

TIN

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Tin has not been mined in the United States since 1993; consequently, the country is mostly reliant on imports and recycling for its tin needs. Twenty-five firms consumed 80% of the reported primary tin used domestically in 2003. The major uses were as follows: electrical solders, 24%; metal containers, 21%; transportation, 14%; construction, 11%; and other, 30%. The estimated value of primary tin metal consumed domestically was about \$246 million. Industry stocks declined by 11% (table 1).

Approximately 7,900 metric tons (t) of tin, most of it from old scrap, was recycled (table 5). About one-eighth of the tin consumed in the United States was recycled metal produced at 3 detinning plants and 80 secondary nonferrous metal processing plants. Interest remained strong in the recycling of used tin cans, partly because of high disposal fees and limited space at landfills. The recycling rate for steel cans was 60%, compared with 59% in 2002, 56% in 1995, and 15% in 1988 (Steel Recycling Institute, 2004).

The Defense Logistics Agency (DLA), which manages the National Defense Stockpile (NDS), sold 8,876 t of pig tin from the stockpile during 2003.

World primary tin mine output declined by 13% (tables 1, 9). Industry observers believed that the world tin market in 2003 was in a moderate supply deficit status. World primary tin smelter production rose by about 1%. The composite tin price rose by 16%, following the pattern of most other metals. The strong price activity was attributed to exceptional demand from China, which now is both the world's largest consumer and miner/smelter of tin. Of the 20 countries in which tin was mined, the top 6 accounted for 93% of the world total of 209,000 t. Indonesia was the largest producer (33% of world output) and was followed by China (24%), Peru (19%), Bolivia (7%), Brazil (7%), and Australia (3%). World tin reserves were estimated to be 8 million metric tons (Mt). Assuming that world primary tin consumption will be about 200,000 metric tons per year (t/yr), these reserves would last 40 years. Most tin reserves are in Asia and South America.

Legislation and Government Programs

In 2003, the DLA sold 8,876 t of pig tin under the basic ordering agreement (BOA) and the long-term negotiated contract formats. The effect of proposed NDS sales on domestic markets is assessed by the Market Impact Committee comprising several Federal agencies, including the U.S. Geological Survey (USGS).

The DLA Annual Materials Plan proposed disposal for tin is 12,000 t per fiscal year. This quantity represents the maximum amount of tin that can be sold in a fiscal year. Under the BOA, the Defense National Stockpile Center (DNSC) posts the amount of tin

that it wants to sell on its Web site each day. Interested companies submit a quote, and DNSC makes a sales determination by the end of the day. BOA sales began in June 2002.

The NDS tin is stored at four government sites: Hammond, IN; New Haven, IN; Point Pleasant, WV; and Baton Rouge, LA. As of December 31, 2003, the tin inventory was 35,584 t.

Production

Mine.—Tin was not produced at any domestic mine in 2003. Until 1993, a few small tin mines had operated sporadically in the United States. However, USGS canvasses confirm that there has been no primary domestic tin production since that year.

Secondary.—Industry observers believe that the United States is the world's largest producer of secondary tin. Most secondary tin has been produced in the United States from various scrapped alloys of tin and recycled in those same alloy industries. Secondary tin from recycled fabricated parts has been used in many kinds of products and is a particularly important source of tin for the manufacture of solder and brass/bronze.

The Steel Recycling Institute, funded by the domestic steel industry, continues to promote the collection, preparation, and transportation of steel can scrap. The domestic recycling rate for steel cans, most of which are made from tinplate, was 60% in 2003.

Hydromet Environmental Recovery Ltd. announced that its plant in Newman, IL, has successfully begun to extract tin from tin waste slurry. Hydromet changed its name to Stanmet Ltd. and is listed on the TSX Venture Exchange (Hydromet Environmental Recovery Ltd., 2003).

Consumption

In 2003, consumption of primary tin declined 3% (tables 1, 2). Domestic consumption data for tin were developed by the USGS from a voluntary survey of tin consumers. Of the 130 firms to which a survey form was sent, 109 responded, including the major consumers.

The total number of metal cans shipped was 135 billion, in 2003, slightly below that of 2002. The Can Manufacturer's Institute no longer provides a categorization by types of can (for example, aluminum versus steel). Steel (essentially tinplate and tin-free steel) dominated in the food, pet, and the "general line" can markets, and aluminum held 100% of the beverage can market (Can Manufacturer's Institute, 2003).

After several years of operating in bankruptcy, several large domestic steel producers, which also produce tinplate, were absorbed by larger organizations. International Steel Group Inc. (Cleveland, OH) acquired Bethlehem Steel Corp. (Bethlehem, PA) for \$1.60 billion. U.S. Steel Corp. (Pittsburgh, PA) purchased National Steel Corp. (Mishawaka, IN) for \$1.05

billion. Weirton Steel Corp. (Weirton, WV) filed for Chapter 11 bankruptcy protection after 3 years of effort to avoid such a filing. Weirton ranks as the sixth largest integrated steel producer in the United States and is also a major producer of tinplate. Weirton continued operating throughout 2003 (American Metal Market, 2003c).

Price

The Platts Metals Week average composite price for tin metal rose by 16%. The Platts Metals Week average composite tin price was \$3.14 per pound in January and rose fairly steadily throughout the year, reaching \$3.36 per pound in August and \$4.05 per pound in December. The strong price pattern for tin paralleled similar increases for many other metals. Industry analysts attributed the remarkable price increases to increased demand from China at a time of continuing moderate world tin supply deficits.

The London Metal Exchange (LME) remained the primary trading arena for tin. Tin is one of only six metals traded on the LME. The other metals are aluminum, copper, lead, nickel, and zinc.

In its October 2003 "Review," Natexis Metals Ltd. (an LME broker) examined the unusual strength in the recent prices of base metals, including tin. Natexis highlighted a number of common themes that were driving the bull market in base metals—investment funds, China, accelerating global economic growth, relatively low inventories, lack of new capacity, and the weak U.S. dollar. The firm ranked nickel, copper, lead, and tin as showing superior price performance that reflected strong fundamentals. The report indicates that Asia is the focus of base-metals consumption, with China at the forefront. Industrial production in China increased 18% in December compared with that in December 2002. Key features of China's impact on the metal market are the remarkable rate of metal-intensive economic growth the country is experiencing and the country's lack of sufficient raw materials to feed its rapidly growing nonferrous metals production (Metal-Pages, 2004§¹).

The LME amended its contract rules for tin trading, dropping its maximum ingot size to 30 kilograms (kg) from 50 kg, effective March 30, 2004. The LME approved tin in ingot form to weigh between 12 kg and 30 kg (Platts Metals Week, 2003b).

Trade

U.S. imports of refined tin, which supplied most domestic tin requirements, decreased by 12%. Imports of tin in all forms (metal, ore and concentrate, scrap, and waste) remained duty free (tables 7, 8). Most of the tin metal imported from a variety of countries was held in U.S. warehouses by trading firms until sold to customers. Foreign-owned trading firms tended to dominate the marketing of imports. U.S. imports of refined tin came mostly from Peru, Bolivia, China, and Indonesia, in descending order. Refined tin exports were small compared with imports (table 6).

¹References that include a section mark (§) are found in the Internet References Cited section.

World Review

Tin Technology (Uxbridge, United Kingdom), the world's foremost tin research laboratory, announced that world tin consumption increased by 6% in the first half of 2003, compared with the same period in 2002. Annual consumption in 2003 was forecast to rise to 293,000 t, while the 2004 total was forecast to top 300,000 t for the first time. These estimates were presented to the Board of Tin Technology by CRU International Ltd.

Several key points were made by CRU:

- Asia accounts for more than one-half of world tin demand and is the most rapidly growing market in the world. In the first half of 2003, tin consumption increased by more than 10% than that of the same period in 2002.
- As is the case for many metals, China accounts for most of worldwide tin demand growth because of rising local demand and the transfer of manufacturing activity from elsewhere in the world.
- Tin consumption in Japan rose by almost 20% in the first half of 2003, partly reflecting a switch to lead-free soldering there. The use of high-tin, lead-free solders will have a major positive impact on tin use as they are adopted throughout the world in coming years.
- World tin consumption also will be stimulated by a strengthening American economy, including some recovery in the electronics sector.

CRU concluded that global tin demand would exceed tin supply by 18,000 t in 2003 and 16,000 t in 2004 (Tin Technology, 2003).

Australia.—The ailing Renison Bell Tin Mine (Tasmania) suffered a series of setbacks during the year. Owner Murchison United NL closed the mine for about 8 weeks in the spring to make the facility safer following the death of a worker. Only 20 of the mine's 150-person staff remained to perform maintenance, and the rest were redeployed to other west coast sites of Renison's mining contractor Barminco. Then, by early summer, the inactive mine was offered a \$400,000 lifeline by the State Government. The 6-month, fully secured loan, provided by the Tasmanian Development Board, would cover the cost of maintaining ventilation and powering pumps that dewater the mine. Renison officials stated that if the mine was not maintained, it would inevitably flood and make the cost of reopening the mine prohibitive. The mine was considered critical to the economy of Tasmania. The mine was placed in the hands of an administrator in late June with debts of about \$28 million. Renison Bell has long ranked as Australia's major tin producer. It began production about 40 years ago and had a capacity of 10,000 t/yr of tin-in-concentrate. This equates to about 4% of the current world tin consumption and about 25% of the international market for tin concentrates. Murchison had acquired Renison from RGC Ltd. in 1998. Renison remained closed the balance of the year as new buyers were sought (Mining Journal, 2003b).

Marlborough Resources plc announced plans to expand output at its Ardlethan Tin Mine in New South Wales, by 70% to 2,200 t/yr of tin-in-concentrate. Production at the mine was reported to be running at record levels, but the installation of a second treatment plant was seen as an opportunity to optimize the mine's scale of operations (CRU Tin Monitor, 2003b).

Malachite Resources NL announced that it had acquired a 12-month option to purchase the Elsmore alluvial tin mine in northern New South Wales. Malachite paid \$45,000 for the option. Elsmore, which was Australia's first commercial tin mine, is about 25 kilometers (16 miles) from Malachite's Conrad Silver project and thus offers significant geographic and geologic synergies. The exercise price is \$3 million, payable in four annual installments. Company officials indicated that substantial resources at Elsmore remain as alluvial, colluvial, and eluvial deposits; and as tailings from earlier production. The processing plant remains onsite, and the company thinks it could be recommissioned at low cost. Malachite plans to conduct drilling and bulk sampling of the various surface deposits to delineate resources to a level sufficient to support a limited period of pilot-scale production. The firm hopes to develop an operation producing 1,000 t/yr of tin-in-concentrate during a mine life of more than 5 years (Metal-Pages, 2003e§).

Senior representatives from Malaysia Smelting Corp. Bhd (MSC) visited Australia to examine a number of new tin mining opportunities. MSC officials met in Perth with executives from Marlborough Resources NL, which owns and operates the Ardlethan tin mine in New South Wales. Four or five mines were discussed, and MSC planned to examine three others. MSC had recently purchased a 30% stake in Sydney-listed Marlborough for \$3 million. MSC was buying all the tin concentrate produced at Ardlethan. MSC was running its Penang, Malaysia, tin smelter at about 1,200 t monthly after halving output in response to low demand and prices. Tin output at Penang was expected to reach 15,000 t in 2003. MSC also owns a 75% stake in PT Koba Tin, itself a producer of about 15,000 t/yr of tin (Metal Bulletin, 2003c).

Australian steel producer BHP Steel Ltd. announced that it had changed its name to BlueScope Steel Ltd. The name change was a condition of its separation from BHP Billiton. BlueScope is the leading steel producer in Australia and New Zealand, supplying about 80% of the flat-rolled steel sold in those markets from its steelworks at Port Kembla. The firm is an important producer of tinplate (TIN World, 2003a).

Brazil.—Mamore Mineração e Metalurgia (MMM), part of Grupo Paranapanema, reportedly produced 7,500 t of tin in 2003, which was essentially unchanged from the production level of 2002. Output was maintained by reprocessing tailings from the exhausted Pitinga Mine and from tin ore from the new Rocha Sur site. Rocha Sur, a hard-rock deposit at Pitinga, produces about 2,850 t/yr of tin-in-concentrate. MMM hoped that in 2003 the State development bank, BNDES, would fund a \$60 million project to expand capacity to 9,500 t/yr. MMM officials think that if the Rocha Sur expansion is not completed by 2006, tin mining at Pitinga will no longer be viable (Mining Journal, 2003a).

Not only Paranapanema, but other producers, such as Companhia Estanífera Brasileira SA (Cesbra) and Best Metais e Solas SA, were producing less tin owing to the general depletion of alluvial cassiterite deposits, particularly at the Garimpo Bom Futuro (a cooperative of independent miners). Following disorganized and uncontrolled mining at the Bom Futuro Mine in 1989, Paranapanema moved in to instill some order, purchasing large quantities of the cassiterite produced

there from the garimpo cooperatives (American Metal Market, 2003a).

Steelmaker Companhia Siderúrgica Nacional, a major tinplate producer, completed the purchase of a 50% stake in Portugal's Lusosider Aces Planos SA, also a tinplate producer. The Anglo-Dutch steelmaker, Corus Group plc, is the only other stakeholder in Lusosider (Canmaker, 2003a).

Canada.—The country's sole tinplate producer, Dofasco Ltd., announced a \$700 million improvement program for its finishing division. The tin mill, located at Dofasco's Hamilton, Ontario, steel plant has combined tinplate/tin-free steel capacity of 450,000 t/yr. The improvement program, designed to increase the throughput of value-added products at lower operating costs, will focus on coupled and continuous manufacturing, automated processes, and information technology that will seamlessly link manufacturing and order management. All finishing operations (including tinplating, annealing, tempering, cold rolling, and galvanizing) will be upgraded through the construction of new facilities (Canmaker, 2003d).

China.—The country's second largest tin producer, Liuzhou China Tin Group, reportedly opened a new tin mine. Liuzhou had experienced tin shortages for 2 years. The company opened the new mine in June, but the ore grade reportedly was low. Liuzhou's tin smelters continued to run below capacity owing to a lack of concentrates. The company expected to produce 15,000 t/yr of tin, only one-half of what it produced 2 years ago before its major tin mine in Nandan was closed due to a major mining accident.

Liuzhou resumed mining in late 2003 at its Gaofeng Tin Mine, which was one of five mines in the Nandan area of Guangxi Province closed by the Government earlier in the year. Gaofeng, which is the largest mine in the area, and the other four smaller mines, which do not belong to Liuzhou, remain closed. Nandan is China's major producing area for antimony, indium, lead, tin, and zinc (Metal-Pages, 2003d§).

The Ministry of Land and Resources (MLR) issued regulations to control the production of antimony, rare earths, and tin. Following earlier reports that China was tightening its control over these industries, the ministry announced that unlicensed mining activities and companies that wasted the country's natural resources, ignored safety and environmental legislation, or violated industry policies would be closed. The MLR also intended to investigate all mineral reserves and mining projects in China involved in the production of antimony, rare earths, and tin. It called on local land and resource offices throughout the country to provide, by October 1, 2003, a list of enterprises producing these metals. In addition, all companies on the list had to provide copies of mining permits and copies of certificates granted by the health and safety authorities and the environmental protection bureau. Based on this information and on spot checks, the MLR was to publish a list of firms authorized to mine the three metals (Metal-Pages, 2003a§).

Czech Republic.—U.S. Steel Kosice [a part of U.S. Steel Corp. (USA)] announced plans to add a new electrolytic tinplating line with a capacity of 40,000 t/yr to its existing tin mill. The new line was expected to start up in early 2004 (CRU Tin Monitor, 2003a).

Egypt.—Gippsland Ltd. (Australia) was attempting to raise \$300,000 through a sale of common stock. The company planned to use most of the funds raised by the sale to finance its Abu Dabbab tin-tantalum-feldspar project in Egypt. Some of the cash would be used to fund a bankable feasibility study currently underway at the 40-Mt Abu Dabbab deposit. Gippsland had a 50% economic interest in the deposit through an incorporated joint venture with the Egyptian Government. The remainder of the \$300,000 raised would be used to list the company's securities on the London Stock Exchange's Alternative Investment Market (Metal-Pages, 2003b§).

Germany.—A new federal law implemented on January 1, 2003, required a deposit of €0.25 to €0.50 (equivalent to 30 to 60 cents) per container to be charged on the sale of beverages in glass, metal, and plastic containers—a deposit which is recovered when the empty container is returned. Beverage container sales have plummeted because customers dislike the inconvenience of being forced to return to the point of sale to recover the deposit. Consequently, retailers began attempting to develop a nationwide program for installing 60,000 so-called “reverse vending” machines that will allow customers to recover their deposit in exchange for empty drink containers. Demand for tin began to be affected because most metal drink cans in Germany are made from tinplate.

As the year progressed, turmoil built about the Government's mandatory deposit system on one-way beverage packaging. Beverage Can Makers Europe (BCME), the organization that represents the European beverage can producers, relayed the fear that unless there was a moratorium on the deposit system, beverage cans may virtually disappear from the market. Beverage can sales in Germany were estimated to have declined by 80% in 2003. Germany ranks as the second largest national market in Europe for beverage cans, after the United Kingdom. In Europe, most beverage cans are made from tinplate (Canmaker, 2003b).

The Tui Group (previously known as the Preussag Industrial Group) announced plans to sell its metals subsidiary, Amalgamated Metal Corp. (AMC), to AMC's senior management for \$225 million. AMC's trading, distribution, and manufacturing interests included an LME brokerage (Amalgamated Metal Trading), a nonferrous physical trading group (focused on aluminum alloys and tin), and the Thaisarco tin smelter in Thailand. AMC had 3,000 employees.

Indonesia.—The country's major tin producer, PT Timah, announced plans to list the company on the Euronext cross-border exchange in Amsterdam, Netherlands. The plan was part of a pilot project by the Jakarta Stock Exchange (JSX) to test dual listing collaboration between the JSX and Euronext. Timah was listed on the JSX and was one of two firms selected for the trial (Platts Metals Week, 2003a).

Government-owned Timah reportedly signed a contract to construct a tin smelter with Malaysia Smelting Corp. in a joint venture. The plant, with a capacity of 3,000 t/yr, was expected to be built on Kunder Island in Ruau Province in 2004. Also, Timah planned to restart five dredges in the waters near Bangka Island in response to rising tin prices (Mining Journal, 2003c).

A new smelting company, CV Donna Kembara Jaya, began operations on Bangka Island in March. It reportedly has a

capacity of 6,000 t/yr. Four other companies were reported to have submitted plans for tin smelters, taking advantage of the Indonesian ban on exports of concentrates introduced in June (CRU Tin Monitor, 2003a).

Japan.—The nation's second- and third-ranked steelmakers, NKK Corp. and Kawasaki Steel Corp., merged on April 1, 2003. Both firms had long been major tinplate producers and ranked worldwide as important tin consumers. The new organization, JFE Steel Corp., will be Japan's second largest steel producer (Metal Bulletin, 2003a).

Malaysia.—MSC and PT Mitra Stania Prima (Indonesia) agreed to a production-sharing alliance under which MSC would explore for and mine tin on parts of Bangka Island (Indonesia) for which PT Mitra holds exploration and mining permits. The permits covered several thousand acres within and adjacent to established tin mining districts on Bangka Island. MSC approved spending \$1.76 million on drilling and exploration programs in the given areas during 2004 and 2005, and indicated that the cooperation with PT Mitra was expected to provide substantial long-term tin production for the firm. MSC produced more than 35,000 t/yr of tin metal at its smelter, accounting for about 15% of world production. In 2002, it acquired a 75% stake in Bangka Island-based tin miner and smelter PT Koba Tin. Indonesia has contributed about 60% of the MSC's smelter feed during the past 3 years (Platts Metals Week, 2003c).

MSC reportedly was to acquire a 25% stake in ZR Network Sdn Bhd, the scientific equipment company that had recently bought Rahman Hydraulic Tin Bhd, Malaysia's largest tin miner. The acquisition was to cost \$630,000. Rahman operated the Klian Intan tin open pit operation in Northern Perak. The mine produced some 1,400 t/yr and employs 350 people (CRU Tin Monitor, 2003a).

In 2003, 28 companies were members of the Malaysian Tin Can Manufacturers Association. Owing to a 15% duty on imports, the canmakers purchased tinplate locally from Malaysia's only domestic tinplate supplier, Perusahaan Sadur Timah Malaysia Berhad (PERSTIMA), which has two tinplate lines and a total capacity of 240,000 t/yr. PERSTIMA had decided to move one of its tinplate lines to Vietnam and was building a tin mill in Ho Chi Minh City scheduled to open in late 2003 (Canmaker, 2003c).

Russia.—The Novosibirsk Tin Works restarted production at its Molodyozhny and Perevalny tin mines. Novosibirsk is Russia's only tin smelter, but had continuing difficulty in obtaining sufficient raw material. The smelter planned to raise refined tin output by 10% in 2003 to about 5,600 t. This was significantly less than the smelter's design capacity of 15,000 to 20,000 t/yr. As recently as 1995, the smelter was producing approximately 12,000 t/yr, but a decline in output from domestic mines caused the smelter's output to dwindle. The Molodyzhny and Perevalny Mines were believed to contain large reserves of tin, but significant investment was required to exploit them fully (Metal Bulletin, 2003d).

Serbia.—U.S. Steel Corp. (Pittsburgh, PA) announced that it would acquire steel producer Sartid and six of its subsidiaries. Reportedly, the purchase price was to be \$23 million, but the firm has also agreed to spend \$150 million during the next 5 years on

working capital for rehabilitation and improvement of the facilities. Sartid produced tinplate (American Metal Market, 2003b).

Slovakia.—U.S. Steel Corp. (Pittsburgh, PA) announced the completion of an \$80 million tin mill expansion at its U.S. Steel Kosice plant. A new continuous annealing line and an electrolytic tinning line had more than doubled Kosice's capacity to 375,000 t/yr (Canmaker, 2003e).

United Kingdom.—Baseresult Holding Ltd., the owner of the South Crofty tin mine in Cornwall, was notified by local government officials that it could be acquired by them if the mine fails to reopen within 2 years. The mine was closed almost 5 years ago. The new owner, Baseresult, bought the mine in June 2001, but it still remained inactive. Baseresult had been conducting a review of the mine's environmental impact and its technical operations (Metal Bulletin, 2003e).

Current Research and Technology

Researchers at the University of Wisconsin announced the development of a nickel-tin-aluminum catalyst that could replace the precious metal platinum in a process for extracting hydrogen gas from plants. The relatively low-temperature process was said to be environmentally sustainable and greenhouse-gas neutral. The catalyst was discovered by testing more than 300 materials before finding a nickel-tin-aluminum combination which reacts with biomass-derived oxygenated hydrocarbons to produce hydrogen and carbon dioxide without producing large amounts of unwanted methane. The new catalyst offers opportunities for making the transition from a world economy based on fossil fuels to one based on renewable resources. The reportedly simple process converts hydrocarbons such as glucose into hydrogen, carbon dioxide, and gaseous alkanes with hydrogen constituting one-half of the products (Advanced Materials & Processes, 2003).

During the past 20 years, one of the important uses of tin has been as a component of indium-tin oxide (ITO), mostly for electronic flat panel displays. This end use has been growing rapidly. Moreover, there seems to be no effective substitute for it. ITO is used in thin film transistors to convert data from electrical to optical form in liquid crystal displays, flat panel displays, and more recently in plasma display panels. Although there has been a trend to reduce the ITO content in individual liquid displays, many more units are being sold; thus, demand for ITO has continued to grow (Metal Bulletin, 2003b).

Oki Electric Co. (Japan) announced that it has jointly developed a heating technology for lead-free soldering called "Component Temperature Control Reflow Technology." According to the developers, this new technology will enable manufacturers to automate soldering for low-heat tolerance electronic components using lead-free solder that has a higher melting temperature than leaded solders. While the soldering process generally used increases the inner temperature evenly (which damages those components that have low-heat tolerance), this new technology combines far-infrared radiation with heated air to heat solder in a reflow furnace. With this new technology, Oki aimed to complete the transition to lead-free solder for all of its products manufactured for the domestic market by the end of 2003. Tin is the dominant material in conventional solders and is the dominant

component (often well into the 90% range) for almost all lead-free solders (TIN World, 2003b).

A recent survey shows that the Japanese electronics industry is still behind the forecast schedule of the Japan Electronics and Information Technology Industries Association (JEITA), which projected a 50% conversion to lead-free solders by 2002. The lack of a standardized method for evaluating the reliability of lead-free solders has caused Japanese electronics manufacturers to resist the change to lead-free solders. JEITA has, therefore, instituted a project to establish standards for lead-free solders to be completed by the end of 2003. The Japanese industry still needs to comply with the European Union's schedule for a lead-free electronics industry by 2006 if it expects to sell electronics to the European market (Metal-Pages, 2003c§).

Researchers in several countries continue to seek solutions for advanced and sustainable lead-free soldering including processes that utilize tin as a substitute for lead. One of the major projects in such research is the Next Generation Environment-Friendly Soldering Technology (EFSOT) initiative—an €11 million project utilizing 132 person-years of research to investigate lead-free soldering technologies. The European Union, and the Governments of Korea and Japan are providing funding for the project (EFSOT, 2003§).

Outlook

Domestic demand for primary tin is expected to grow slowly in the next few years, at a rate of about 1% per year. That rate, however, could double in a few years if new applications—especially those in which tin is substituted for toxic materials, such as lead-free solders—find acceptance in the marketplace.

World tin reserves appear to be adequate to meet foreseeable demand. Secondary sources of tin are likely to remain an important component of tin supply, especially in the United States. NDS sales are expected to continue for a few more years and remain an important segment of domestic supply until the inventory is exhausted. Domestic tin requirements will probably continue to be met primarily through imports.

References Cited

- Advanced Materials & Processes, 2003, Nickel-tin replaces platinum in extracting catalyst: Advanced Materials & Processes, v. 161, no. 10, October, p. 27.
- American Metal Market, 2003a, From boom to bust—Brazil backpedals as tin reserves shrink: American Metal Market, v. 111, no. 6, February 10, p. 11.
- American Metal Market, 2003b, U.S. Steel buying Serbia steel mill-6 subsidiaries: American Metal Market, v. 111, no. 13-3, April 2, p. 1-2.
- American Metal Market, 2003c, Weirton files for Chapter 11 bankruptcy protection: American Metal Market, v. 111, no. 10-2, May 20, p. 2.
- Can Manufacturer's Institute, 2003, Annual report and can shipments report: Can Manufacturer's Institute, p. 19.
- Canmaker, 2003a, CSN buys into European Steel: Canmaker, v. 16, August, p. 8.
- Canmaker, 2003b, German drinks cans could disappear: Canmaker, v. 16, December, p. 12.
- Canmaker, 2003c, Gloomy prospects for Malaysian canmakers: Canmaker, v. 16, March, p. 19.
- Canmaker, 2003d, Revamp for Dofasco tinplate operations: Canmaker, v. 16, March, p. 14.
- Canmaker, 2003e, U.S. Steel Kosice expands tin lines: Canmaker, v. 16, August, p. 9.
- CRU Tin Monitor, 2003a, Industry news: CRU International Ltd., June, p. 7.
- CRU Tin Monitor, 2003b, Industry news: CRU International Ltd., August, p. 8.

Hydromet Environmental Recovery Ltd., 2003, Financial News: Newman, IL, Hydromet Environmental Recovery, Ltd. press release, August 29, 1 p.
 Metal Bulletin, 2003a, Genesis of a giant: Metal Bulletin, no. 8762, April 3, p. 18.
 Metal Bulletin, 2003b, Indium displays clear growth: Metal Bulletin, no. 8748, February 13, p. 7.
 Metal Bulletin, 2003c, MSC, Marlborough explore tin mining projects: Metal Bulletin, no. 8800, August 21, p. 6.
 Metal Bulletin, 2003d, Novosibirsk restarts tin mining: Metal Bulletin, no. 8763, April 7, p. 7.
 Metal Bulletin, 2003e, South Crofty owners reject takeover threat: Metal Bulletin, no. 8757, March 17, p. 7.
 Mining Journal, 2003a, Parapanema maintains tin output: Mining Journal, January 9, p. 3.
 Mining Journal, 2003b, Renison Bell in administration: Mining Journal, v. 340, no. 8742, June 27, p. 433-434.
 Mining Journal, 2003c, Timah plans new smelter: Mining Journal, v. 340, no. 8722, February 7, p. 92.
 Platts Metals Week, 2003a, Indonesia's Timah to list on Euronext: Platts Metals Week, v. 74, no. 33, August 18, p. 7.
 Platts Metals Week, 2003b, LME drops maximum ingot size to 30kg: Platts Metals Week, v. 74, no. 52, December 29, p. 10.
 Platts Metals Week, 2003c, MSC to explore on Bangka Island: Platts Metals Week, v. 75, no. 1, January 5, p. 11.
 Steel Recycling Institute, 2004, Steel recycling rates: Pittsburgh, PA, Steel Recycling Institute news release, May 3, 1 p.
 Tin Technology, 2003, World Tin consumption to exceed 300,000 tons: Uxbridge, United Kingdom, Tin Technology press release, October 23, 2 p.
 TIN World, 2003a, BHP becomes BlueScope Steel: TIN World, no. 2, December/January, p. 11.
 TIN World, 2003b, Oki and Furukawa jointly develop new technology for lead-free soldering: TIN World, no. 2, December/January, p. 17.

Internet References Cited

EFSOT, 2003 (February 17), EFSOT- next generation environment-friendly soldering technology website, accessed August 11, 2003, at URL <http://www.efsot-europe.info>.
 Metal-Pages, 2003a (August 11), China clamps down on rare earth, tin and antimony production, accessed August 12, 2003, at URL <http://www.metal-pages.com>.

Metal-Pages, 2003b (December 3), Gippsland seeks to raise \$300,000 through placement, accessed December 4, 2003, at URL <http://www.metal-pages.com>.
 Metal-Pages, 2003c (July 29), Japan slow to take up lead-free solders, accessed July 30, 2003, at URL <http://www.metal-pages.com>.
 Metal-Pages, 2003d (November 4), Liuzhou China Tin reopens Gaofeng mine in Nandan, accessed November 5, 2003, at URL <http://www.metal-pages.com>.
 Metal-Pages, 2003e (November 12), Malachite acquires option to mine Elsmore tin mine, accessed November 14, 2003, at URL <http://www.metal-pages.com>.
 Metal-Pages, 2004 (January 30), Base metal bull run to gather pace in 2004—Natexis Metals, accessed February 2, 2004, at URL <http://www.metal-pages.com>.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

Recycling—Metals. Ch. in Minerals Yearbook, annual.
 Tin. Ch. in Mineral Commodity Summaries, annual.
 Tin. Ch. in United States Mineral Resources, Professional Paper 820, 1973.
 Tin. International Strategic Minerals Inventory Summary Report, Circular 930-J, 1990.
 Tin. Mineral Industry Surveys, monthly.
 Tin Resources of the World. Bulletin 1301, 1969.

Other

Canadian Mining Journal.
 Resources Recycling.
 Roskill Information Services Ltd.
 Tin. Ch. in Mineral Facts and Problems, U.S. Bureau of Mines Bulletin 675, 1985.
 Wall Street Journal.
 Waste Age.

TABLE 1
 SALIENT TIN STATISTICS¹

	1999	2000	2001	2002	2003
United States:					
Production, secondary, contained tin ^c metric tons	16,400	15,700	13,900	10,500 ^f	7,880
Exports, refined tin do.	6,770	6,640	4,350	2,940	3,690
Imports for consumption, refined tin do.	47,500	44,900	37,500	42,200	37,100
Consumption, contained tin:					
Primary do.	38,000	38,100	34,200	34,000	32,900
Secondary do.	8,890	8,940	7,630	5,830	4,490
Stocks, yearend, U.S. industry, contained tin do.	10,700	10,400	9,620	8,910 ^f	7,950
Prices, average, contained tin:					
New York, NY market cents per pound	254.54	254.92	211.48	194.75	232.36
Platts Metals Week composite do.	365.98	370.16	314.88	291.97	339.78
London, United Kingdom do.	245.00	246.00	203.00	184.00	222.00
Kuala Lumpur, Malaysia do.	240.70	244.12	200.77	184.35	221.67
World, production, contained tin:					
Mine metric tons	246,000 ^f	277,000 ^f	281,000 ^f	241,000 ^f	209,000 ^e
Smelter:					
Primary do.	249,000	271,000	284,000 ^f	265,000 ^f	267,000 ^e
Secondary do.	17,300 ^f	16,600	16,200	14,200 ^f	11,900 ^e
Undifferentiated do.	100	--	--	75	200 ^e

^cEstimated. ^fRevised. -- Zero.

¹Data are rounded to no more than three significant digits, except prices.

TABLE 2
U. S. CONSUMPTION OF PRIMARY AND SECONDARY TIN¹

(Metric tons of contained tin)

	2002	2003
Stocks, January 1 ²	8,500	7,940
Net receipts during year:		
Primary	34,200 ^r	32,400
Secondary	1,610	1,370
Scrap	4,230 ^r	3,420
Total receipts	40,100 ^r	37,200
Total available	48,600 ^r	45,200
Tin consumed in manufactured products:		
Primary	34,000	32,900
Secondary	5,830	4,490
Total	39,800	37,400
Intercompany transactions in scrap	222 ^r	258
Total processed	40,000 ^r	37,600
Stocks, December 31 (total available less total processed)	8,550 ^r	7,540

^rRevised.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Includes tin in transit in the United States.

TABLE 3
U.S. CONSUMPTION OF TIN, BY FINISHED PRODUCT¹

(Metric tons of contained tin)

Product	2002			2003		
	Primary	Secondary	Total	Primary	Secondary	Total
Alloys, miscellaneous ²	W	W	W	W	W	W
Babbitt	1,310	W	1,310	2,570	W	2,570
Bar tin	617	W	617	849	W	849
Bronze and brass	1,330	1,720	3,040	1,260	1,340	2,600
Chemicals	8,400	W	8,400	8,720	W	8,720
Collapsible tubes and foil	W	W	W	W	W	W
Solder	10,000	3,790	13,800	7,660	2,950	10,600
Tinning	679	W	679	833	--	833
Tinplate ³	7,750	--	7,750	7,790	--	7,790
Tin powder	W	W	W	W	W	W
Type metal	W	W	W	W	W	W
White metal ⁴	1,320	W	1,320	1,220	W	1,220
Other	2,590	327	2,920	1,980	202	2,180
Total	34,000	5,830	39,800	32,900	4,490	37,400

W Withheld to avoid disclosing company proprietary data; included with "Other." -- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Includesterne metal.

³Includes secondary pig tin and tin acquired in chemicals.

⁴Includes pewter, britannia metal, and jewelers' metal.

TABLE 4
U.S. INDUSTRY YEAREND TIN STOCKS¹

(Metric tons)

	2002	2003
Plant raw materials:		
Pig tin:		
Virgin ²	6,670 ^r	5,930
Secondary	393	361
In process ³	895 ^r	949
Total	7,950 ^r	7,240
Additional pig tin:		
Jobbers-importers	916	382
Afloat to United States	40	330
Total	956	712
Grand total	8,910 ^r	7,950

^rRevised.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Includes tin in transit in the United States.

³Data represent scrap only, tin content.

TABLE 5
U.S. STOCKS, RECEIPTS, AND CONSUMPTION OF NEW AND OLD SCRAP AND TIN RECOVERED, BY TYPE OF SCRAP¹

(Metric tons)

Type of scrap	Gross weight of scrap								
	Stocks, January 1	Receipts	Consumption			Stocks, December 31	Tin recovered ^e		
			New	Old	Total		New	Old	Total
2002:									
Copper-base scrap:									
Ingot makers	6,290 ^r	103,000 ^r	25,200 ^r	78,900 ^r	104,000 ^r	5,700 ^r	1,020 ^r	2,990 ^r	4,010 ^r
Brass mills ²	--	98,400	98,400	--	98,400	--	1,450	--	1,450
Foundries and other plants	1,970 ^r	27,800	16,500 ^r	11,000 ^r	27,400 ^r	2,290 ^r	W	432 ^r	432 ^r
Total	XX	XX	XX	XX	XX	XX	2,470 ^r	3,430 ^r	5,890 ^r
Lead-base scrap	31,100	1,140,000	50,200	1,090,000	1,140,000	27,800	1,320	3,330	4,650
Tin-base scrap ³	W	W	W	W	W	W	W	W	W
Grand total	XX	XX	XX	XX	XX	XX	3,790 ^r	6,760 ^r	10,500 ^r
2003:									
Copper-base scrap:									
Ingot makers	5,700	69,800	17,700	52,400	70,000	5,440	692	2,030	2,730
Brass mills ²	--	28,400	28,400	--	28,400	--	487	--	487
Foundries and other plants	2,290	28,000	16,900	11,500	28,300	1,920	W	407	407
Total	XX	XX	XX	XX	XX	XX	1,180	2,440	3,620
Lead-base scrap	27,800	1,200,000	48,800	1,150,000	1,200,000	29,000	1,280	2,980	4,260
Tin-base scrap ³	W	W	W	W	W	W	W	W	W
Grand total	XX	XX	XX	XX	XX	XX	2,460	5,420	7,880

^eEstimated. ^rRevised. W Withheld to avoid disclosing company proprietary data. XX Not applicable. -- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

²Consumption is assumed to be equal to receipts.

³Includes tinplate and other scrap recovered at detinning plants.

TABLE 6
U.S. EXPORTS OF TIN IN VARIOUS FORMS¹

Year	Tinplate and terneplate				Tin scrap and other tin-bearing material except tinplate scrap ²	
	Quantity		Ingots and pigs		Quantity	
	(metric tons, gross weight)	Value (thousands)	Quantity (metric tons)	Value (thousands)	(metric tons, gross weight)	Value (thousands)
2002	219,000	\$129,000	2,940	\$14,800	24,500	\$32,200
2003	263,000	154,000	3,690	18,500	24,500	32,600

¹Data are rounded to no more than three significant digits.

²Includes rods, profiles, flakes, tubes, and pipes.

Source: U.S. Census Bureau.

TABLE 7
U.S. IMPORTS FOR CONSUMPTION OF TIN IN VARIOUS FORMS¹

Year	Miscellaneous, ³ value (thousands)	Dross, skimmings, scrap residues, tin alloys, n.s.p.f. ²		Tinplate and terneplate		Tin compounds		Tinplate scrap	
		Quantity (metric tons, gross weight)	Value (thousands)	Quantity (metric tons, gross weight)	Value (thousands)	Quantity (metric tons, gross weight)	Value (thousands)	Quantity (metric tons, gross weight)	Value (thousands)
		2002	\$1,510	2,280	\$7,170	254,000	\$143,000	449	\$3,230
2003	3,510	3,290	10,500	282,000	173,000	443	3,000	20,100	3,390

¹Data are rounded to no more than three significant digits.

²Not specifically provided for.

³Includes tin foil, tin powder, flitters, metallics, manufactures, and n.s.p.f.

Source: U.S. Census Bureau.

TABLE 8
U.S. IMPORTS FOR CONSUMPTION OF UNWROUGHT TIN METAL, BY COUNTRY¹

Country	2002		2003	
	Quantity (metric tons)	Value (thousands)	Quantity (metric tons)	Value (thousands)
Australia	100	\$363	200	\$876
Belgium	92	492	87	585
Bolivia	6,150	24,300	5,720	26,700
Brazil	4,840	19,000	3,000	12,800
Canada	20	37	5	27
Chile	--	--	636	3,160
China	7,600	31,000	4,340	19,600
Indonesia	3,340	11,600	3,070	10,200
Japan	--	--	136	646
Malaysia	122	501	490	2,200
Netherlands	--	--	40	168
Peru	19,900	79,300	19,100	90,900
Taiwan	--	--	34	527
United Kingdom	2	18	143	528
Vietnam	--	--	59	294
Other	72	535	1	26
Total	42,200	167,000	37,100	169,000

-- Zero.

¹Data are rounded to no more than three significant digits; may not add to totals shown.

Source: U.S. Census Bureau.

TABLE 9
TIN: WORLD MINE PRODUCTION, BY COUNTRY^{1,2}

(Metric tons)

Country	1999	2000	2001	2002	2003 ^e
Australia	10,011	9,146	9,602	6,268	6,500
Bolivia	12,417	12,464	12,298	15,242	15,000
Brazil	13,202	13,773 ^r	14,200 ^r	14,200 ^r	14,200
Burma ³	149	212	212 ^r	190 ^r	200
Burundi	18 ^e	7	4	-- ^r	--
China ^e	80,100	99,400	95,000	62,000 ^r	50,000
Congo (Kinshasa) ^e	50	50	50	20	40
Indonesia	47,754	51,629	61,862 ^r	88,142 ^r	70,000
Kyrgyzstan ^e	250	300	300	300	350
Laos	404	408 ^r	490 ^r	366 ^r	360
Malaysia	7,339 ^r	6,307	4,972	4,215	3,359 ⁴
Mexico	4	4	8	9 ^r	10
Niger	32	22	9 ^{r,e}	11 ^r	20
Nigeria ^{e,5}	3,300 ^r	2,760 ^r	2,870 ^r	2,800 ^{r,4}	2,000
Peru	59,191	70,901 ^r	69,696	38,815 ^r	38,800
Portugal	2,200	1,200 ^e	1,200 ^e	1,000	1,000
Russia ^e	2,500 ^r	2,500 ^r	2,000 ^r	1,300 ^r	2,000
Rwanda	248	276	169 ^r	197 ^r	140
Spain ^e	2	3	2	2	2
Thailand	2,712	1,930 ^r	1,950 ^r	1,130 ^r	817 ⁴
Uganda	(6)	(6)	18	-- ^r	--
Vietnam ^e	4,000	4,100	4,500	4,500 ^r	4,600
Zimbabwe ^e	1	-- ⁴	-- ⁴	--	--
Total	246,000 ^r	277,000 ^r	281,000 ^r	241,000 ^r	209,000

^eEstimated. ^rRevised. -- Zero.

¹World totals and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Table includes data available through July 18, 2004.

³Includes content of tin-tungsten concentrate.

⁴Reported figure.

⁵Concentrate gross weight reported, estimated 62% tin content.

⁶Less than 1/2 unit.

TABLE 10
TIN: WORLD SMELTER PRODUCTION, BY COUNTRY^{1,2}

(Metric tons)

Country	1999	2000	2001	2002	2003 ^c
Australia:					
Primary	600	775	1,171	611	600
Secondary ^e	300	300	300	300	300
Total ^c	900	1,080	1,470	911	900
Belgium, secondary ^e	8,100	8,500	8,000	6,000	5,000
Bolivia, primary	11,166	9,353	11,292 ^f	10,976	11,000
Brazil:					
Primary	12,787	13,825 ^f	13,800 ^f	11,675 ^f	11,700
Secondary ^e	250	250	250	250	250
Total ^c	13,000	14,100 ^f	14,100 ^f	11,900 ^f	12,000
Bulgaria, secondary ^e	10	10	10	10	10
Burma, primary ^e	32 ³	30 ^e	30	30	30
China, primary ^e	90,800	112,000	105,000	82,000 ^f	100,000
Czech Republic, secondary ^e	100	100	100	100	100
Denmark, secondary ^e	100	100	100	100	100
Greece, secondary ^e	200	150	150	150	100
Indonesia, primary	49,105	46,432	53,470	67,455 ^f	65,000
Japan, primary	568	593	668	659	662 ³
Malaysia, primary	28,913	26,228	30,417	30,887 ^f	18,000
Mexico, primary	1,262 ^f	1,204 ^f	1,789 ^f	1,756 ^f	1,800
Nigeria, primary ^e	50	25 ^f	25 ^f	26 ^f	25
Norway, secondary ^e	50	50	50	50	50
Peru, primary	30,618	37,410	38,182	35,828	39,181 ³
Portugal, primary and secondary ^e	100	--	--	--	--
Russia: ^e					
Primary	4,500 ^f	4,800 ^f	4,569 ^{f,3}	4,615 ^{f,3}	5,500
Secondary	500 ^f	500	500	500	500
Total	5,000 ^f	5,300 ^f	5,070 ^f	5,120 ^f	6,000
Rwanda	--	--	--	75	200
Spain: ^e					
Primary	50	--	--	--	--
Secondary	50	25	25	25	25
Total	100	25	25	25	25
Thailand, primary	17,306	17,076	22,387 ^f	17,548 ^f	12,000
United States, secondary	7,720	6,600	6,700 ^f	6,760 ^f	5,420 ³
Vietnam, primary ^e	1,693 ^f	1,490 ^f	1,400 ^f	1,400 ^f	1,300
Grand total	267,000 ^f	288,000	300,000 ^f	280,000 ^f	279,000
Of which:					
Primary	249,000	271,000	284,000 ^f	265,000 ^f	267,000
Secondary	17,300 ^f	16,600	16,200	14,200 ^f	11,900
Undifferentiated	100	--	--	75	200

^cEstimated. ^fRevised. -- Zero.

¹World totals, U.S. data, and estimated data are rounded to no more than three significant digits; may not add to totals shown.

²Whenever possible, total output has been separated into primary (from ores and concentrates) and secondary (tin metal recovered from old scrap). This table reflects metal production at the first measurable stage of metal output. Table includes data available through July 18, 2004.

³Reported figure.