita consumption of refined copper refers to the amount of copper consumed by industry divided by the total domestic population and does not represent consumption of copper in finished products per person.

Intensity of Refined Copper Use[1]

Sources: ICSG, International Monetary Fund, U.S. Census Bureau



The intensity of use for a material relates the demand (consumption) of that material to economic activity (gross domestic product, or GDP).

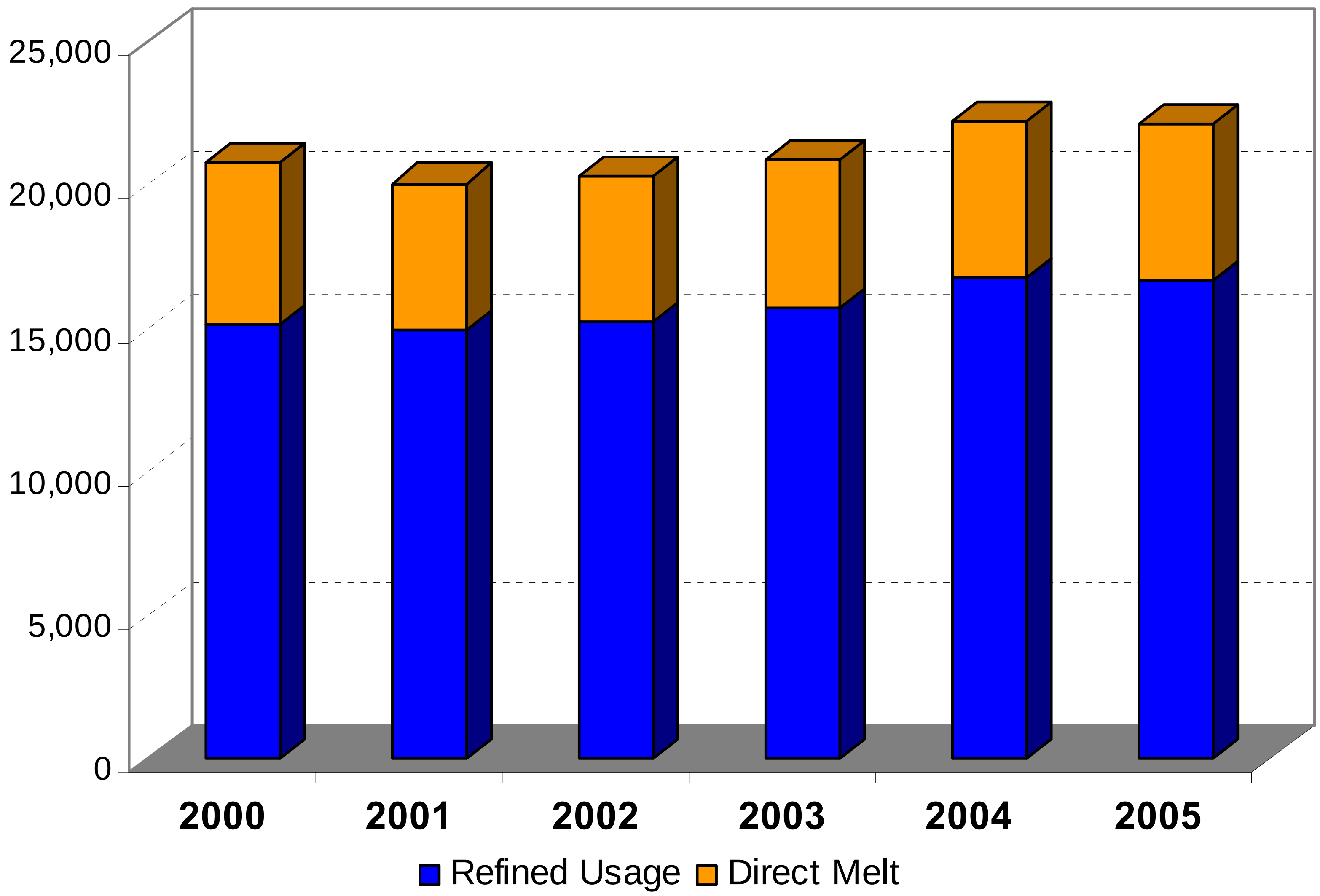
More developed regions of the world benefit from a well established infrastructure, to which copper is an important contributor.

As less developed regions expand their infrastructure, copper and other materials form the building blocks needed to increase living standards.

[1] Note: Refined copper is consumed by semis fabricators or the "first users" of refined copper, including ingot makers, master alloy plants, wire rod plants, brass mills, alloy wire mills, foundries and foil mills. As a result, per capita consumption of refined copper refers to the amount of copper consumed by industry divided by the total domestic population and does not represent consumption of copper in finished products per person.

Total Copper Use (Including Direct Melt Scrap), 2000-2005

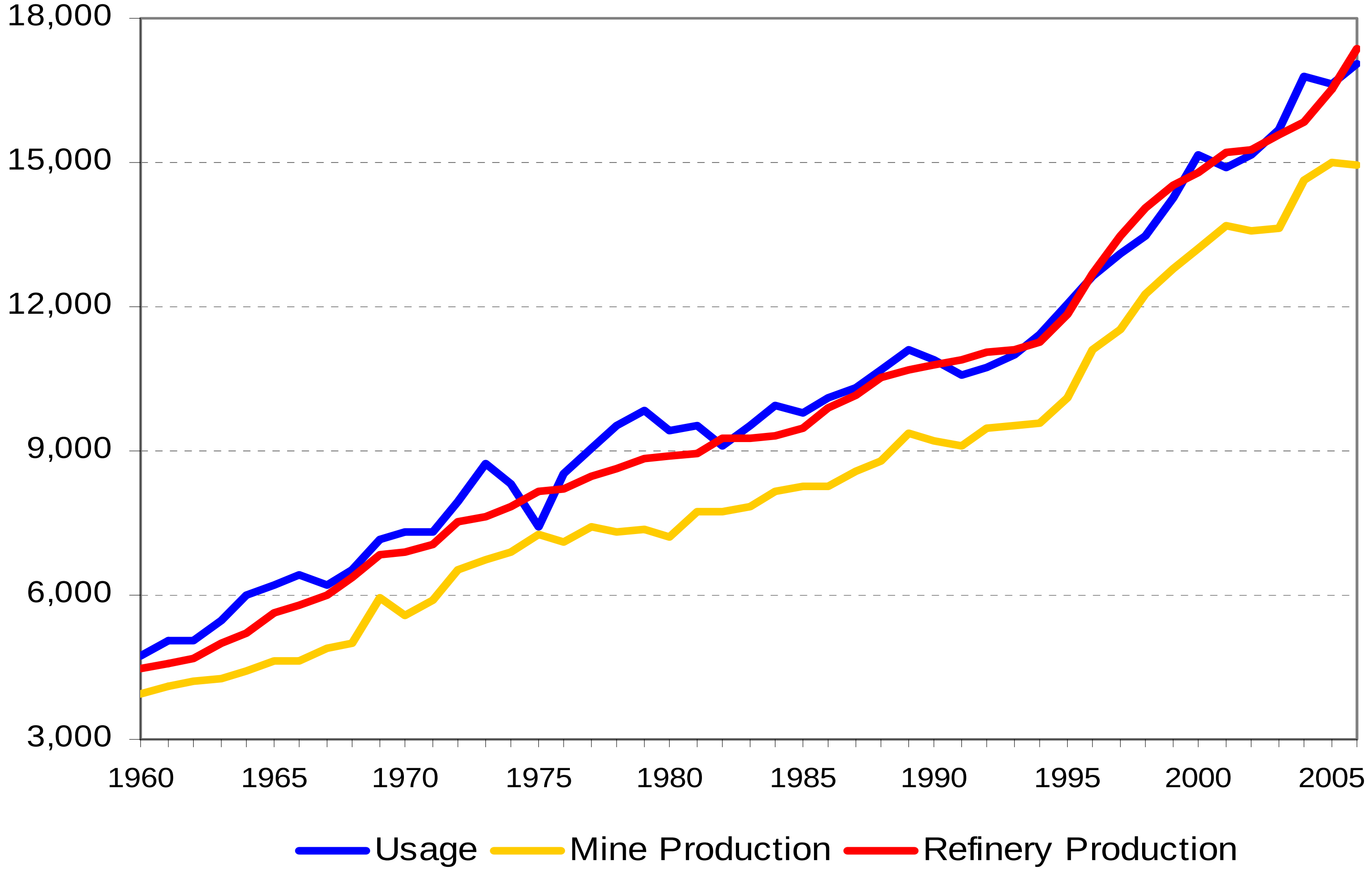
Thousand metric tonnes
Source: ICSG



Chapter 4: Copper Products Along the Value Chain

World Copper Production and Consumption, 1960-2006

Thousand metric tonnes
Source: ICSG



Economic, technological and societal factors influence the supply and demand of copper. As society's need for copper increases, new mines and plants are introduced and existing ones expanded. In times of market surplus, existing operations can be scaled back or closed down, while planned expansions can be delayed or canceled.

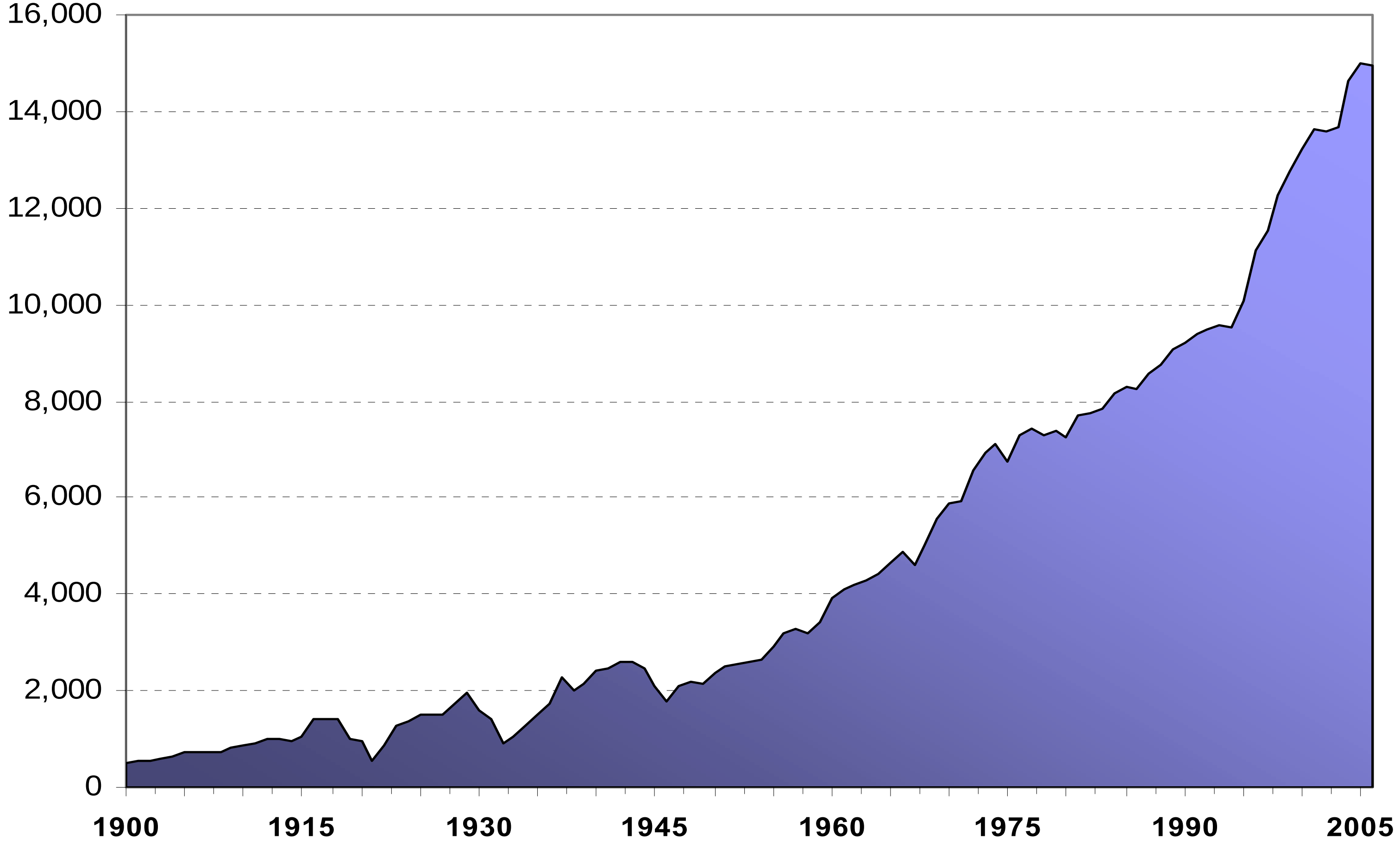
Copper Production and Usage by Country, 2006

Thousand metric tonnes
Source: ICSG

	Mine Production	Refined Production	Refined Usage
Argentina	180	16	30
Australia	859	429	143
Austria		88	33
Belgium		391	301
Botswana	24		
Brazil	143	220	339
Bulgaria	99	66	46
Canada	607	500	301
Chile	5,361	2,811	111
China	844	3,047	3,674
Colombia	2	10	10
Congo, Dem Rep	134		
Czech Republic			6
Egypt		4	107
Finland	13	138	83
France			540
Germany		662	1,398
Greece			88
Hungary			8
India	29	647	440
Indonesia	816	218	220
Iran	217	201	130
Italy		36	800
Japan	0	1,532	1,282
Kazakhstan	434	428	71
Korea, North	12	15	15
Korea, South	0	575	812
Laos	61	61	
Malaysia			189
Mauritania	7		
Mexico	338	318	302
Mongolia	132	3	
Morocco	5		
Myanmar	20	20	
Namibia	15		
Netherlands			34
Norway		40	
Oman		25	15
Pakistan	20		35
Papua New Guinea	194		
Peru	1,049	508	53
Philippines	18	181	50
Poland	497	556	267
Portugal	79		2
Romania	15	28	28
Russian Fed.	675	943	678
Saudi Arabia	1		185
South Africa	90	100	90
Spain	7	256	319
Sweden	87	229	184
Switzerland			5
Taipei, China			639
Thailand		20	261
Turkey	46	106	320
United Arab Emirates			20
United Kingdom			180
United States	1,220	1,250	2,130
Uzbekistan	80	115	45
Vietnam	5		75
Zambia	509	461	27
Zimbabwe	3	7	10

Copper Mine Production, 1900-2006

Thousand metric tonnes (copper content)
Source: ICSG

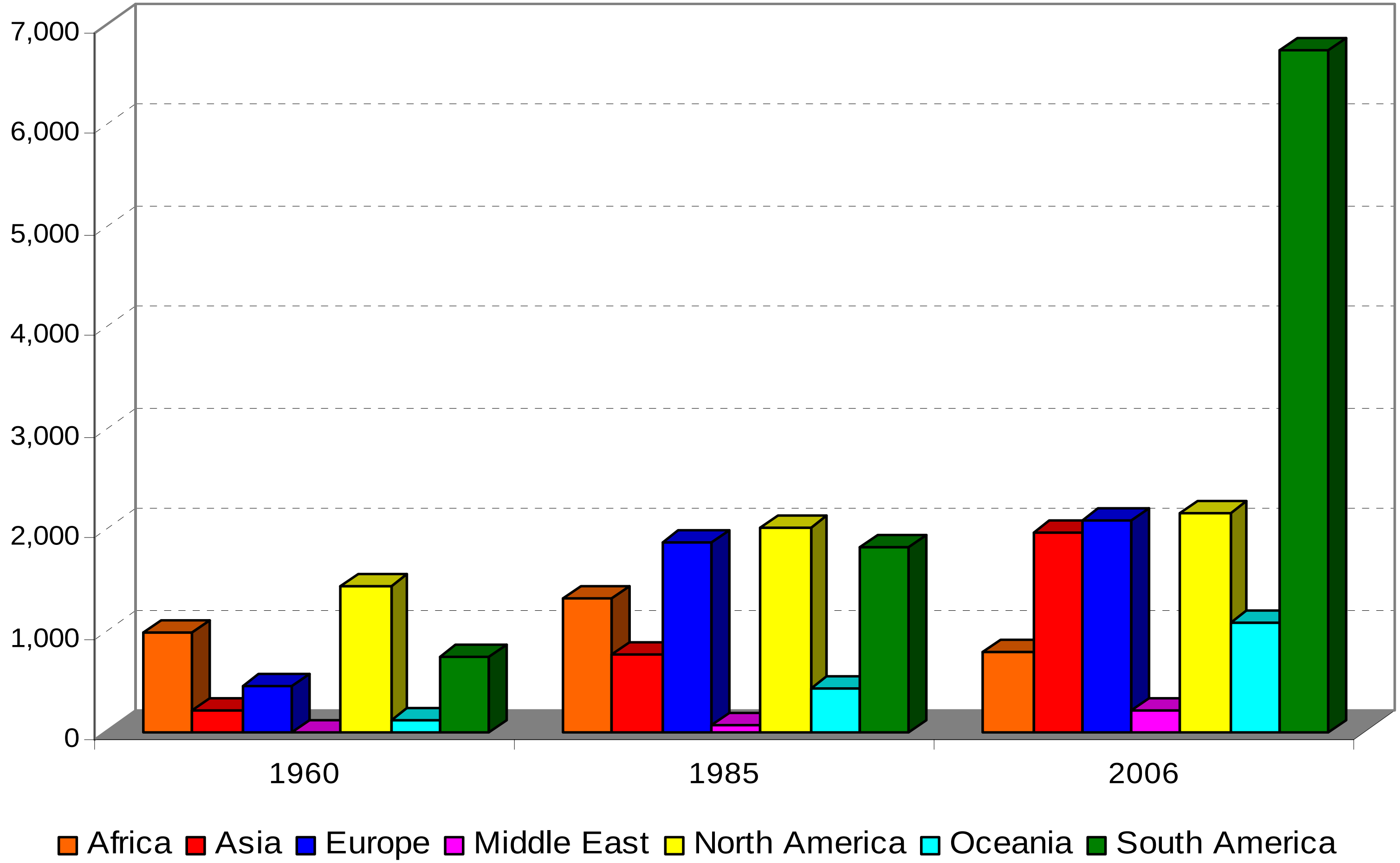


World production:
1900: 495 kt
2006: 15,008 kt

Average annual growth rate since 1900: 4%

Copper Mine Production by Region

Thousand metric tonnes
Source: ICSG

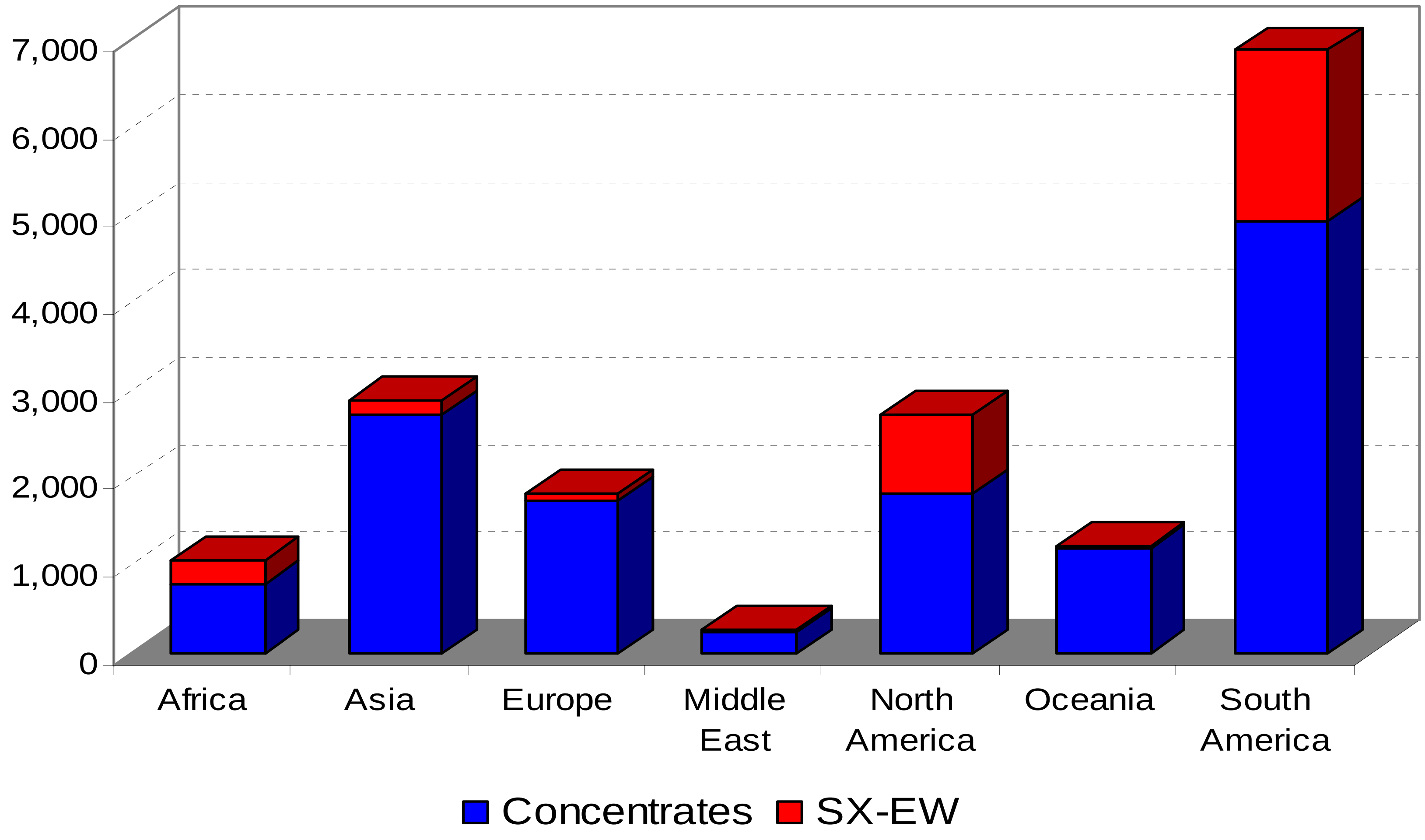


Copper Mine Production in South America:
1900: 731 kt
2006: 6,735 kt

Reason: Chile's share of world copper mine production increased from 14% in 1960 to 36% in 2006, producing 5,361 thousand tonnes last year.

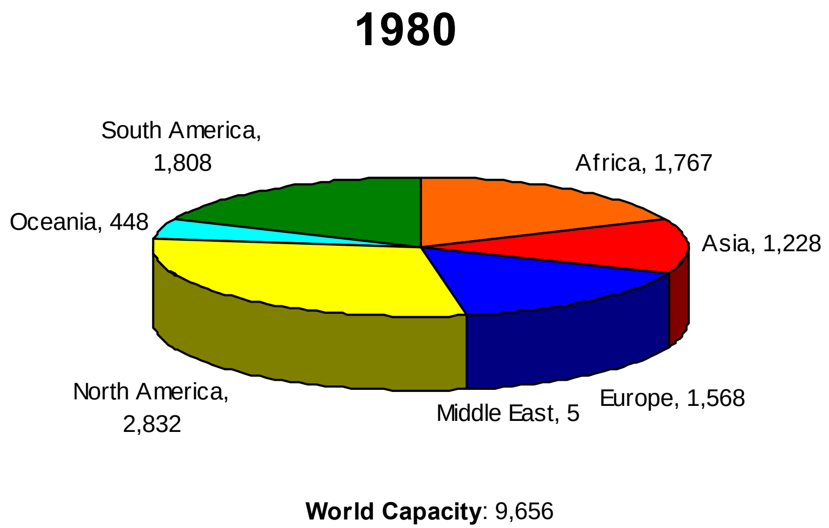
Copper Mine Capacity by Region, 2006

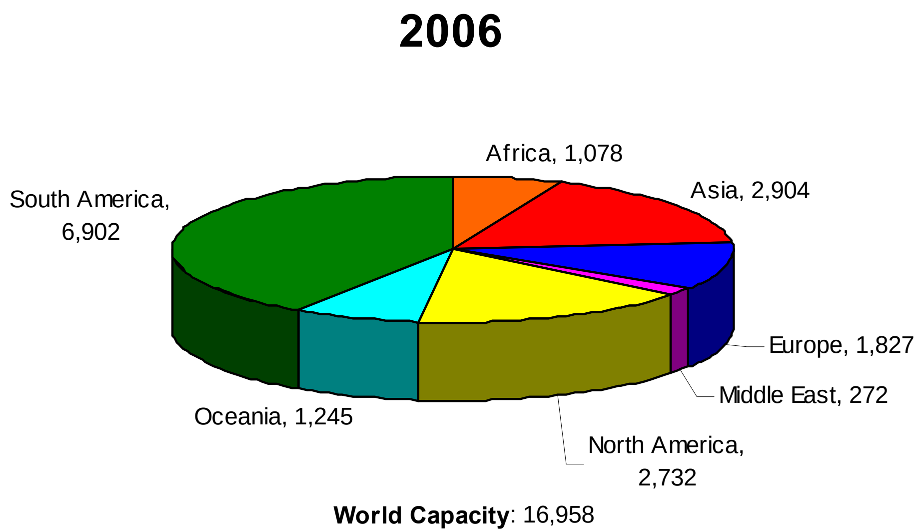
Thousand metric tonnes
Source: ICSG



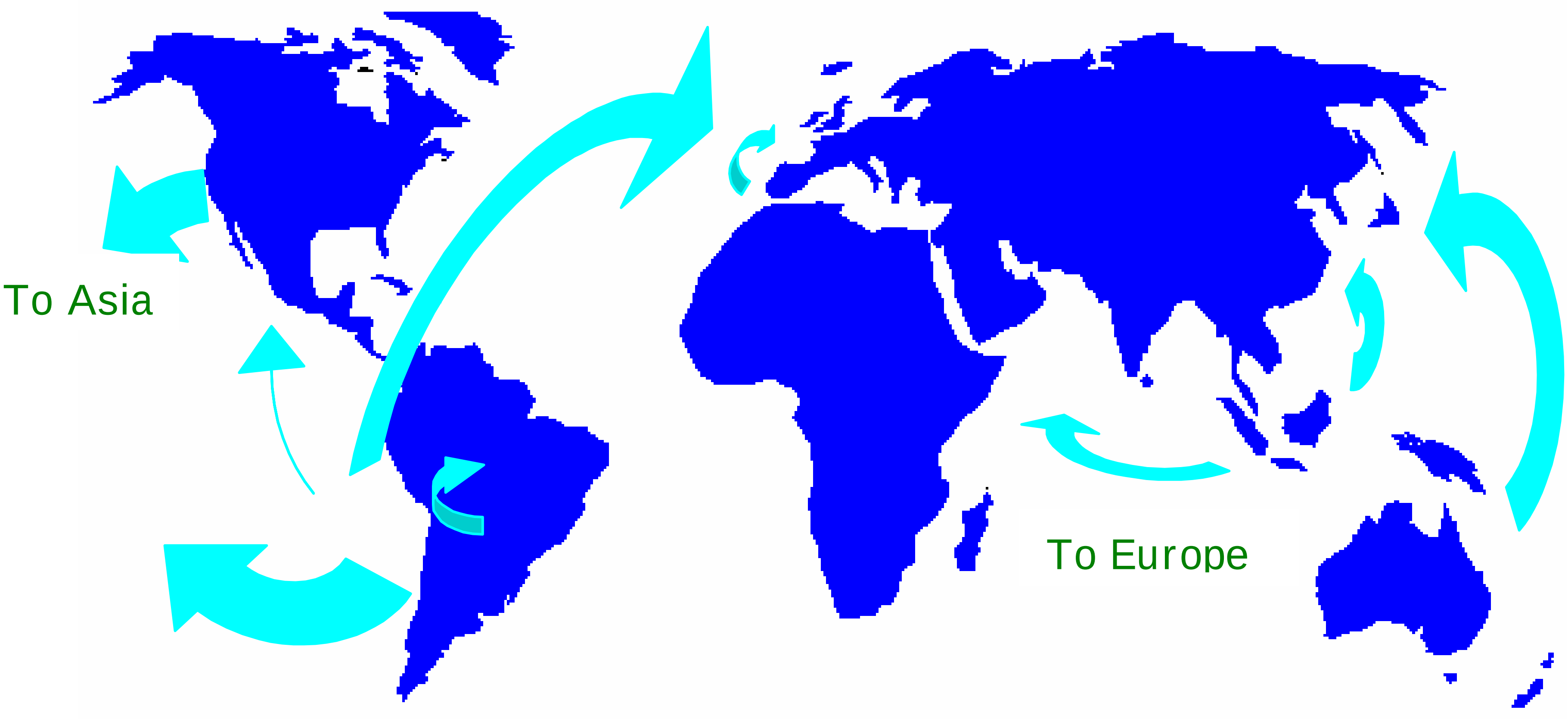
Copper Mine Capacity, 1980 and 2006

Thousand metric tonnes
Source: ICSG



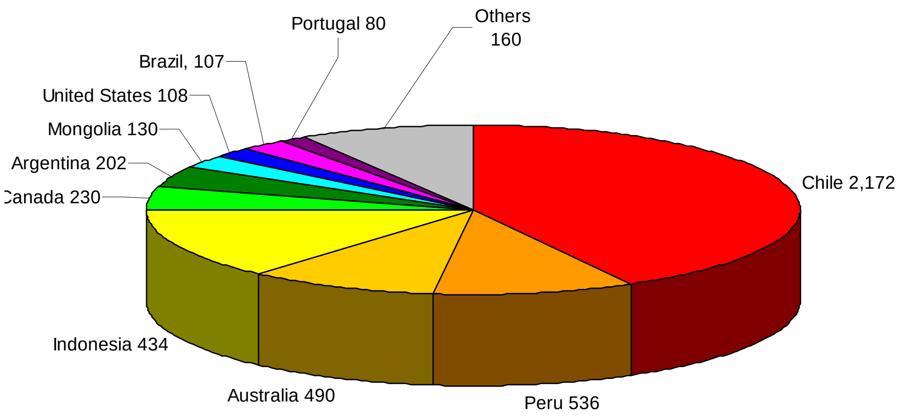


Trade Flow of Copper Ores and Concentrates

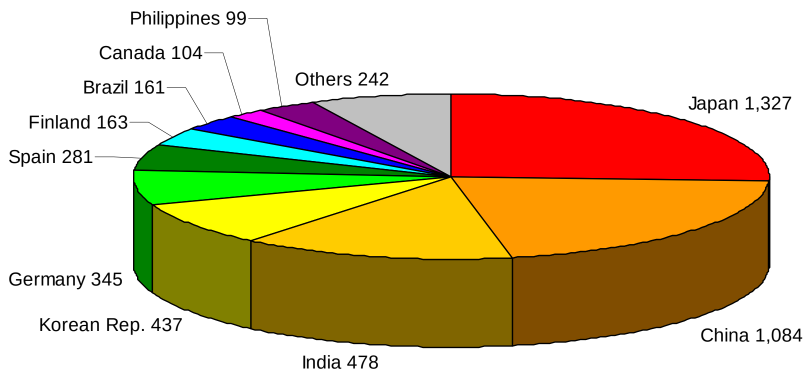


Leading Exporters and Importers of Copper Ores and Concentrates, 2006

Thousand metric tonnes copper content
Source: ICSG



World Total: 5,188



World Total: 5,230

Top 20 Copper Mines by Capacity, 2006

Thousand metric tonnes
Source: ICSG

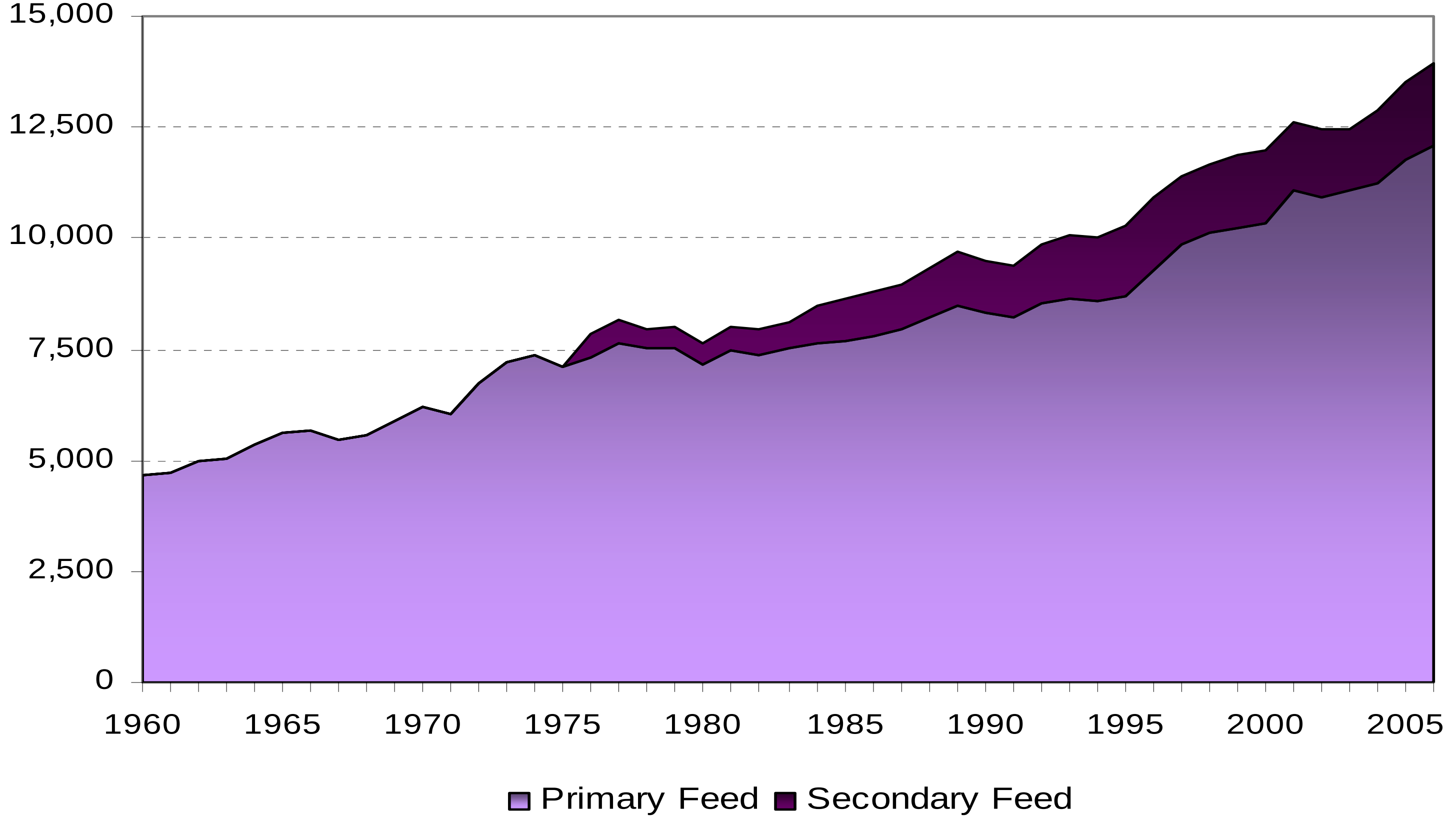
Rank	Mine Name	Capacity	Country	Owner(s)
1	Escondida	1,311	Chile	BHP Billiton, Rio Tinto, Japan Escondida
2	Codelco Norte	957	Chile	Codelco
3	Grasberg	750	Indonesia	P.T. Freeport Indonesia, Rio Tinto
4	Collahuasi	450	Chile	Anglo American, Xstrata plc, Mitsui, Nippon
5	Morenci	430	United States	Freeport McMoran Copper & Gold, Sumitomo
6	Taimyr Peninsula	430	Russian Federation	Norilsk Nickel
7	El Teniente	418	Chile	Codelco
8	Antamina	400	Peru	BHP Billiton, Teck, Xstrata plc, Mitsubishi
9	Los Pelambres	335	Chile	Antofagasta Holdings, Nippon Mining, Mitsubishi Materials
10	Batu Hijau	300	Indonesia	P.T. Pukuafu Indah, Newmont, Sumitomo Corp., Sumitomo Metall Mining
11	Bingham Canyon	280	United States	Kennecott
12	Olympic Dam	255	Australia	BHP Billiton
13	Andina	236	Chile	Codelco
14	Zhezkazgan Complex	230	Kazakhstan	Kazakhmys
15	Los Bronces	226	Chile	Anglo American
16	Rudna	220	Poland	KGHM Polska Miedz S.A.
17	El Abra	219	Chile	Codelco, Freeport McMoran Copper & Gold
18	Mount Isa	212	Australia	Xstrata plc
19	Toquepala	210	Peru	Southern Copper Corp.
20	Cananea	210	Mexico	Grupo Mexico

In 2006, Chile contained 5 of the top 10 and 8 of the top 20 copper mines by capacity in the world.

Copper Smelter Production[1]

Thousand metric tonnes

Sources: ICSG and U.S. Geological Survey



Smelting is the pyrometallurgical process used to produce copper metal. Recently, the trend to recover copper directly from ores through leaching processes has been on the increase.

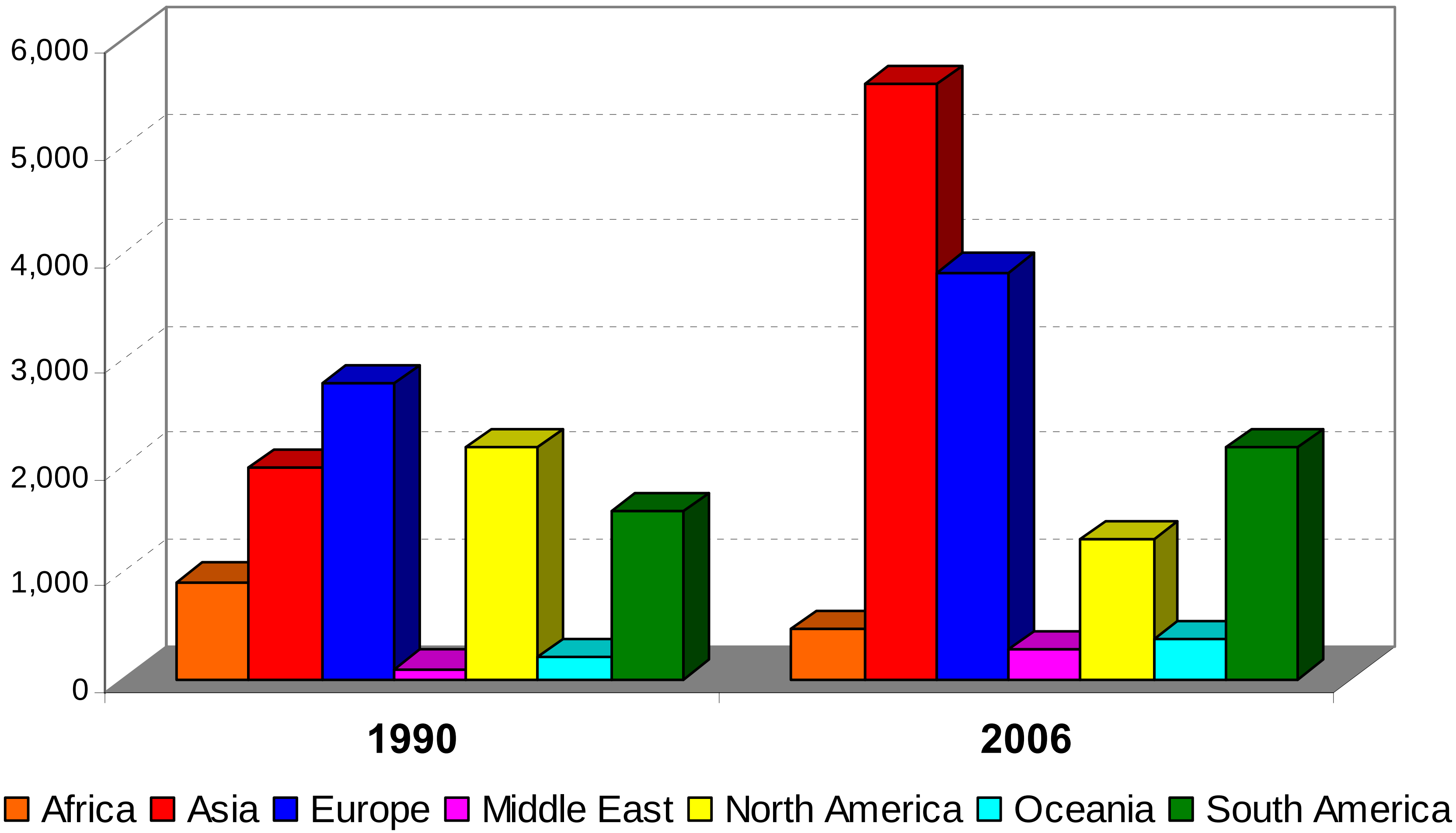
Primary smelters use mine concentrates as their main source of feed (although some use copper scrap as well).

Secondary copper smelters use copper scrap (mainly low grade) as their feed.

[1] Prior to 1975, secondary smelter production in included in primary production figures.

Copper Smelter Production by Region

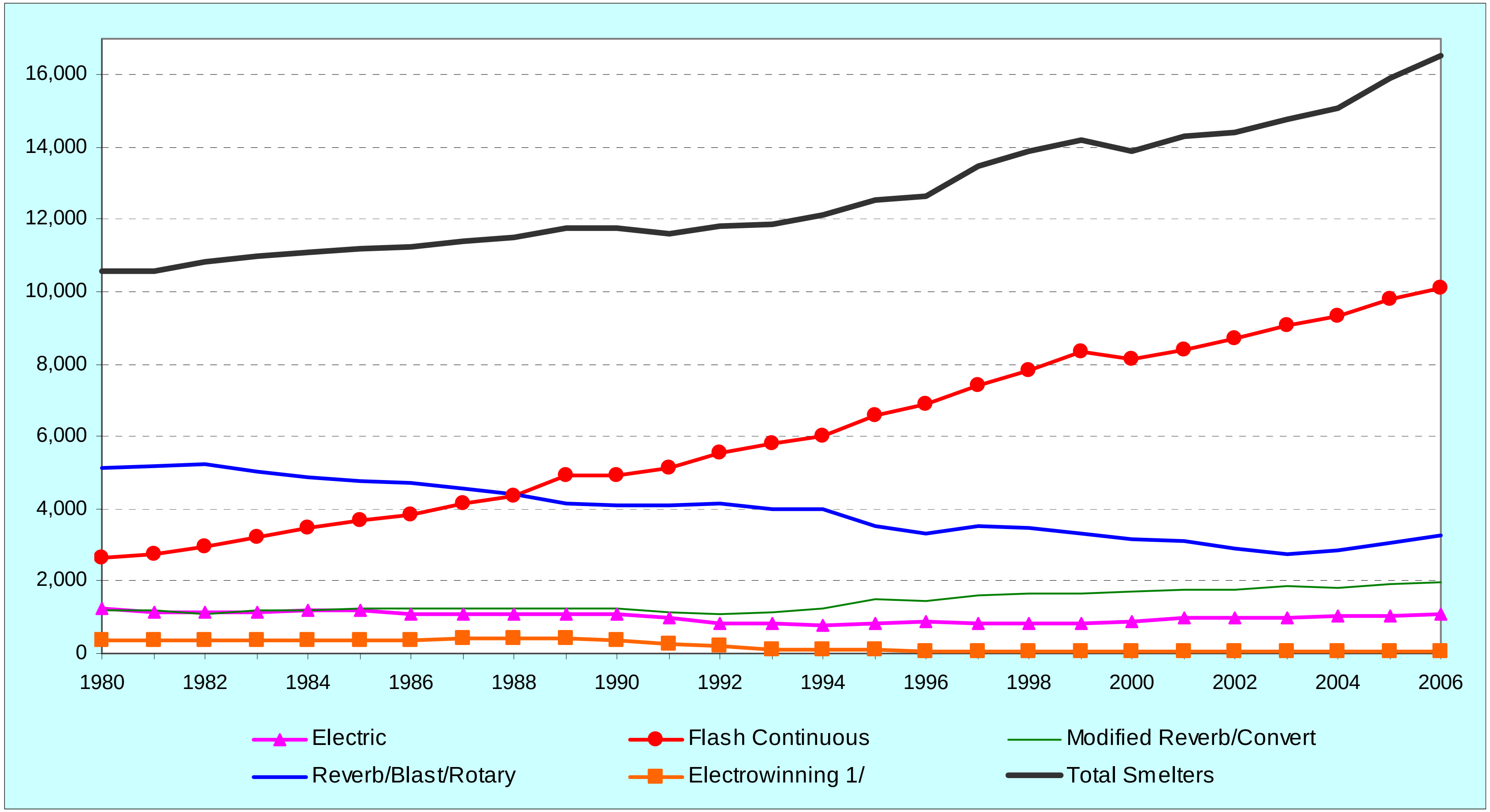
Thousand metric tonnes
Source: ICSG



Trends in Copper Smelting Capacity, 1980-2006

Thousand metric tonnes

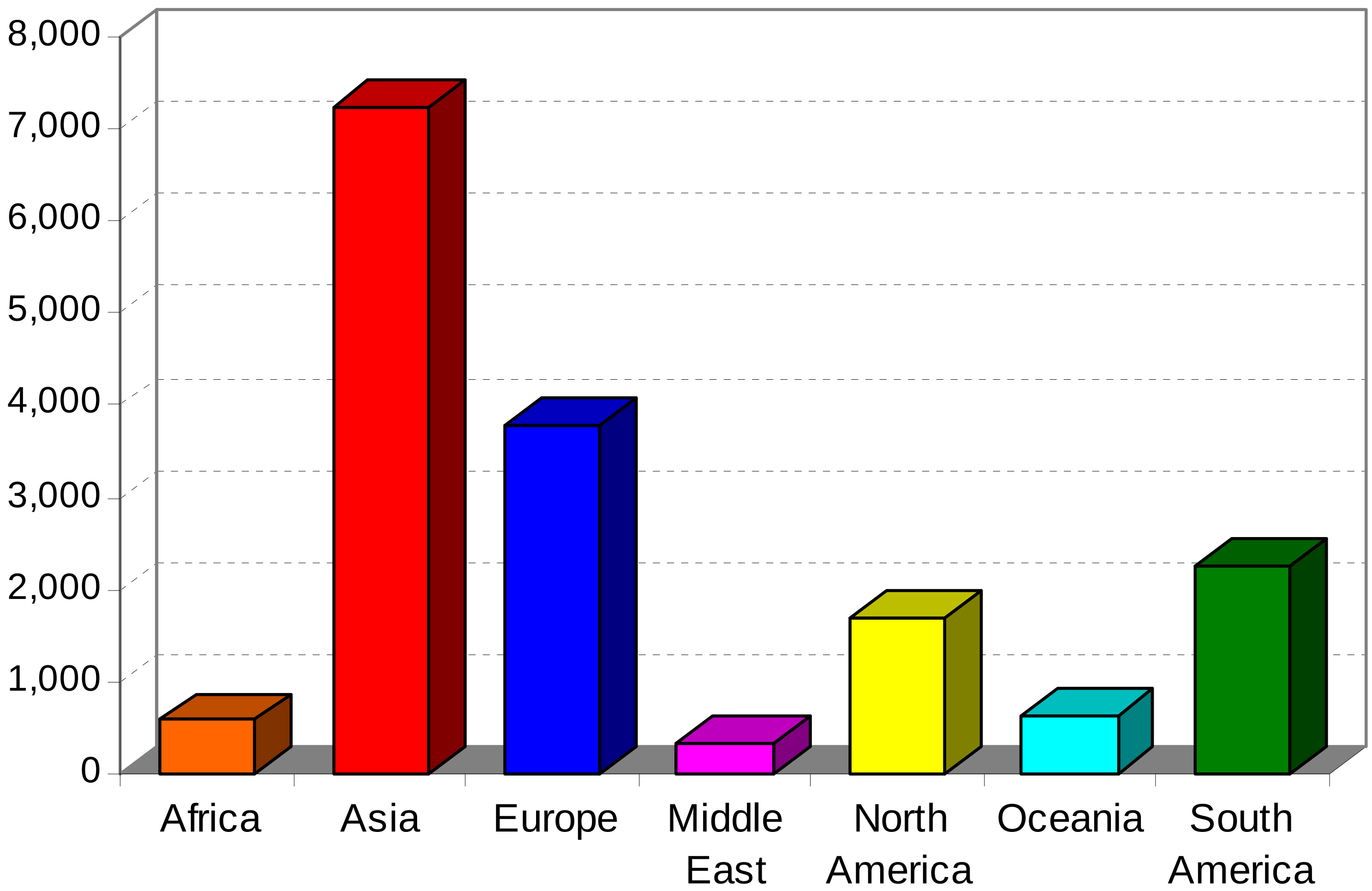
Source: ICSG



1/ Low grade copper to be re-refined.

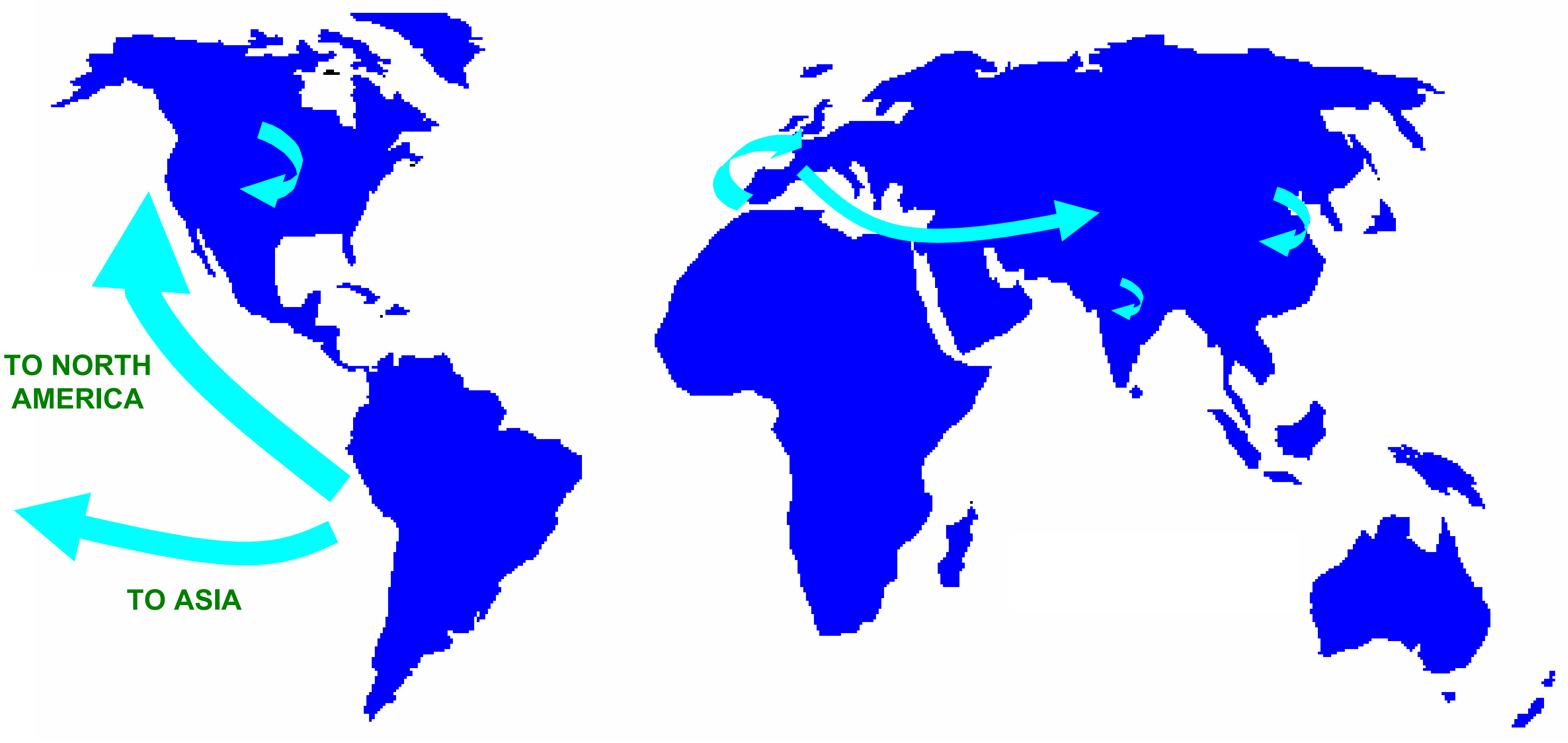
Copper Smelter Capacity, 2006

Thousand metric tonnes
Source: ICSG



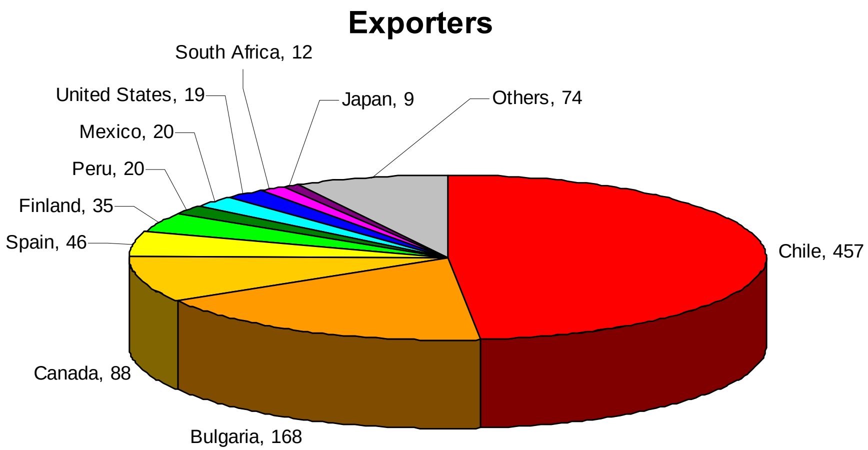
China accounted for 16%, or 2.7 million metric tonnes, of the world's total smelter capacity of 16.5 million metric tonnes in 2006.

Trade Flow of Copper Blister and Anodes

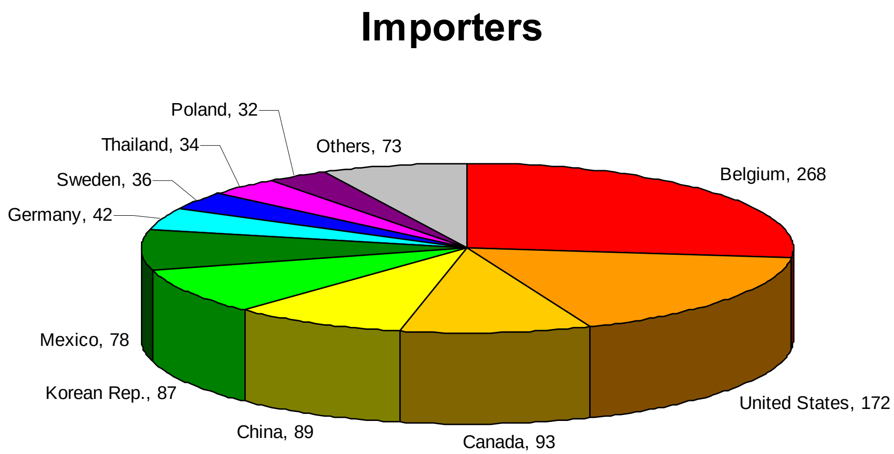


Leading Exporters and Importers of Copper Blister and Anodes, 2006

Thousand metric tonnes
Source: ICSG



World Total: 948



World Total: 1,010

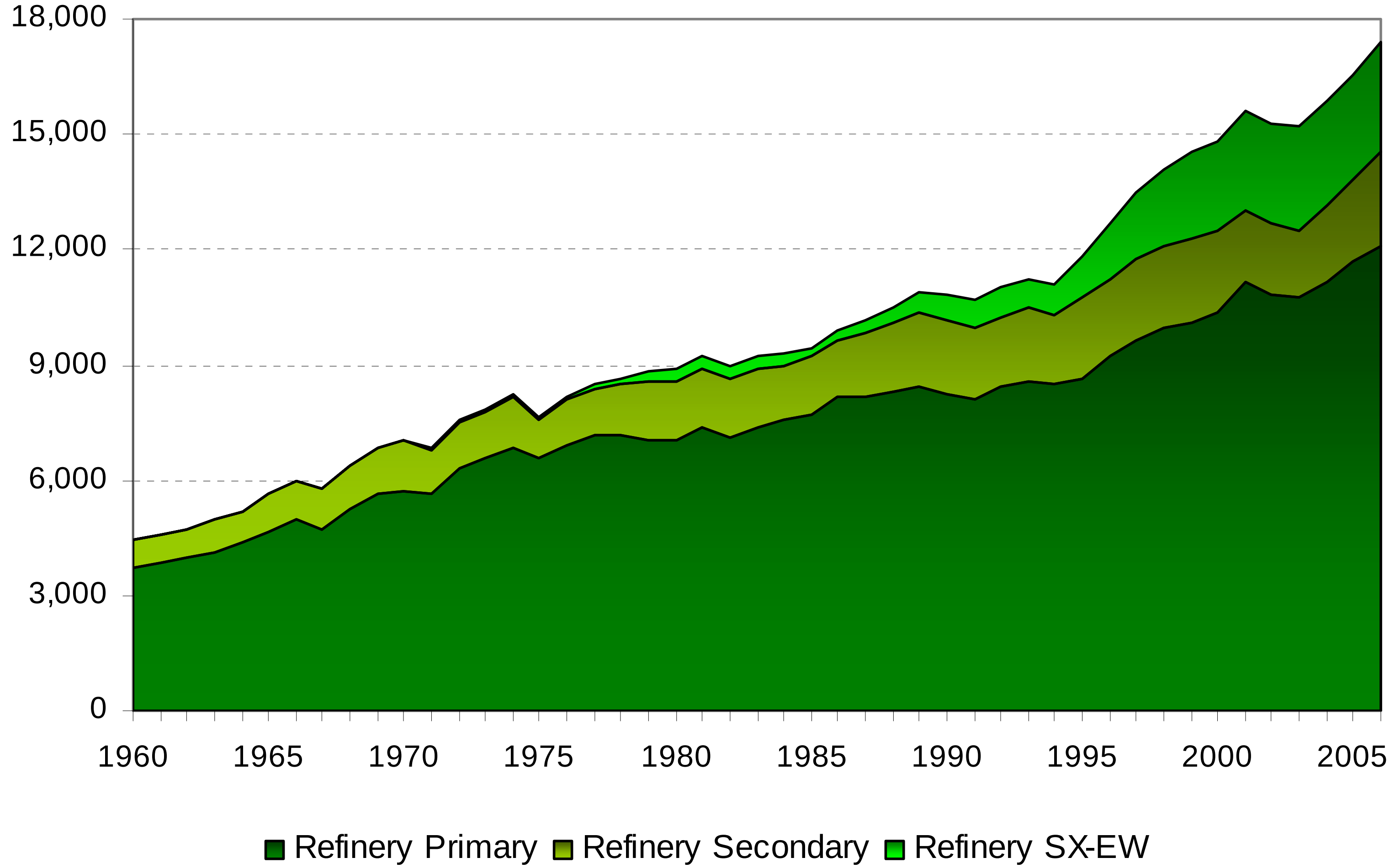
Top 20 Smelters by Capacity, 2006

Thousand metric tonnes
Source: ICSG

Rank	Smelter Name	Capacity	Process	Country	Owner(s)
1	Birla Copper (Dahej)	500	Outokumpu Flash, Ausmelt, Mitsubishi Continuous	India	Birla Group
2	Norddeutsche Affinerie	450	Outokumpu, Contimelt, Electric	Germany	Norddeutsche Affinerie AG
2	Saganoseki/ Ooita	450	Outokumpu Flash	Japan	Pan Pacific Copper Co. Ltd
4	Codelco Norte	400	Outokumpu/Teniente Converter	Chile	Codelco
4	Guixi	400	Outokumpu Flash	China	Jiangxi Copper Corp.
4	Norilsk (Nikelevy, Medny)	400	Reverb, Electric, Vanyukov	Russia	Norilsk G-M
7	El Teniente (Caletones)	391	Reverberatory/ Teniente Conv.	Chile	Codelco Chile
8	Besshi/ Ehime (Toyo)	365	Outokumpu Flash	Japan	Sumitomo Metal Mining Co. Ltd.
9	Jinchuan	350	Reverberatory/ Kaldo Conv.	China	Jinchuan Non- Ferrous Metal Co.
9	Yunnan	350	Isasmelt Process	China	Yunnan Copper Industry Group (Local Government)
11	Onahama/ Fukushima	324	Reverberatory	Japan	Mitsubishi Materials Corp., Dowa Metals & Mining Co. Ltd., Furukawa Metals & Resources Co. Ltd.
12	Huelva	320	Outokumpu Flash	Spain	Atlantic Copper S.A. (Freeport McMoran)
12	Garfield	320	Kennecott/ Outokumpu	United States	Kennecott (Rio Tinto)
14	Ilo Smelter	315	Isasmelt Process	Peru	Southern Copper Corp. (Grupo Mexico)
15	Naoshima/ Kagawa	312	Mitsubishi Continuous	Japan	Mitsubishi Materials Corp.
16	Sterlite Smelter (Tuticorin)	300	Isasmelt Process	India	Vedanta
17	Onsan II	300	Mitsubishi Continuous	Korea Republic	LS-Nikko Co. (LS, Nippon Mining)
17	La Caridad	300	Outokumpu/ Teniente Converter	Mexico	Mexicana de Cobre S. A. (Grupo Mexico)
19	Altonorte (La Negra)	290	Noranda Continuous	Chile	Xstrata plc
20	Gresik	260	Mitsubishi Flash	Indonesia	Mitsubishi, Freeport McMoran

Refined Copper Production, 1960-2006

Thousand metric tonnes
Source: ICSG

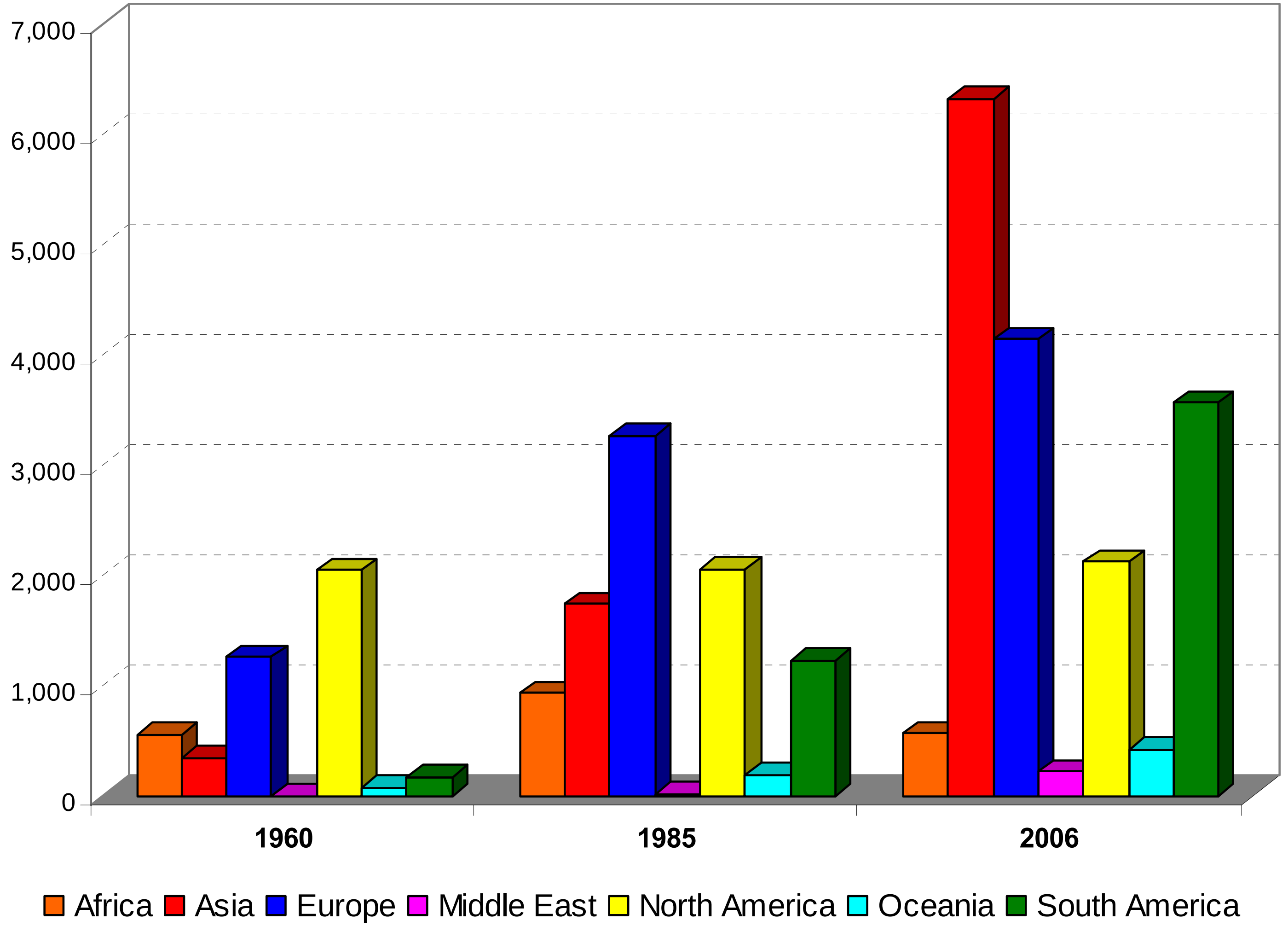


With the gradual emergence of solvent extraction-electrowinning (SX-EW) technology, refined copper produced from leaching ores now accounts for 16% of production.

Recognizing the economic and environmental importance of recycling, part of refined production is sourced from scrap.

Refined Copper Production by Region

Thousand metric tonnes
Source: ICSG

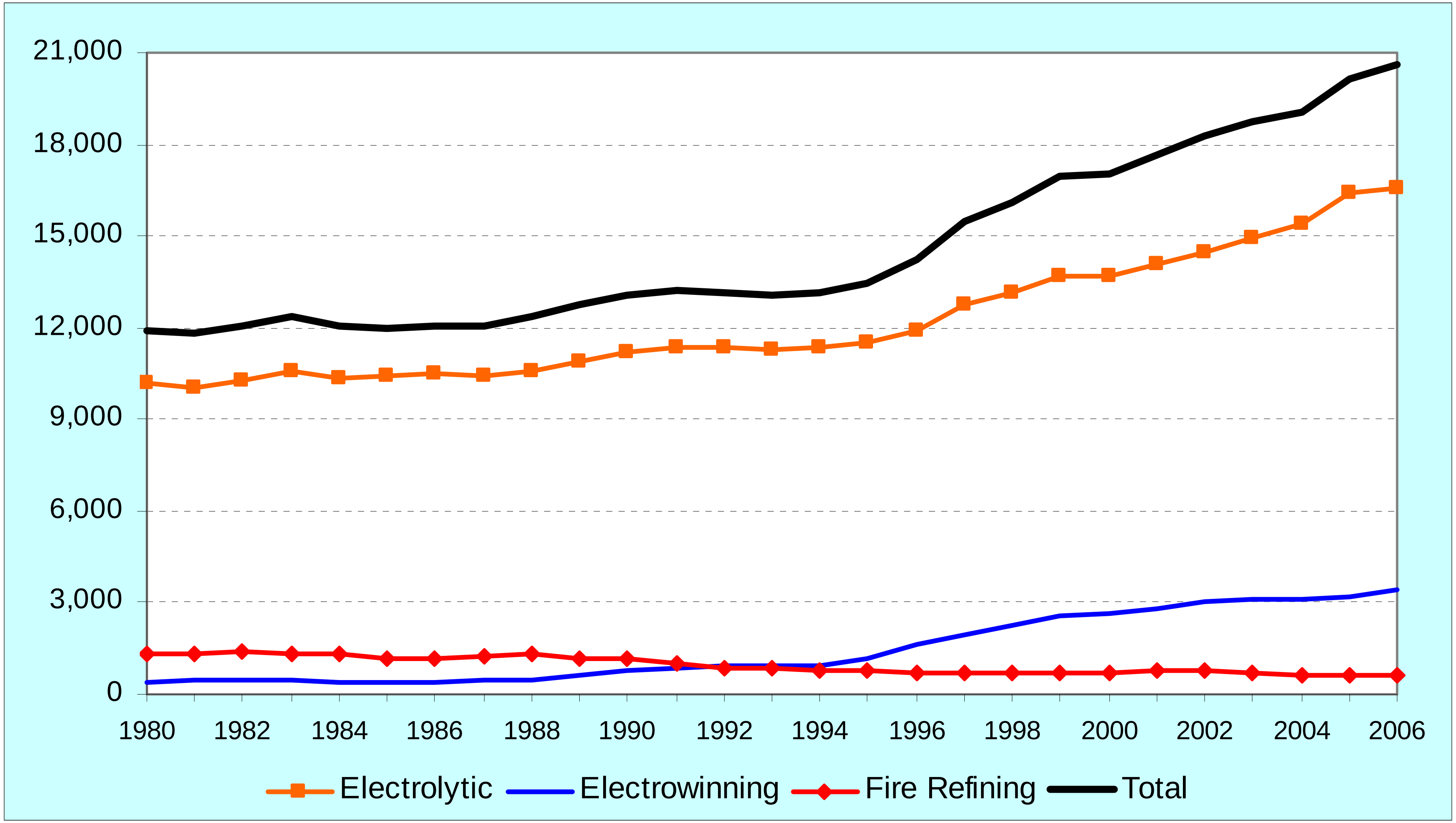


Asian share of world refined copper production:

1960: 8%
1985: 18%
2006: 36%.

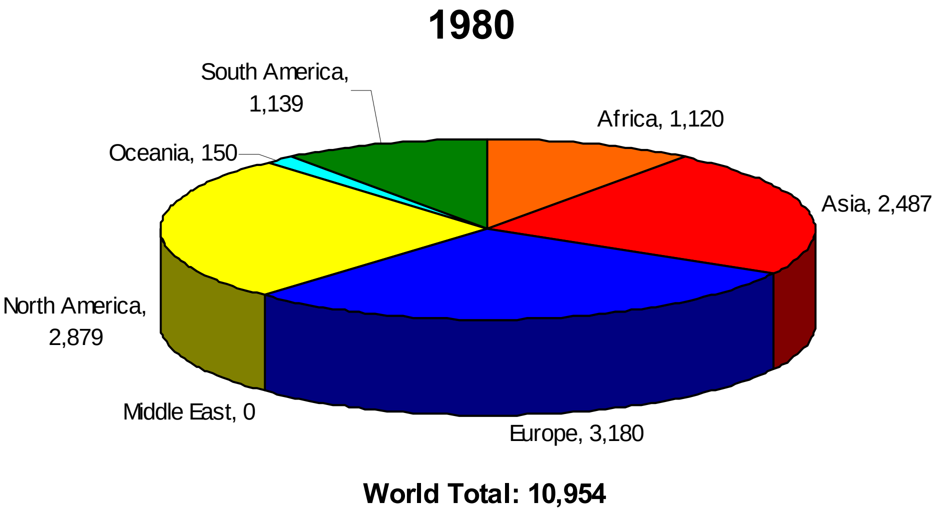
Trends in Refining Capacity, 1980-2006

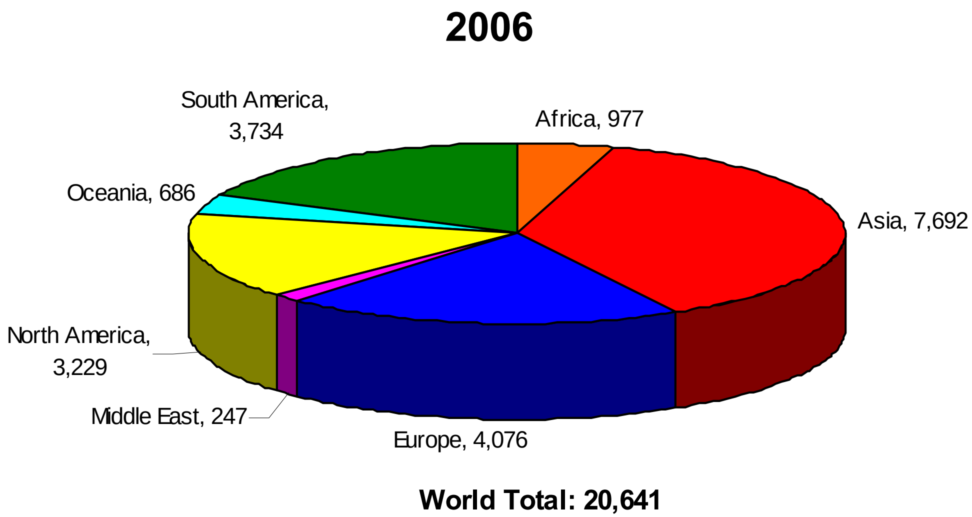
Thousand metric tonnes
Source: ICSG



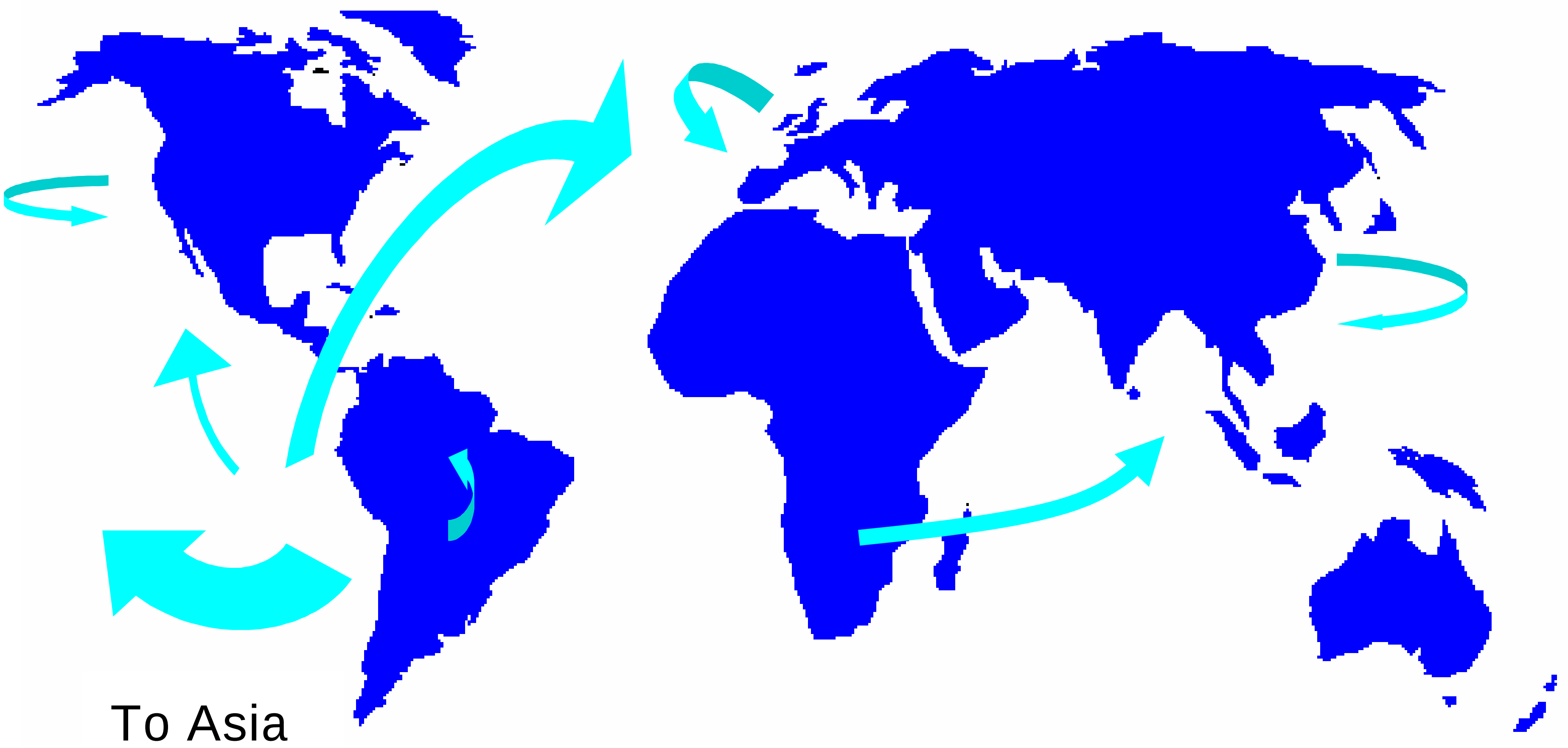
Refined Copper Capacity

Thousand metric tonnes
Source: ICSG



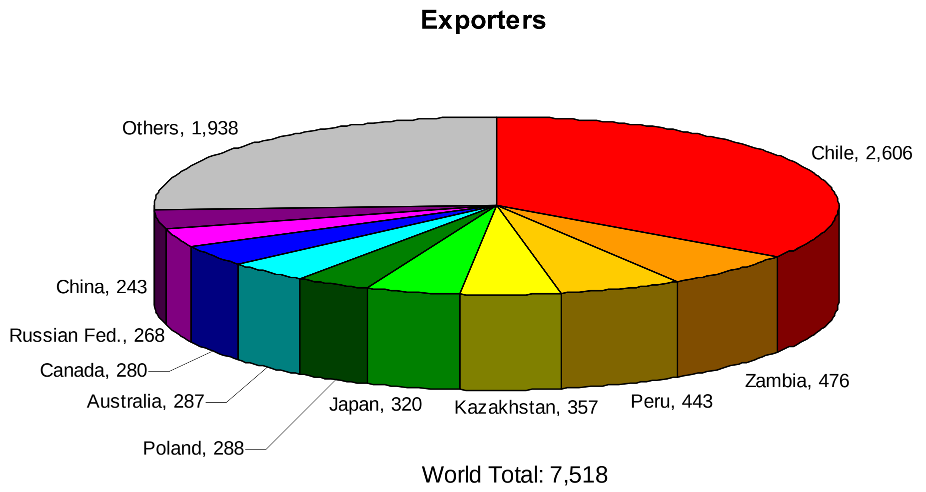


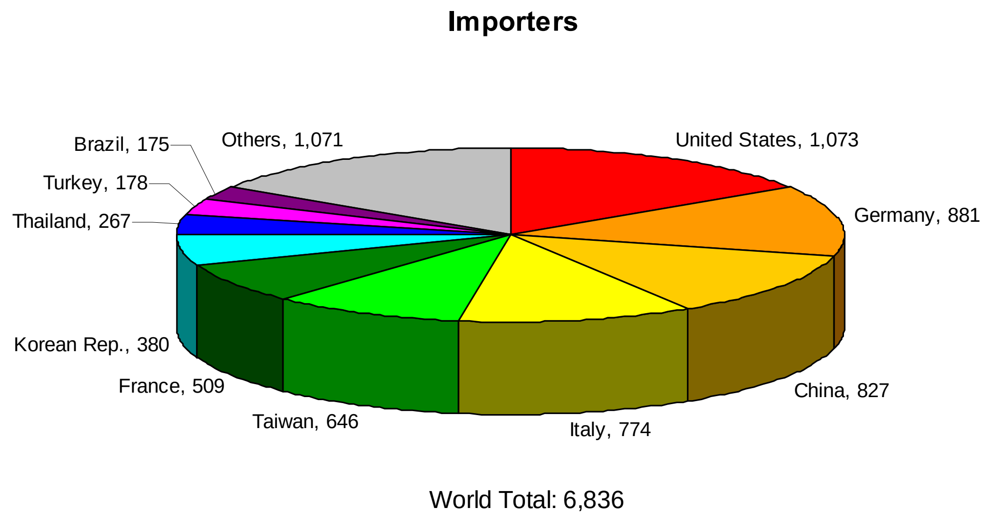
Trade Flow of Refined Copper



Leading Exporters and Importers of Refined Copper, 2006

Thousand metric tonnes
Source: ICSG





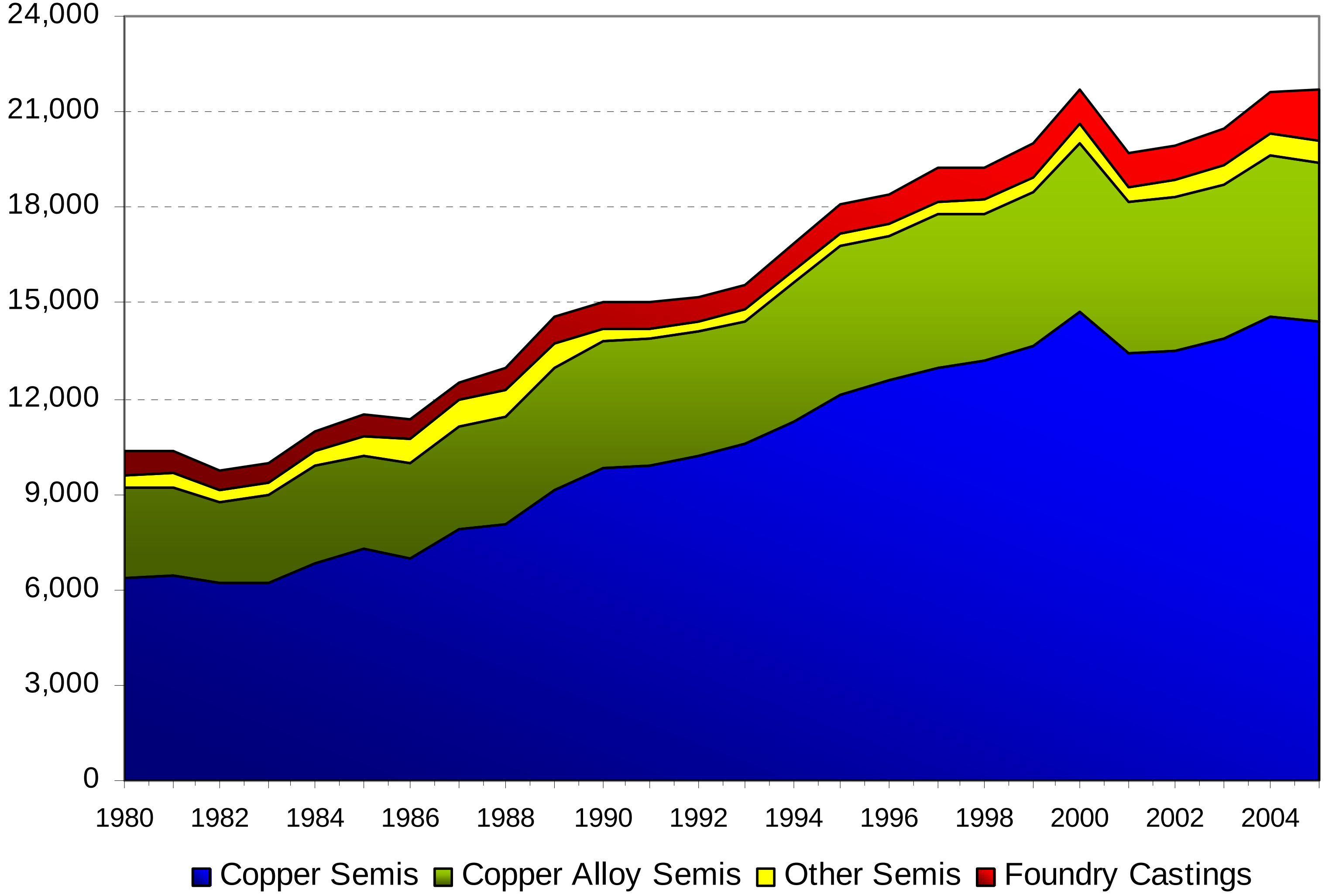
Top 20 Copper Refineries by Capacity, 2006

Thousand metric tonnes
Source: ICSG

Rank	Refinery Name	Capacity	Process	Country	Owner(s)
1	Birla	500	Electrolytic	India	Birla Group
2	Codelco Norte	457	Electrowinning	Chile	Codelco
3	Amarillo	450	Electrolytic	United States	Grupo Mexico
4	Chuquicamata Refinery	443	Electrolytic	Chile	Codelco
5	Morenci	420	Electrowinning	United States	Freeport-McMoRan Copper & Gold Inc., Sumitomo
6	El Paso	415	Electrolytic	United States	Freeport-McMoRan Copper & Gold Inc.
7	Guixi	400	Electrolytic	China	Jiangxi Copper Corporation
8	Norddeutsche Affinerie	385	Electrolytic	Germany	Norddeutsche Affinerie AG
9	CCR Refinery (Montreal)	380	Electrolytic	Canada	Xstrata plc
9	Pyshma Refinery	380	Electrolytic	Russia	Uralelectromed (Urals Mining & Metallurgical Co.)
11	Las Ventanas	376	Electrolytic	Chile	Codelco
12	Toyo/Niihama (Besshi)	365	Electrolytic	Japan	Sumitomo Metal Mining Co. Ltd.
13	Ilo Copper Refinery	350	Electrolytic	Peru	Southern Copper Corp. (Grupo Mexico)
13	Jinchuan	350	Electrolytic	China	Jinchuan Non Ferrous Co.
13	Yunnan	350	Electrolytic	China	Yunnan Copper Industry Group
16	Olen	345	Electrolytic	Belgium	Cumerio
17	Norilsk Refinery	330	Electrolytic	Russia	Norilsk Copper
18	Huelva	320	Electrolytic	Spain	Atlantic Copper S.A. (Freeport McMoran)
19	Garfield	300	Electrolytic	United States	Kennecott (Rio Tinto)
20	La Caridad	300	Electrolytic	Mexico	Mexicana de Cobre S. A. (Grupo Mexico)

Copper Semis and Casting Production, 1980-2005

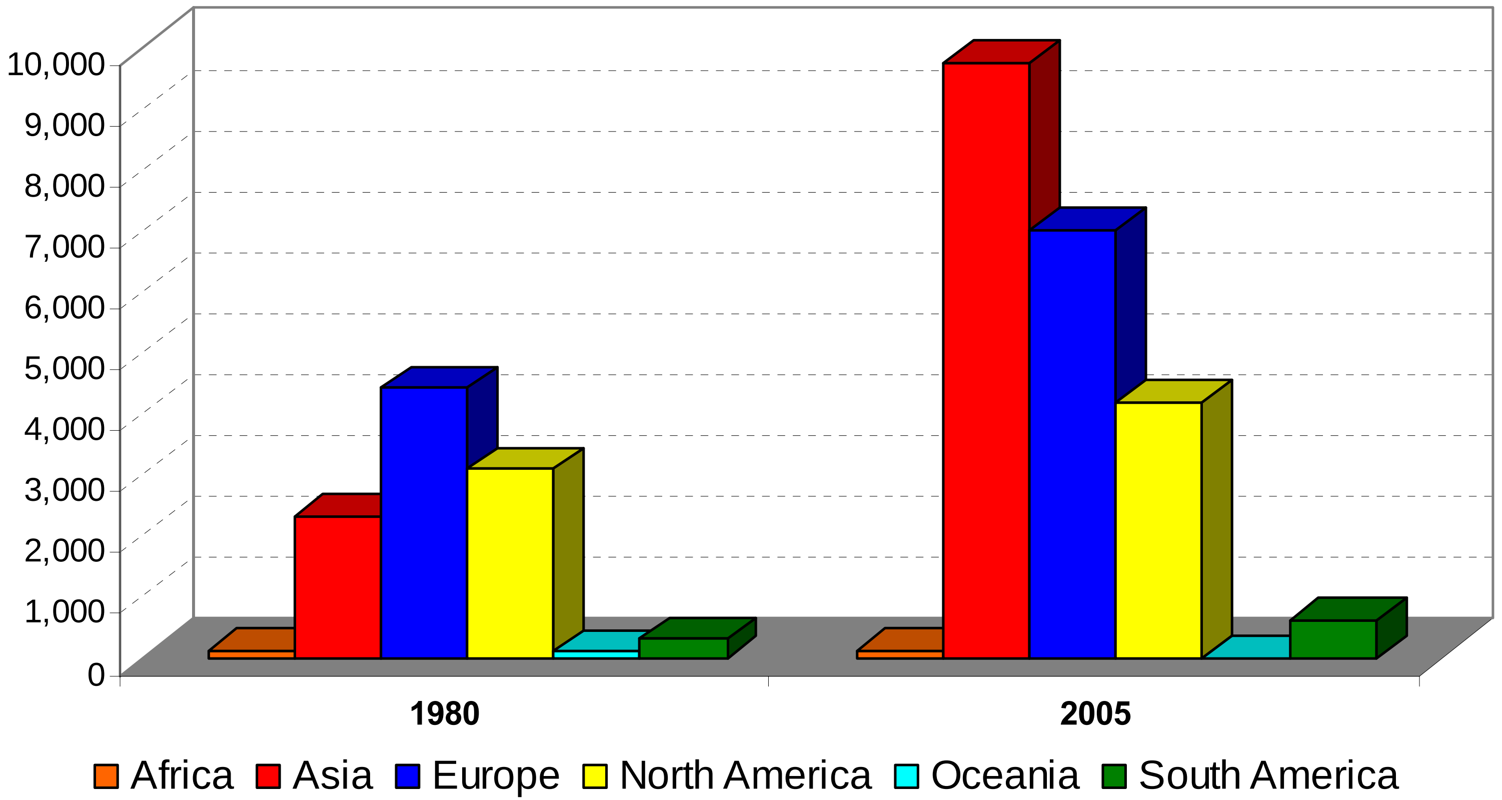
Thousand metric tonnes
Source: ICSG



Semis fabricators process refinery shapes such as 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. Semis fabricators are considered to be the "first users" of refined copper and include ingot makers, master alloy plants, wire rod plants, brass mills, alloy wire mills, foundries and foil mills.

Copper Semis and Casting Production by Region

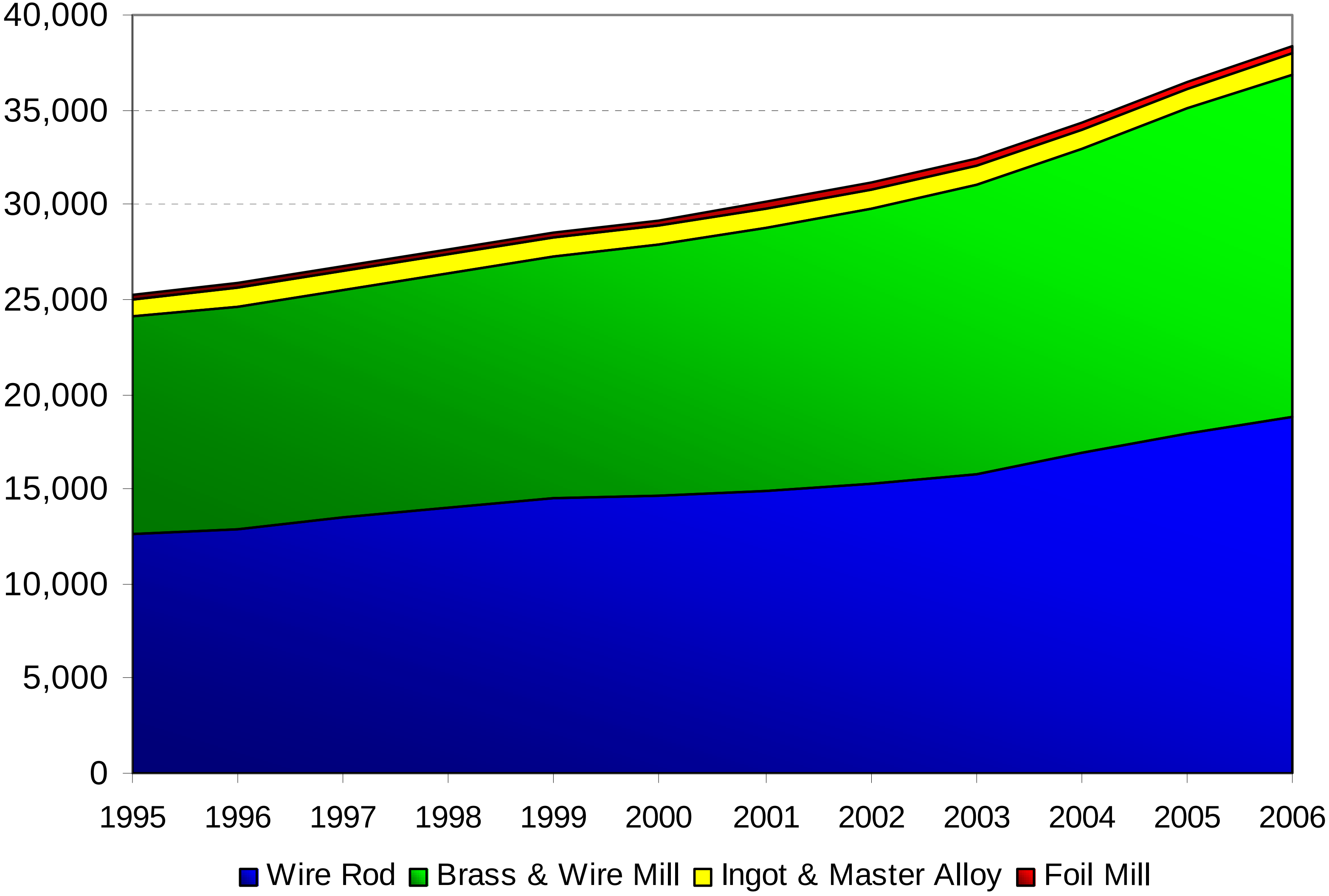
Thousand metric tonnes
Source: ICSG



Asian countries accounted for 45% of semis production in 2005, or nearly 9.8 million metric tonnes, up from 22% in 1980.

Trends in First Use Capacity

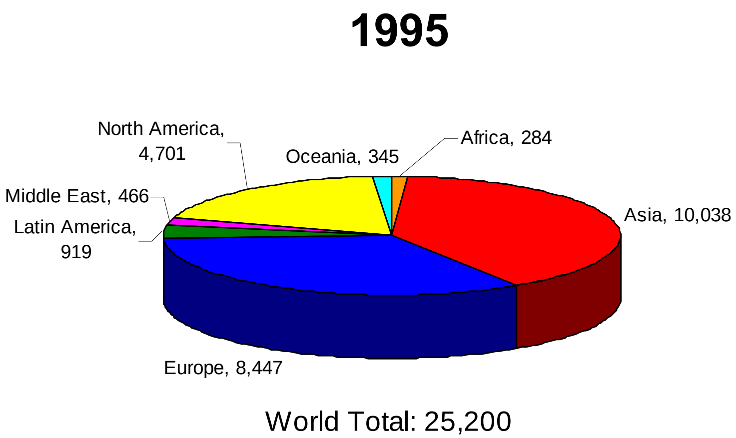
Thousand metric tonnes
Source: ICSG

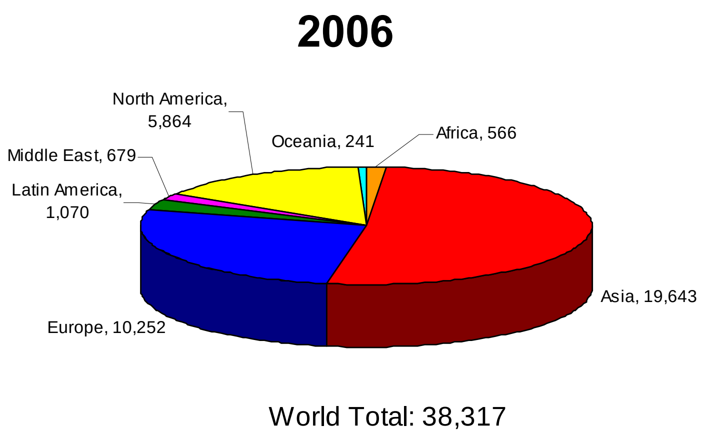


Wire rod, brass and wire mills are estimated to have accounted for 96% of first use capacity in 2006.

First Use Capacity by Region

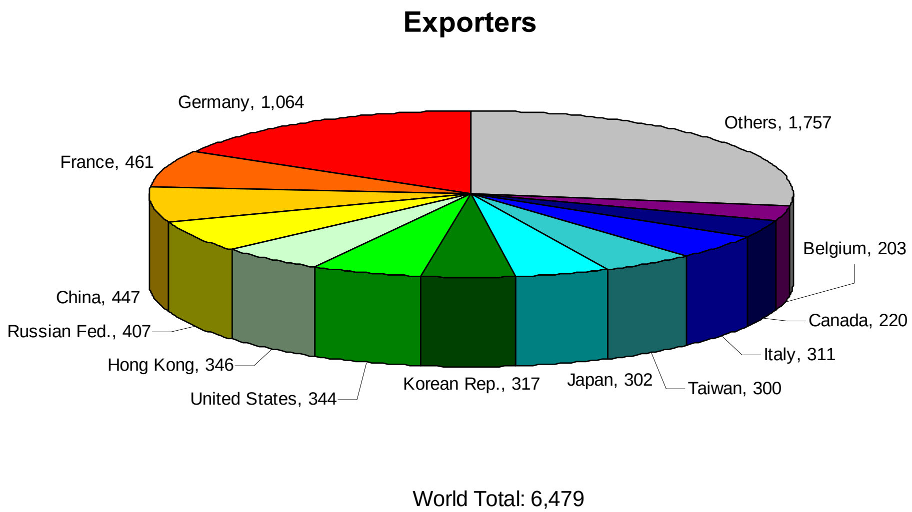
Thousand metric tonnes
Source: ICSG

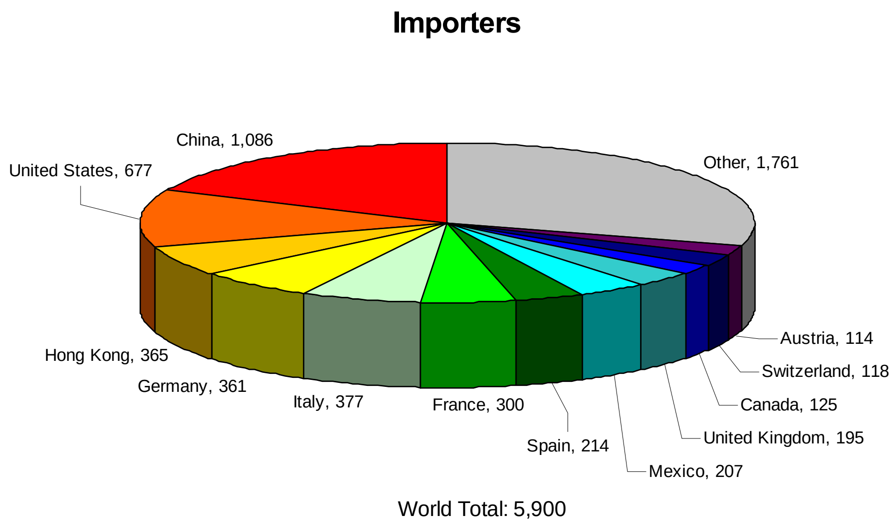




Leadings Exporters and Importers of Semi-Fabricated Copper Products, 2006

Thousand metric tonnes
Source: ICSG





Top 20 Copper Fabricating Plants by Capacity, 2006

Thousand metric tonnes
Source: ICSG

Rank	Owner(s)	Plant	Capacity	Country	Plant type
1	Wieland Werke (Wieland Metals)	Voehringen	360	Germany	Brass mill
2	Freeport McMoRan Copper & Gold Inc.	El Paso, TX	355	USA	Wire rod plant
3	Freeport McMoRan Copper & Gold Inc.	Norwich, CT	355	USA	Wire rod plant
4	Southwire	Carollton, GA	320	USA	Wire rod plant
5	Conticon (Grupo Condumex - Grupo Carso)	Celaya	318	Mexico	Wire rod plant
6	SCCC - Societe de Coulee Continue de Cuivre (Nexans)	Chauny	300	France	Wire rod plant
7	Trafilierie Carlo Gnutti	Chiari	300	Italy	Brass mill
8	Umicore - Cumerio	Olen (Plant 1)	280	Belgium	Wire rod plant
9	Hitachi Wire Rod (Hitachi Cable)	Ibaraki-Ken	280	Japan	Wire rod plant
10	Norddeutsche Affinerie	Hamburg (Plant 1)	275	Germany	Wire rod plant
11	LS Cable	Gumi	270	Korea	Wire rod plant
12	Asarco (Grupo Mexico)	Amarillo, TX	270	USA	Wire rod plant
13	Katur-Invest (Uralelektromed)	Verkhnaya Pyshma (Plant 1)	265	Russia	Wire rod plant
14	Nexans Canada Inc. (Nexans)	Montreal-East	260	Canada	Wire rod plant
15	Deutsche Giessdraht (Norddeutsche Affinerie, Codelco)	Emmerich	250	Germany	Wire rod plant
16	MKM Mansfelder Kupfer & Messing (Kazakhmys)	Hettstedt	250	Germany	Brass mill
17	Taihan Electric	Anyang	250	Korea	Wire rod plant
18	Huta Miedzi Cedynia (KGHM Polska Miedz)	Orsk, Rudna (Plant 1)	240	Poland	Wire rod plant
19	Poongsan	Onsan, Ulsan	235	Korea	Brass mill
20	Caraiba Metais (Paranapanema)	Camacari, Salvador (Plant 1)	230	Brazil	Wire rod plant

Chapter 5: The Commodity “Copper” in the Global Economy

Exchanges

Copper, as any other good or merchandise, is traded between producers and consumers. Producers sell their present or future production to clients, who transform the metal into shapes or alloys, so that downstream fabricators can transform these into different end-use products. One of the most important factors in trading a commodity such as copper is the settlement price for the present day (spot price) or for future days.

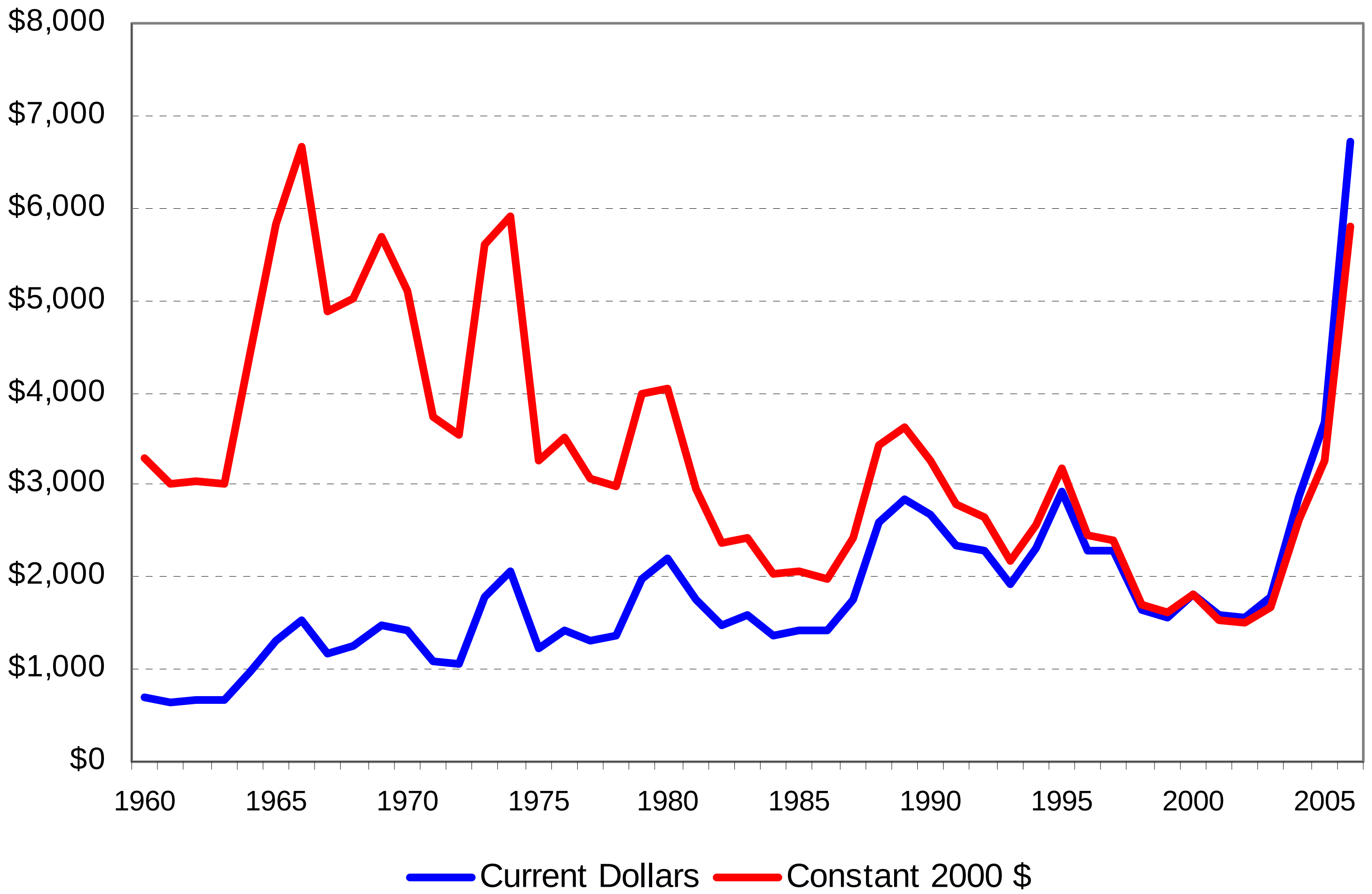
The role of a commodity exchange is to facilitate and make transparent the process of settling prices. Three commodity exchanges provide the facilities to trade copper: The London Metal Exchange (LME), the Commodity Exchange Division of the New York Mercantile Exchange (COMEX/NYMEX) and the Shanghai Metal Exchange (SHME). In these exchanges, prices are settled by bid and offer, reflecting the market's perception of supply and demand of a commodity on a particular day. On the LME, copper is traded in 25 tonne lots and quoted in US dollars per tonne; on COMEX, copper is traded in lots of 25,000 pounds and quoted in US cents per pound; and on the SHME, copper is traded in lots of 5 tonnes and quoted in Renminbi per tonne. More recently, mini contracts of smaller lots sizes have been introduced at the exchanges.

Exchanges also provide for the trading of futures and options contracts. These allow producers and consumers to fix a price in the future, thus providing a hedge against price variations. In this process the participation of speculators, who are ready to buy the risk of price variation in exchange for monetary reward, gives liquidity to the market. A futures or options contract defines the quality of the product, the size of the lot, delivery dates, delivery warehouses and other aspects related to the trading process. Contracts are unique for each exchange. The existence of futures contracts also allows producers and their clients to agree on different price settling schemes to accommodate different interests.

Exchanges also provide for warehousing facilities that enable market participants to make or take physical delivery of copper in accordance with each exchange's criteria.

Copper Prices (LME, Grade A, Cash)

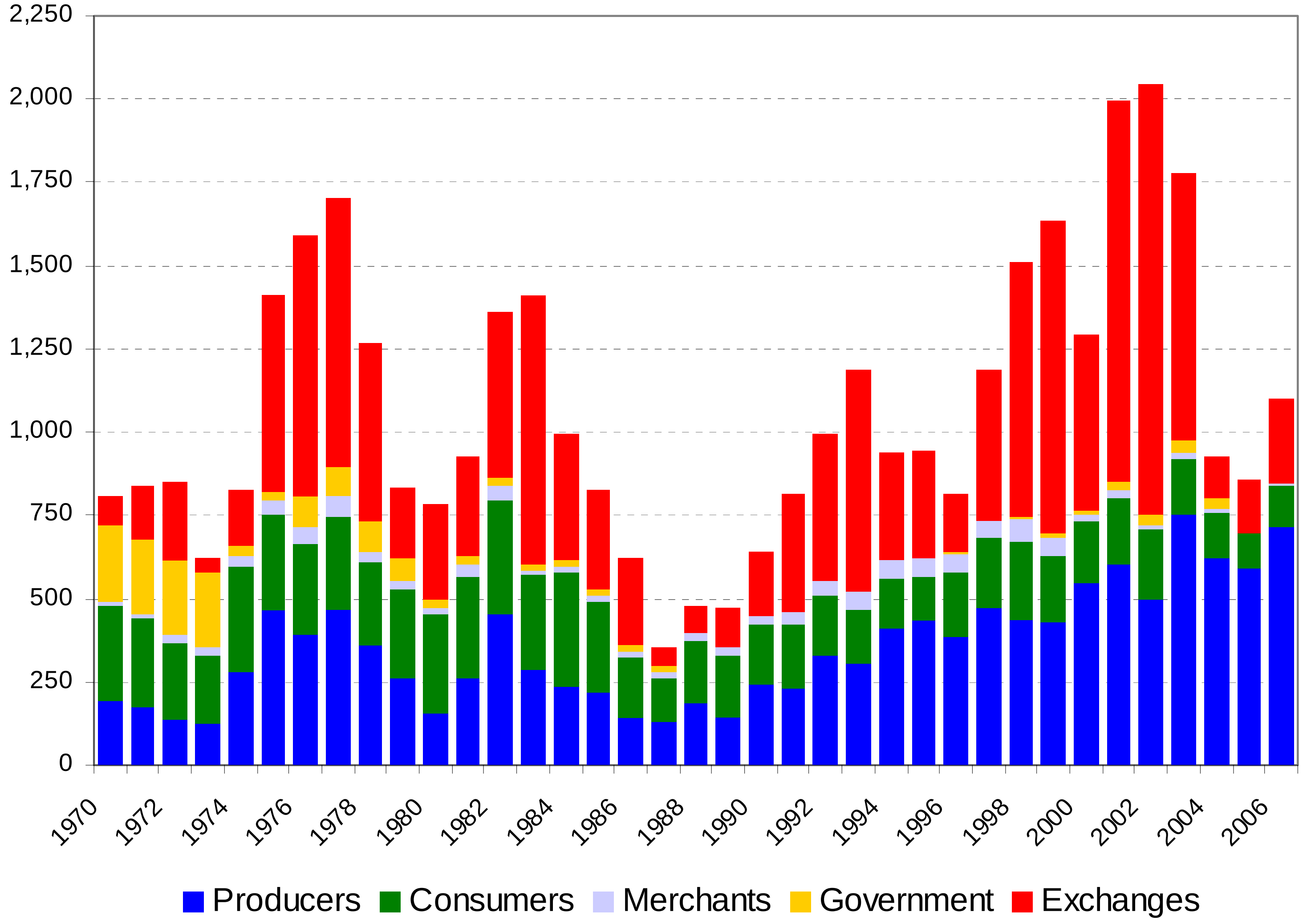
US$ per tonne
Source: ICSG



The average annual current (not adjusted for inflation) cash price of copper at the London Metal Exchange surged by over 330% between 2002 and 2006.

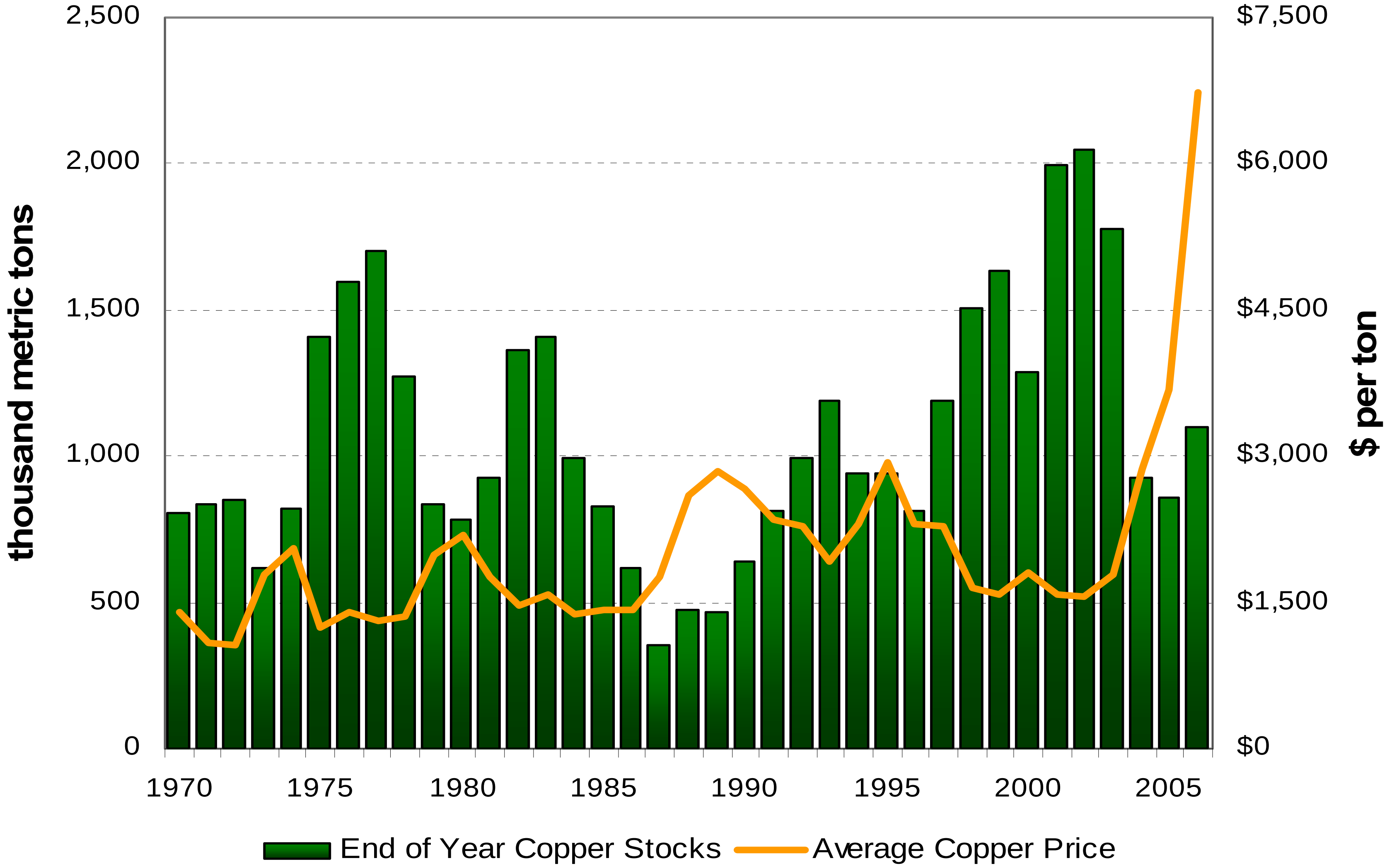
Copper Stocks by Sector

Thousand metric tonnes
Source: ICSG



Copper Stocks vs Price

Thousand metric tonnes and US$ per tonne
Source: ICSG



ANNEX

World Copper Production and Usage, 1960-2006

Thousand Metric Tonnes
Source: ICSG

	Mine Production	Refined Production	Refined Usage		Mine Production	Refined Production	Refined Usage		Mine Production	Refined Production	Refined Usage
1960	3,924	4,475	4,738	**1976**	7,097	8,211	8,539	**1992**	9,497	11,045	10,761
1961	4,081	4,567	5,050	**1977**	7,444	8,500	9,057	**1993**	9,549	11,124	10,981
1962	4,216	4,689	5,048	**1978**	7,306	8,632	9,527	**1994**	9,553	11,239	11,420
1963	4,286	4,978	5,500	**1979**	7,371	8,834	9,848	**1995**	10,084	11,832	12,059
1964	4,443	5,210	5,995	**1980**	7,230	8,869	9,396	**1996**	11,097	12,677	12,636
1965	4,647	5,636	6,193	**1981**	7,745	8,970	9,522	**1997**	11,537	13,478	13,098
1966	4,626	5,778	6,445	**1982**	7,721	9,246	9,090	**1998**	12,248	14,075	13,511
1967	4,872	6,006	6,195	**1983**	7,843	9,260	9,510	**1999**	12,776	14,578	14,293
1968	5,010	6,360	6,523	**1984**	8,138	9,313	9,930	**2000**	13,209	14,796	15,138
1969	5,941	6,849	7,137	**1985**	8,288	9,455	9,798	**2001**	13,763	15,256	14,946
1970	5,562	6,871	7,291	**1986**	8,266	9,920	10,112	**2002**	13,576	15,334	15,231
1971	5,900	7,050	7,296	**1987**	8,592	10,148	10,293	**2003**	13,634	15,638	15,716
1972	6,541	7,548	7,942	**1988**	8,775	10,512	10,668	**2004**	14,601	15,915	16,846
1973	6,735	7,647	8,740	**1989**	9,372	10,687	11,081	**2005**	14,921	16,591	16,731
1974	6,915	7,858	8,310	**1990**	9,226	10,804	10,886	**2006**	15,008	17,331	17,042
1975	7,289	8,175	7,445	**1991**	9,084	10,908	10,565				

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