

Tin Review

Overlooked with long term potential.

Tin is in the shadows of the base metals world.

Used in the electrical and electronic industries as well as for tin-plate, tin chemicals and float glass production.

Tin is the smallest London Metal Exchange (LME) traded metal market by value. It is not even covered by industry giant Kitco and the tin market is in the shadows of the base metals world. Tin saw a major bull market between 2005 and the peak in May 2008. The financial crisis prompted a crash in late summer 2008, while some recovery has been seen in 2009. Further recovery is forecast for 2010.

Traditional industrial uses of tin include tinplate, tin alloy coatings, solder, pewter and chemical compounds mainly used in the plastics industry. Tinplate has long been and remains an ideal food packaging material, while with the advent of the electronic age the use of tin in solders has vastly increased. Since the change to lead free solder, this has become the single largest sector of tin consumption. Other environmentally friendly uses of tin focus on its non-toxic properties.



Source: LME, price in US\$/tonne

Conclusion

Longer term outlook very encouraging with growth in electrical and electronics demand. Supply constraints are exacerbated by few new mine developments.

Short term production outlook uncertain. Will the hedge fund holder of visible stocks liquidate?

Research

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The longer term outlook for tin looks very encouraging for two main reasons: growing demand from electrical and electronic applications, and growth in the emerging markets for traditional uses such as tin plate, tin chemicals and float glass. Supply is constrained with few new mining projects being planned. China is an important producer and consumer, and as domestic concentrate production appears to be constrained, Chinese companies have been active in international markets. It has also been argued that Indonesian and Democratic Republic of Congo (DRC) supply is potentially in long term decline.

In the short term however the outlook is more uncertain. Most analysts are expecting some increase in demand in 2010, while also expecting Indonesian supply restrictions and anticipating action from a hedge fund that appears to control the bulk of reported LME stockpiles. It is not clear how long Indonesian supply constraint may last, and the actions of the hedge fund are uncertain. Furthermore, primary production is increasing in Bolivia and it is not clear whether DRC production is sustainable or indeed legal.

Introduction

Tin, chemical symbol Sn, is a silvery white metal with a specific gravity of 7.29 and a low melting point of 232° Celsius (C). It has a brilliant lustre and when polished it has a high light reflectivity. The metal is highly resistant to corrosion and fatigue, it is very malleable and ductile, and it has a low melting point and alloys well with many other metals particularly with copper (bronze) and lead (solder). Chemically, the most outstanding property of tin is its ability to resist attack by air and by many of the organic acids, including those found in food of various kinds.

Total world tin consumption amounts to around 310,000 tonnes per annum. At around US\$16,000 per tonne, this represents a US\$5 bn per annum world market. The most significant use of tin is in solders, which represent 51% of world consumption. The other major areas of tin consumption are tinplate, which represents 17%, and the plastic industry, which represents 13% of total world consumption.

From early 2000, restrictions of the use of certain hazardous substances in new electrical and electronic equipment, as promulgated by European Union Directive 2002/95, banned more than agreed levels of lead, cadmium, mercury hexavalent chromium, polybrominated biphenyl and polybromated diphenyl ether flame retardants. In particular, this ban on the use of lead in solder triggered tin substitution, and has transformed tin from being dependent on tin-plate demand into a metal dependent on the outlook for the electrical and electronics industry. As the world electrical and electronics industry is so universal in outlook, European regulations have been adopted worldwide, and there is now little demand for traditional lead based solders.

Tin is also used in the production of float glass: in essence, molten glass floats on a bed of molten tin in the production process. Float glass baths typically require about 200 tonnes (t) of tin.

Tin production and consumption

As in many metal markets China is an important consideration in the outlook not only for tin demand but also for supply. In 2009 China produced 38.7%, and consumed 39.3% of the world's tin. Second largest producer is Indonesia with 19.5% of world production, while the USA was the second largest customer and represented 9.5% of world consumption.

A note on prices and output terminology

Tin production and consumption is expressed in tonnes, while the London Metal Exchange (LME) and Kuala Lumpur Tin Market (KLTM) contracts are priced in US dollars per tonne (US\$/t). Occasionally tin prices and grades are described in US\$ per pound (lb). To convert pounds into tonnes, divide by 2,000, or multiply US\$/lb by 2000 to get US\$/t.

Tin production

Tin metal is produced from tin concentrates. Tin is found in a number of ore deposits, the bulk of which are so called alluvial deposits whereby the main tin ore, cassiterite, has become concentrated as a result of weathering and sedimentation. Alluvial deposits are usually much lower grade than hard rock tin deposits. Cassiterite is usually separated from the waste material (gangue) by gravity means. In hard rock polymetallic tin resources the other base metals are separated by floatation, and the tin is concentrated by gravity means. Concentrates grade from 55-77% tin from both alluvial and hard rock sources.

The tin concentrate is placed in a furnace along with carbon in the form of either coal or fuel oil. If a tin concentrate with excess impurities is used, limestone and sand may also be added to react with the impurities. As the materials are heated to about 1400° Celsius, the carbon reacts with the carbon dioxide in the furnace atmosphere to form carbon monoxide. In turn, the carbon monoxide reacts with the cassiterite in the tin concentrate to form crude tin and carbon dioxide.

Because tin readily forms compounds with many materials, it often reacts with the slag. As a result, the slag from the first furnace contains an appreciable amount of tin and must be processed further before it is discarded. The slag is heated in a second furnace along with additional carbon, scrap iron, and limestone. As before, crude tin is formed and recovered along with a certain amount of residual slag. The slag and crude tin are heated several more times to remove impurities and recover tin. The residual slag from the

second furnace is heated one more time to recover any tin that has formed compounds with iron. This material is known as the hard head. The remaining slag is discarded. The crude tin from the first furnace is placed in a low-temperature furnace along with the crude tin recovered from the slag plus the hard head. Because tin has a melting temperature much lower than most metals, it is possible carefully to raise the temperature of the furnace so that only the tin melts, leaving any other metals as solids. The melted tin runs down an inclined surface and is collected in a so-called poling kettle, while the other materials remain behind. This process is called liquitation and it effectively removes much of the iron, arsenic, copper, and antimony that may be present.

The molten tin in the poling kettle is agitated with steam, compressed air, or poles of green wood. This process is called boiling. The green wood, being moist, produces steam along with the mechanical stirring of the poles. It was from this crude, but effective, use of wood poles that the poling kettle got its name. Most of the remaining impurities rise to the surface to form a scum, which is removed. The refined tin is now about 99.8% pure.

For applications requiring an even higher purity, the tin may be processed further in an electrolytic refining plant. The tin is poured into moulds to form large electrical anodes, which act as the positive terminals for the electrorefining process. Each anode is placed in an individual tank, and a sheet of tin is placed at the opposite end of the tank to act as the cathode, or negative terminal. The tanks are filled with an electrically conducting solution. When an electrical current is passed through each tank, the tin is stripped off the anode and is deposited on the cathode. The remaining impurities, which are generally bismuth and lead, fall out of the solution and form slime at the bottom of the tank. The cathodes are remelted, and the refined tin is cast in iron moulds to form ingots or bars, which are then shipped to the various end users.

Tin production is measured in terms of both tin in concentrates and refined tin. Tin production has fallen in recent years, as a response to falling demand owing to the effects of the financial crisis on the electrical and electronics industries, but this generalisation covers a number of subtle developments in world production.

Tin Production	2007	2007	2008	2008	2009	2009
	Concentrates '000 tonnes	Refined '000 t	Concentrates '000 t	Refined '000 t	Concentrates '000 t	Refined '000 t
China	104.0	144.0	93.7	122.0	93.8	124.0
Indonesia	103.1	78.0	94.1	67.1	88.7	62.5
Peru	39.0	35.9	39.0	38.0	37.6	34.8
Malaysia	2.3	25.5	2.6	31.6	2.5	37.0
Thailand	0.2	19.8	0.2	21.7	0.2	20.0
Bolivia	16.0	12.3	17.3	12.7	18.2	14.5
Brazil	11.8	10.2	13.0	10.8	10.4	10.0
Belgium	0.0	8.4	0.0	9.2	0.0	9.1
Russia	2.4	2.5	1.1	1.4	0.7	0.7
Australia	2.7	0.0	2.2	0.0	6.6	0.0
DR Congo	12.2	0.0	15.5	0.0	15.0	0.0
Other Africa	2.9	0.0	2.5	0.0	3	0.0
Other	5.1	0.0	5.3	0.0	5.5	0.0
Concentrate producers						
Other refined producers	0.0	8.5	0.0	7.2	0.0	8.0
Total World	301.7	345.1	286.5	321.7	282.2	320.6

Source: Commodities Research Unit (CRU) and Kasbah Resources

China

According to the metals consultancy the Commodities Research Unit (CRU), China suffers from overcapacity in smelting and refining, and hence low margins, but remains an important importer of concentrates and refined tin.

Indonesia

Indonesia suffers from high levels of illegal tin production; the CRU estimates that almost 50% of the above concentrate production numbers comprise illegal unreported production. The Indonesian Government periodically clamps down on this illegal production, partially to support semi-state owned PT Timah and partially to control tin prices. Indonesian tin production is currently restricted by the state but it has been argued that the long term trend for production is constrained as PT Timah is selling mainly from stock, and its sources of alluvial tin are becoming more difficult to access.

Peru

The world's lowest cost tin producer, Minsur, is mainly responsible for Peru's position in the list of world tin producers. Minsur's San Rafael mine seems likely to be able to continue supplying ore grading 5% tin to its concentrator for some time to come.

Malaysia & Thailand

Malaysia and Thailand are historical tin producers that are now almost wholly dependent on imported concentrates.

Bolivia

Bolivia is ramping up operations at the state owned Empresa Minera Huanuni (EMH) mining and processing company and at the Vinto smelter. A US\$40m project to double milling capacity at EMH is due to be completed by 2011, while the Government is investing US\$25m in a new Ausmelt furnace at Vinto. Vinto was seized from Glencore in February 2007; negotiations continue over compensation.

Australia

The recent increase in Australian production is due to the reopening of the Renison tin mine in Tasmania. The mine's owner, **Metals X Limited (MLX-ASX)** has recently received Foreign Investment Review Board (FIRB) approval to sell 60% of their Tasmanian tin assets to the world's largest tin producer, Yunnan Tin of China, for US\$60m. Renison has the capacity to increase production, and has the potential for a tailings recovery project. However it is not clear how quickly these plans will be progressed now Yunnan Tin is a partner. It is particularly unclear whether this partnership will increase global supply or whether Yunnan will use Renison concentrates to augment declining domestic Chinese production.

Democratic Republic of Congo (DRC) & other Africa

The DRC is a wild card for world tin production as much of it is illegal and supplies cash for the various insurgent groups that are active in the country. Much of the Other African concentrate production in the above table is probably smuggled out of the DRC and given false paperwork. In response to international pressure, trading groups Traxys and Amalgamated Metal Corporation suspended purchases of tin in concentrates in July and September 2009 respectively. The DRC Minister of Mines has recently asked these two traders to resume concentrate purchases from the DRC, as the DRC Government has started to co-operate with the UN peacekeeping force (MONUC) in establishing secure trading centres in Kivu.

It is not clear whether DRC production can be maintained in the long term. With little professional mining experience these alluvial resources could be worked out very quickly by artisanal miners.

Potential new tin producers

There are a number of potential new tin mines worldwide. Most are very low grade or represent by-product tin production from other base metal operations. Overall new sources of supply are scant.

Kasbah Resources (KAS-ASX) has been exploring its underground hard rock Achmmach tin project in Morocco since listing in April 2007. The company outlined in December 2008 a Joint Ore Reserves Committee (JORC) compliant indicated resource of 6 million tonnes (Mt) grading 0.9% tin. Since then, the company has been drilling in the Meknes zone with encouraging results. These appear to indicate rising tin grades with depth, the latest hole pulled 30 metres (m) grading 1.5% tin, and included a 10 m intersection grading 2.2% tin. The company has plans to reopen underground exploration drives within the Meknes zone with the aim of outlining a resource of up to 10 Mt grading 0.9-1% tin. A mooted 800,000tpa underground operation could produce 5-6,000 tpa of tin in concentrates.

Kasbah will need to raise funds to progress this project, but as Achmmach appears to be one of the very few potential new tin mines worldwide, this should be supported. The deposit has the benefits of being relatively large, concentrated in area and of high grade. Morocco appears to be a supportive pro-mining economy and is located close to important European consumers.

Commodity trader Traxys signed a memorandum of understanding with **Wolf Minerals (WLF-ASX)** in September 2009 to market tin and wolframite concentrates produced from Wolf's Hemerdon Ball tungsten project in Devon, England. Traxys will market 100% of Hemerdon's wolframite concentrates on commercial terms and intends to make an offtake agreement for 100% of their tin concentrates at spot prices. Wolframite is one of two main tungsten ores, which can be processed into ammonium paratungstate. Ammonium paratungstate can then be further processed to produce tungsten metal. Tungsten is remarkable for its robust physical properties, especially the fact that it has the highest melting point of all the non-alloyed metals and the second highest of all the elements after carbon. Tungsten ores are often found associated with tin minerals in hard rock polymetallic deposits.

The September 2009 announcement coincided with an A\$4m capital raising by Wolf: A\$2m was provided by Traxys and the balance from Resource Capital Funds. The funds raised will go towards the completion of a Bankable Feasibility Study (BFS) on the project. Although more significant for the tungsten market, initially projected tin production amounts to a modest 500 tpa.

Adex Mining (ADE-TSX-V) continues to evaluate their Mount Pleasant property in New Brunswick, Canada. The company has outlined a low grade, low return tungsten/molybdenum resource at its Fire Tower Zone, but at its separate North Zone a tin/indium/zinc resource has been outlined which a recent preliminary assessment shows has more promising economics.

The North Zone contains a Canadian National Instrument NI43-101 compliant estimate of 10.88 million tonnes (Mt) in the indicated category grading 0.43% tin, 67.8 grammes per tonne (g/t) indium and 0.67% zinc, as well as 7.6 Mt in the inferred category grading 0.22% tin, 74.6g/t indium and 0.99% zinc. Indium-tin oxide forms transparent electrodes in liquid crystal displays and touchscreens, while Indium metal is also used for making particularly low melting point alloys, and is a component in some lead-free solders.

Adex's preliminary assessment indicated that a 10 year production life at 850 tonnes per day (tpd), requiring pre-production capital of C\$71.1m, would generate an after tax Internal Rate of Return (IRR) of 24%. The company does not indicate tin recoveries, but 850 tpd of ore could lead to modest tin production of up to 500 tpa.

Western United Mines Ltd, funded by metal trader Trafigura, continues to explore the South Crofty Tin Mine in Cornwall. Closed in March 1998 with resources in a number of deep flooded veins, Western United has concentrated on the search for shallower resources. As yet no results from its extensive underground exploration program have been announced and there is thus no credible timetable for re-opening.

Gippsland (GIP-ASX) is still trying to develop their Abu Dabbab tantalum/tin/feldspar project in Egypt. Although primarily seen as a tantalum project, peak production of 1,500 tonnes of tin per annum has been forecast. With a continuing struggle to raise project finance for this mine development, it is not clear when tin production could start. Gippsland also holds a 40% stake in the Heemskirk tin project, located close to Renison in Tasmania which is being explored by **Stellar Resources (SRZ-ASX)**.

Tin consumption

Tin Consumption	2007 '000 t	2008 '000 t	2009 '000 t
China	132.0	123.3	120.0
Japan	34.2	32.2	25.3
Other Asia	63.6	62.7	54.5
USA	34.1	31.2	28.9
Other Americas	18.7	18.9	16.8
Europe	70.3	66.5	56.5
Other	3.3	3.4	3.0
Total World	356.2	338.2	305.0

Source: Commodity Research Unit and Kasbah Resources

As well as being a large producer of concentrates and refined metal, China is also a large consumer of tin. This is across a wide range of uses, ranging from the electronics industry, low quality tin plate for chemical and paint containers through to tin consumption in new float glass plants. According to the CRU, thirteen new float glass lines have been finished in the first half of 2009 and there are thirty new glass lines under construction. Since each float glass bath typically requires about 200 tonnes of tin, this would suggest a very significant total of 6,000 tonnes of tin for the lines under construction.

Japan, other Asia, the USA and Europe are large consumers of tin in the electrical and electronics industry.

Although not particularly evident in these numbers, food security issues and consumption by emerging economies is increasing tin plate demand.

Stocks

Visible LME and KLTM stocks amount to 44,500 tonnes or about 7.5 weeks' consumption. US Defense Logistics Agency (DLA) sales have ceased. In 2009 South Korea's Public Procurement Service bought about 1,800 tonnes of tin. Since the South Koreans intend to build stocks to about 60 days' supply by 2012 from around 40 days currently, similar sized purchases for stock are expected from South Korea in 2010.

In spite of high visible stocks there is a perception of a stock shortage. This is not only because visible stocks might be controlled by one party, but also due to the considerable run down of non-visible stocks in the price peaks of above US\$20,000/t seen in 2008. It seems likely that manufacturers and traders would wish to rebuild those stocks at lower levels.

Is someone trying to corner the market?

Given that futures trading in tin has risen by 145% this year, compared with 3% for all other LME contracts, it is clear that something is happening. Warrant stocks have more than trebled this year, and are largely controlled by one hedge fund, Ebulio, who was named by Reuters in July 2009. Indeed in September 2009, the exchange required the un-named long position holder to lend over 25,000 tonnes at level (i.e. for free) rather than a backwardation of upwards of US\$30/tonne per day. Since then the position has continued to be rolled forward from day to day, with the exchange providing mandatory 'guidance' on the premium charged.

Purchasing Magazine reported the following in mid December 2009: *"The price of tin, which is widely used in food packaging and to solder electronic products, is expected to increase in 2010, not because of supply/demand fundamentals, but because of possible stockpile manipulation. Demand for tin is weak, production is expanding, inventories are enlarging and, yet, prices could jump by almost 40%. Key reason: Stockpile manipulation by an unnamed investor in London. Analysts say the mysterious investor, most likely the manager of a hedge fund has amassed dominant ownership—about 90%—of London Metal Exchange stocks and is sitting on thousands of metric tons of tin in warehouses across London. The result, analysts say, is "backwardation"—a situation in which futures-contract prices are lower than spot prices. In fact, a consensus of market experts project the world tin price could increase 12% in 2010 to \$6.82/lb from the expected 2009 average of \$6.10. However, they say the price could jump 38%, back to the \$8.39 of 2008."*

"Industrial buyers reportedly are furious that they are paying \$300 a metric ton more for immediate-delivery metal than it would cost them to buy three-month futures contracts. They argue that a contango—where spot prices are lower than forward prices—is considered normal for tin because of the interest, warehouse costs and insurance incurred in carrying the metal. Traders also claim that the investor's dominant position has made the market illiquid and disorderly with distorted prices. "It's a ridiculous situation to have when there is clearly not a shortage of tin and the LME is refusing to admit that anything's wrong," a metals trader tells The Daily Telegraph.

Forecasts

Commentators expect tin demand to show some recovery in 2010. At the same time they point out that supply is increasingly constrained. In recent years, increased supplies from the Democratic Republic of Congo have made that source more unreliable, and more vulnerable to disruption. Hence there is a desire for more reliable long term sources of supply. The International Tin Research Institute (ITRI) surveyed 20 or more potential hard rock tin mining projects. Although a contained resource of over one million tonnes or three years' supply could be identified, an average grade of less than 0.4% tin was seen as discouraging.

Conclusion

The longer term outlook for tin looks very encouraging with growing demand from electrical and electronic applications and growth in the emerging markets for traditional uses such as tin plate, tin chemicals and float glass. Supply is however constrained, with few new mining projects being planned. China is an important producer and consumer, and as domestic concentrate production appears to be constrained, Chinese companies have been active in international markets. It has also been argued that Indonesian and Democratic Republic of Congo (DRC) supply is potentially in long term decline.

In the short term however the outlook is more uncertain. Most analysts are expecting some increase in demand in 2010; at the same time, Indonesian supply restrictions and the actions of a hedge fund that appears to control the bulk of reported LME stockpiles are supportive. It is not clear however how long Indonesian supply constraints may last; the actions of the hedge fund are uncertain; primary production is increasing in Bolivia; Yunnan's production plans for Renison in Australia are uncertain, and it is debatable whether DRC production is sustainable and legal.

However, with such a shortage of new tin mining projects, those that are able to demonstrate economical operations at around current levels are worthy of support.

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Buy: Total return expected to appreciate 10% or more over a 12 month period.

Neutral: Total return expected to be between +10% and -10% over a 12 month period.

Sell: Total return expected to depreciate 10% or more over a 12 month period.

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