Mining and Mineral Series: The Lead Industry

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Overview

Lead is a dense, heavy, ductile, relatively soft, highly malleable metal which is a poor conductor of electricity. It is bluish white when freshly cut, but tarnishes to a dull grey colour when exposed.

Usually, lead is found in conjunction with other metals such as silver and zinc and is mined as a by-product. The ore is first mined post which it is concentrated, smelted and refined in a blast furnace with limestone and coke to remove and recover the other metals.

The lead metal is primarily extracted from sulphide ore i.e galena, which has the 86.6% lead content. Two other minerals commercially mined for lead are cerussite and anglesite. Over 95% of all lead mined is derived from one of these three minerals.

The largest source of lead, worldwide however is from secondary production (recycling). The secondary lead producers cater to about 55% of Indian lead demand.

Lead has the advantage of a very high density, low melting temperature and good malleability which enables lead articles to be cast, joined & shaped easily.

The metal is largely used for the manufacturing of automotive and industrial batteries but it is also suitable for shielding against sound, vibrations and radiation (lead shielding is used to protect your eyes while using computers and TV screens).

Production

Primary Lead

In India, lead mines are mainly concentrated in the state of Rajasthan. Hindustan Zinc (HZL) is the only integrated lead company engaged in mining and smelting operations.

At present, HZL has 5 prominent mining regions; (1) Rampura- Agucha mine (Bhilwara district) (2) Sindesar- Khurd mine (Rajsamand district) (3) Zawar group of mines (Udaipur district) (4) Rajpura-Dariba mine (Rajsamand district) and (5) Kayad mine (Ajmer district). The company also has three lead smelters engaged in the process of refining lead, located in Rajasthan in close proximity of the mines.

Table 1: Smelting capacity for Primary Lead (KT*)

Location	Process	Technology	Capacity
Chanderiya	Pyrometallurgy	Imperial Smelting	35
Chanderiya	Pyrometallurgy	Ausmelt Top Submerged Lance	50
Dariba	Pyrometallurgy	SKS, bottom blowing	116
			201

Source: Hindustan Zinc Annual Report 2017-18

**KT: kilo tonnes/ thousand tonnes*

Chart 1: Mining of Lead Concentrate (KT)

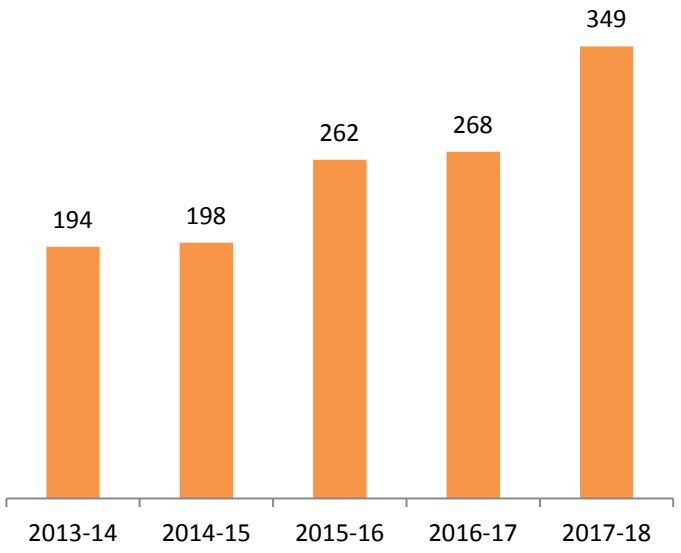
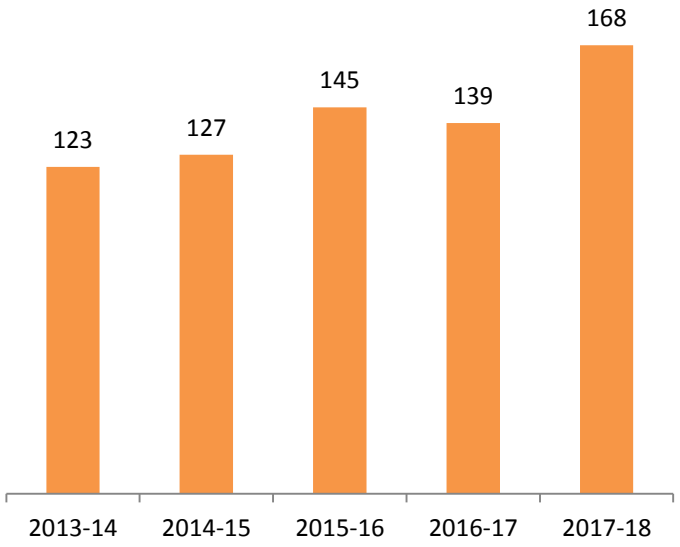


Chart 2: Production of Refined Lead (primary) (KT)



Source: Ministry of Mines, CMIE, Hindustan Zinc Company Filings

Mining of lead concentrate has grown at a CAGR of 15.8% during FY14-18. The industry adopted underground mining during FY14, which was a paradigm shift from opencast mining, leading to a subsequent increase in ore production. Production of lead concentrates has also increased on account of adoption of advance mining technologies and debottlenecking of operations. Production of the ores and concentrates has been the highest during FY18 due to higher ore production from the underground mines. Mining of lead will not be done via open cast operations from FY19 onwards as HZL has now fully converted to underground mining.

The mined metal then undergoes the pyrometallurgy process to get converted into refined lead which is used by the end users. Production of primary refined lead has grown at a CAGR of 8.2% during FY14-18. During FY17, the refined lead production was the lowest on account of lower availability of mined metal during the first half of the year. Production of refined lead was the highest during FY18. The increase was driven by uniform availability of mined metal during the year and debottlenecking of the smelter capacity.

Table 2: Refined Lead Production (primary) during 2018-19 (KT)

	2017-18 (April-July)	2018-19 (April-July)	Y-O-Y Change (%)
Refined Lead (Primary)	48	54	12.8%

Source: Ministry of Mines

Integrated lead production during FY19 was at 48 KT, up by 12.8% y-o-y. Increase in production can be attributed with the availability of lead mined.

Secondary Lead

Lead when used as metal in batteries, cable sheathing and sheathing for containing radiation is fully recyclable and does not lose its properties. Lead is very easy to recycle and is one of the most recycled base metals. It can be re-melted any number of times, and once re-processed, the final product (termed secondary lead) is indistinguishable from primary lead which is extracted from the ore. The secondary lead producers cater to about 55% of Indian lead demand.

Producing lead through this route requires around 1/3rd of the energy needed to extract it from its ores and recovery of secondary lead is economically more attractive because of certain advantages such as lower energy consumption which leads to low capital cost and environmental hazards.

Lead scrap includes lead acid batteries, cable coverings, pipes, sheets and lead coated metals. Soldering product waste and dross may also be recovered for small lead content. Battery scrap from automobile sector accounts for 80% of old scrap recycled as secondary lead raw material. Used lead acid battery is one of the largest sources of secondary lead production globally including India. To recover lead from a battery, the battery is broken and the components are segregated. Almost all the secondary plants use the pyro-metallurgical smelting process.

As per Indian Bureau of Mines there are 448 lead recyclers plant with production capacity of 1,698 KT of secondary lead in the country. However, since most secondary lead producers are from unorganized sectors, credible production data with regard to the same is not available.

We at CARE Ratings have estimated the portion of recycled lead in line with the consumption. Recycled lead during FY18 was around 64%-65% of the total refined lead.

Chart 3: Production of Secondary Lead (Recycled) (KT)

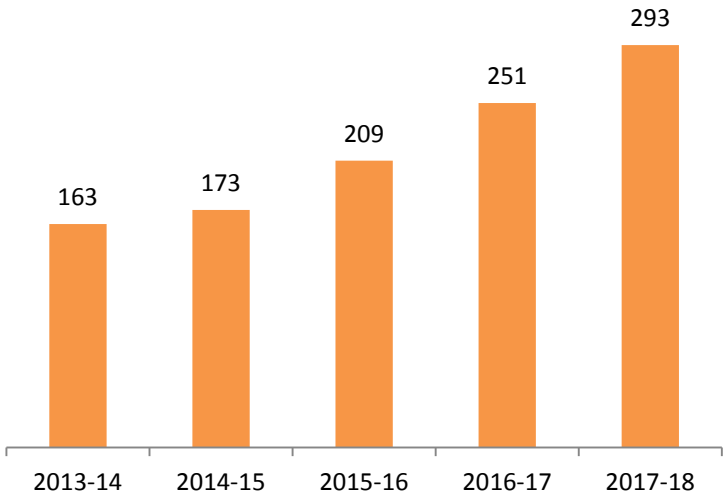
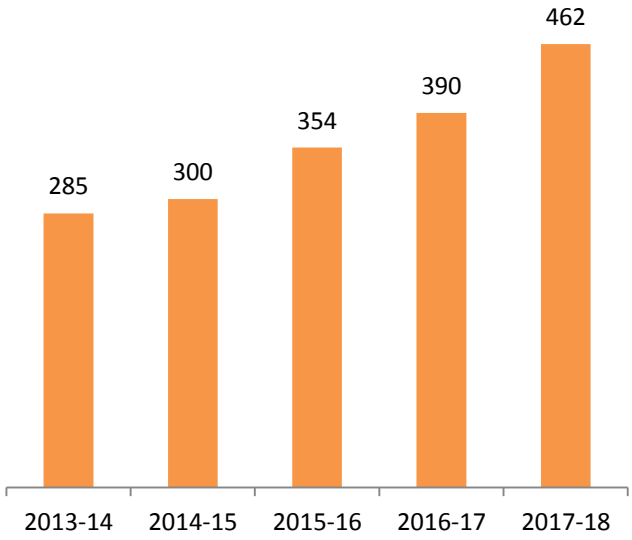


Chart 4: Production of Refined Lead (primary+ secondary) (KT)



Source: CARE ratings

Production via recycling has grown at a CAGR of 15.9% during FY14-18, while production of refined lead (primary & secondary) lead has grown at a CAGR of 12.8% in during the same time frame. Increase in recycled lead can be attributed to the huge domestic generation of used lead acid batteries.

Trade Data

India imports lead ores and concentrates from UAE, Saudi Arabia, Turkey, Sudan, Morocco and Estonia. Refined lead is imported from South Korea, Australia, Malaysia, UAE and Myanmar and exported to USA, South Korea, Taiwan, Vietnam & Thailand.

Chart 5: Imports of Lead Ores and Concentrate (KT)

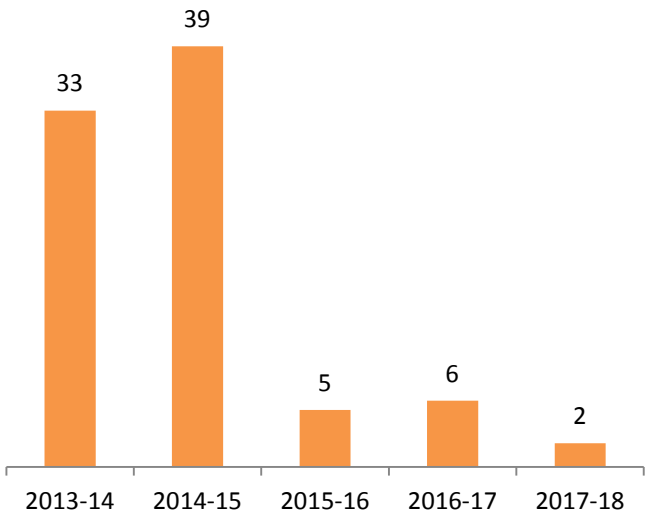
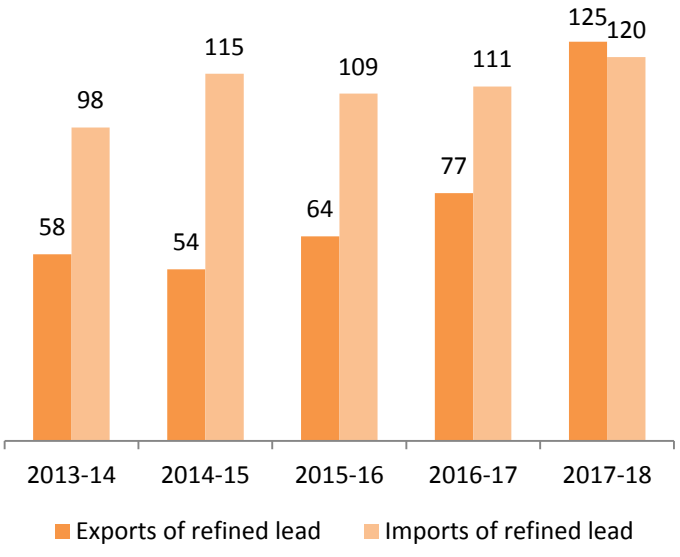


Chart 6: Exports and Imports of Refined Lead (KT)



Source: Ministry of Commerce and Industry, Ministry of Mines

Imports of lead concentrates has fallen drastically as there has been an increase in domestic mining of lead ores and concentrates leading to the import substitution of the mineral.

Over the years India has been a net importer of refined lead, but during FY18 refined lead exports have exceeded refined lead imports. Refined lead exports have increased by 62% on y-o-y basis from its FY17 levels. This can be attributed to the increase in production of recycled lead.

Application/Usage of Lead

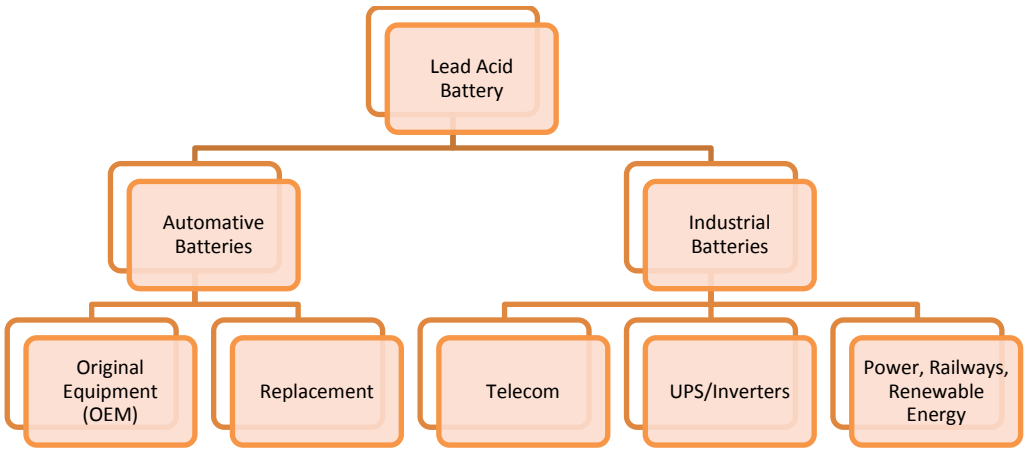
The principal usage of lead is for the manufacturing of lead-acid batteries which is used for both automotive and industrial applications. Lead is also used in remote access power systems, load levelling systems, in compounds in the glass and plastics industries and radiation shielding. Lead is a metal which effectively resists corrosive effects of atmospheric gases and acidic substances and it is, therefore, largely used for coating iron-sheets, sheathing cables, lining acid tanks etc.

Batteries (74%): The single largest use of lead is in the manufacture of batteries (74%), which can be sub-divided into SLI (Starting-Lighting-Ignition) batteries (50%) and Industrial Batteries (24%). Demand for both, SLI batteries and Industrial batteries can be further split into demand from new sales and replacement demand. In addition to this, lead acid batteries are used in many other applications where they may provide main or auxiliary power.

- **SLI batteries:** Lead is the primary ingredient used for manufacturing automotive batteries. These batteries are mainly used in cars and light vehicles, but are also found in other applications such as golf carts and boats. For SLI batteries segment, replacement demand outstrips the demand from the original equipment manufacturers (OEM's) in a ratio of about 3:1. A standard lead acid battery for starting, lighting and ignition of vehicles has the following average composition by weight: *Lead metal: 34%; Lead oxide paste: 39%, Electrolyte (free sulphuric acid): 11-12% others (ebonite, PVC, paper, etc.): 8-10%, polypropylene 5-6%.*

- **Industrial batteries** are mainly used as stationary and traction batteries. Stationary batteries are principally used as backup power supply systems whereas traction batteries are used for motive power in equipment such as forklift trucks and motorised wheelchairs. Industrial segment comprises of its usage in the telecom, UPS (uninterrupted power supply) and residential (power-backup) sectors. Lead-acid batteries also form a major part of power storage systems in renewable power projects. They enable power supply in the night in the case of roof-top and off-grid projects and act as a back-up before diesel generation sets in to take over in larger projects.

Chart 7: Battery Industry Structure

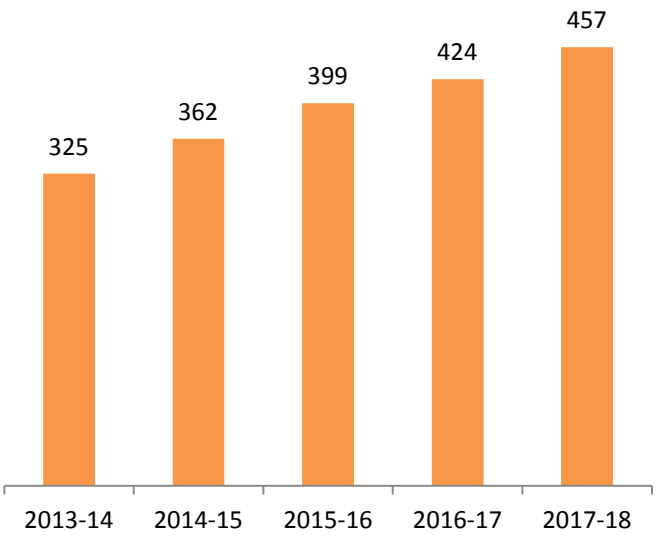


Source: ILZDA

Alloys (3%) & Pigments (9%): Lead alloys are used for soldering; bearings, bronzes (to reduce the melting point) and pewter (which are used for ornaments and table-wares). Lead alloys are also used to reduce the melting point of the alloy. Many compounds of lead are strongly coloured and highly durable. These properties make lead useful in paint and pigments. In addition, lead compounds are used in silica based glass to reduce and soften the temperature considerably. This is quite useful in optical glass which is used in binoculars, microscopes and spectacles. Also, leaded glass has a much higher X-ray absorption coefficient and hence is useful in radiation shielding TV tubes, etc. Lead oxide is added to glasses and glazes since ancient time. Principal markets are for cathode ray tubes used in television screens and computer monitors, and for Poly Vinyl Chloride (PVC) stabilisers. Cable and other industries account for the remaining 5% of lead demand.

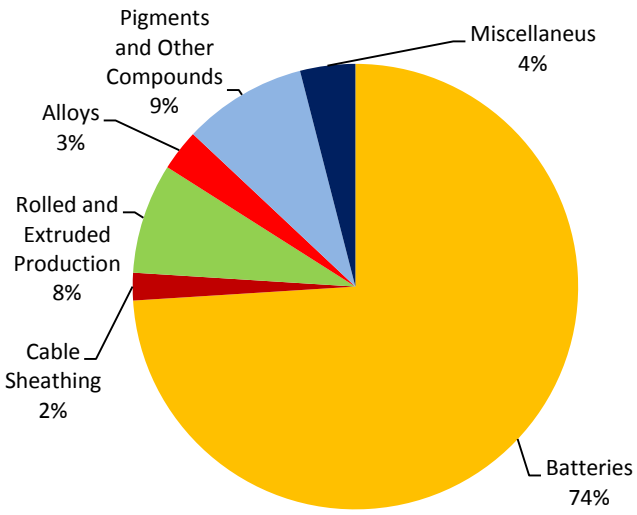
Cable Sheathing (2%): Lead is used for cable sheathing especially for electrical cables and telecom cables due to its corrosion resistance, water imperviousness and ductility properties. Lead is also used for sheathing of cables which are used in the petrochemical industry, under sea and underground high voltage cables. Though, aluminium or stainless steel sheaths can be used for underground cables, there is no substitute for under-sea cables, as stainless steel or aluminium do not have the same resistance to corrosion by salt water as lead. Similarly, lead exhibits corrosion resistance by oils and hence is used in underground cables by the petrochemical industry as well.

Chart 8: Apparent Consumption* of Refined Lead (KT)



Source: CARE Ratings

Chart 9: Domestic end-use pattern of Refined Lead



Source: Ministry Of Mines

Note: The apparent consumption of lead was calculated on the considering of refined lead production (primary+ secondary) and imports & exports of refined lead (unwrought).

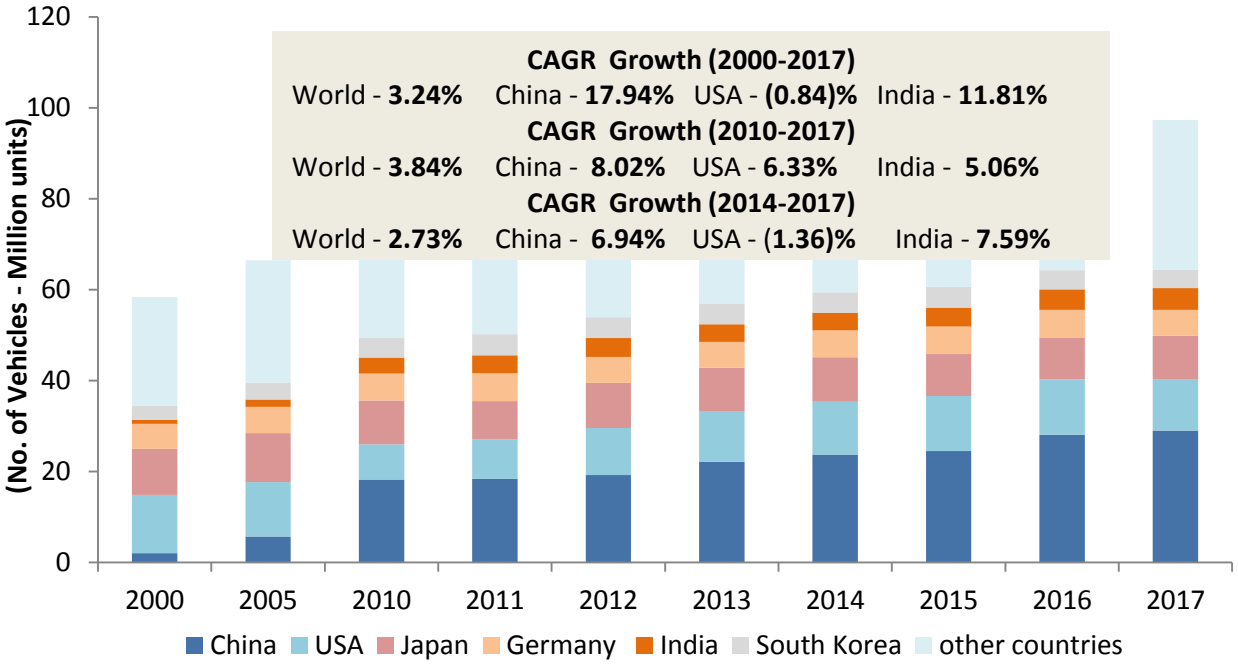
Refined lead consumption had grown steadily, at compounded annual growth rate of 8.9% during FY14-18 supported by the growth in the automotive segment. Use of lead in telecom and power back-up segment has also been an impetus to the increase in consumption of lead.

Industry Growth Drivers for Lead

- **Automobile Sector**: Auto demand is expected to improve on back of various initiatives taken by the government in the Union Budget 2019 for the agriculture and infrastructure sectors. Improved consumer sentiments post the

Seventh Pay Commission by the Centre as well as salary revisions by States and higher farm incomes supported by increased MSPs for certain kharif crops in expected to further increase rural disposable income expected to boost demand for passenger vehicles and two-wheelers especially motor cycles. Improvement in construction and mining activities and higher demand from e-commerce and FMCG industries post streamlining activities is expected to give a fillip to the commercial vehicles segment going forward. Hence more the growth in the automobile sector will lead to an increase in Lead acid battery further opening more business opportunities for the Lead acid battery manufacturers

Chart 10: Global Automobile production over the years



Source: OICA

Over the years India's growth story in automobile manufacturing has been robust and stable especially in the last 5 years as compared with its global peers.

- **Telecom Sector**: The increasing penetration of mobile phones in urban and rural areas will further result in more demand for telecom towers in rural areas.
- **Non-Conventional Power sector (Renewable energy)**: Increasing impetus and investments in the renewable energy domain which will result in increased demand for storage of energy (giving a rise for the manufacture of invertors and UPS).
- **Emerging Segments (E-bikes/EVs)**: The government has announced a series of support measures and incentives, as a result of which electric vehicles will see a steady growth in the coming years across the country.

Global Lead Market

Table 3: Global Lead Market (KT)

						Jan- May	
	2013	2014	2015	2016	2017	2017	2018
Mine Production	5,089	4,946	4,850	4,679	4,703	1,923	1,983
Metal Production*	11,225	11,023	10,959	11,158	11,451	4,753	4,829
Metal Usage	11,213	10,995	10,941	11,126	11,594	4,806	4,872

Source: ILZSG

Note: Metal Production* also includes secondary production

According to US Geological Survey (USGS) and ILZSG during CY17, the global mine production of lead amounted to 4,703 KT, of which China (2,400 KT), followed by Australia (313 KT) accounted for 51% and 9.6% of the production respectively. Other nations which contributed to the global mine production of lead were USA (6.7%), Peru (6.4%), Russia (5.3%), and Mexico (4.9%). India accounted for 3.2% of the global mine production during CY17.

In CY16 Australian lead mine output had declined by 32.6% which further declined by 22.2% during CY17. In the United States output fell by 10.4% and in China by 0.9%. Despite these reductions there was a more than balanced rise in the mine output from Bolivia, India, Kazakhstan and Turkey, which lead to an overall rise in global lead mine output by 0.5%.

Australia is the leading storehouse of lead reserves with 35,000 KT followed by China with 17,000 KT. India ranks 7th and is endowed with 2,200 KT of lead reserves.

Global refined lead production in CY17 increased by 2.6% to 11,451 KT, and metal consumption increased by 4.2% to 11,594 KT, resulting in a production to consumption deficit of about 143 KT of refined lead. There was an increase in production of refined lead in Europe, Canada, China, India and Kazakhstan while the production was significantly lower in the United States, Australia and the Republic of Korea.

The output of refined lead metal from secondary (recycled) production accounted for 59.8% of global output during CY17 compared with 58.5% during CY16. In Western Europe, the share of recycled lead is almost 60% of the refined lead production whereas in the United States the share of recycled lead is accounts for 70% of the refined lead production.

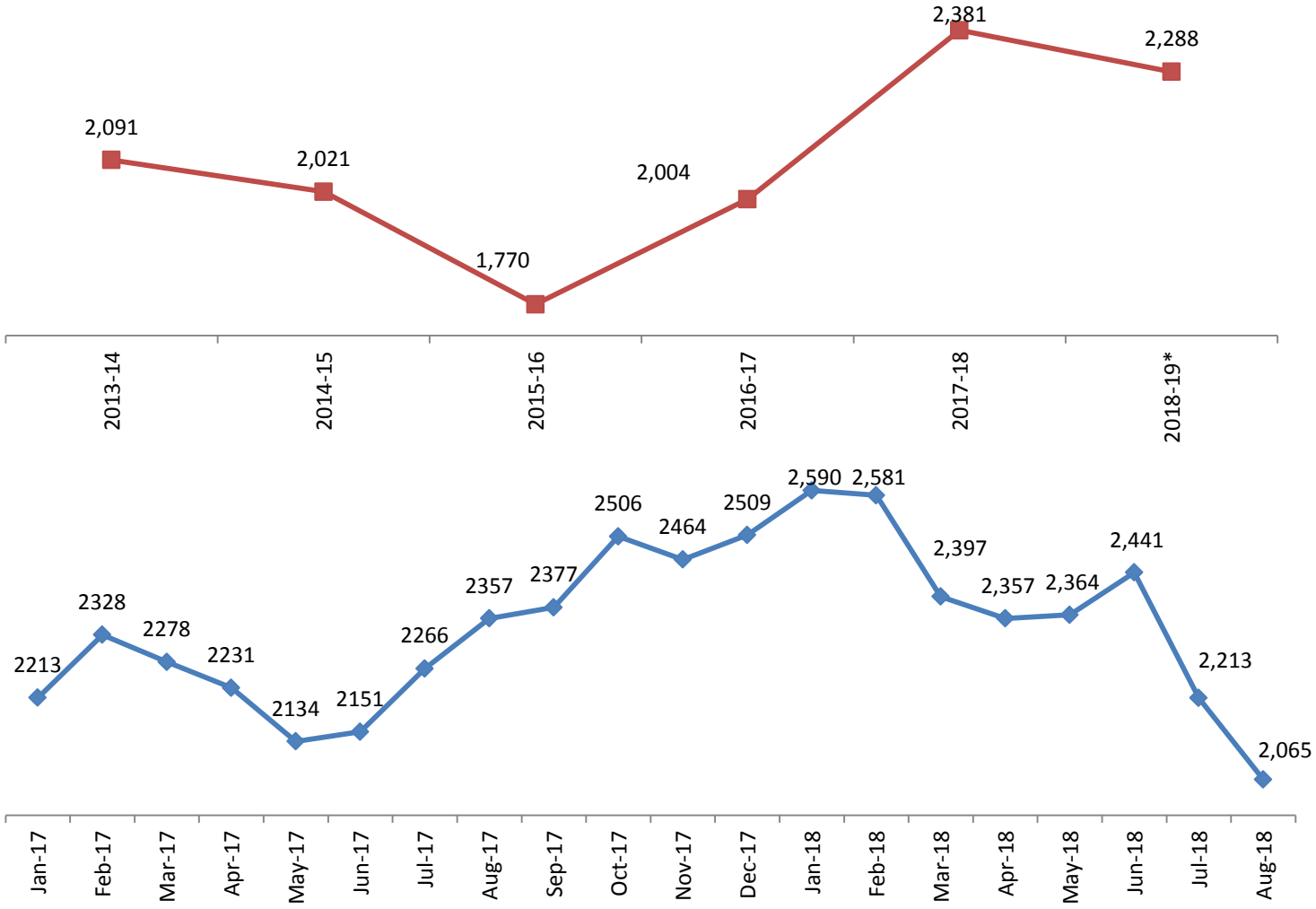
The increase in overall global usage was influenced by a 3.1% rise in demand from China. Refined lead usage also increased in Japan, the Republic of Korea and the United States. In the European region, demand was 3.5% higher due to the increase in usage in Germany, Greece, Italy, Poland and the UK

Lead demand in the global markets is driven by its usage in batteries (80%), rolled and extruded products (6%), pigments and compounds (5%), ammunition (3%), alloys (2%), cable sheathing (1%) and miscellaneous other applications (3%).

Price Movements of Lead

Lead prices are influenced by the global economic conditions and the geopolitical conditions of the major producing countries & major utilizing countries. Mine and metal demand-supply dynamics, inventory levels and currency fluctuations also play into determining lead prices.

Chart 11: Trend in Price movements of Lead in the Global (USD/tonne)



Source: LME, CMIE

Note 2018-19* denotes the April-August period

Global lead prices had started declining FY15 onwards due to the slowdown in the Chinese economy. China being the number one producer and consumer of refined lead has a direct bearing on lead prices. The Chinese economy witnessed a slowdown during the years 2013 to 2015 due to the change from an investment driven economy to a consumer driven economy, which lead to the fall of all the base metals prices, lead included. Slowdown in the European economy was also responsible in supressing the prices of lead.

FY17 there was a pickup in Chinese demand due to stimulus measures, adopted by the Chinese economy, but during FY18 lead prices reached an all- time high (as compared with the annual prices prevailing since the past 5 years) due to the temporary halt in mining operations of major lead-zinc mines in Australia (Century Mine) and due to shutdown of China's targeted polluting industries such as mining and smelting as part of China's environmental clampdown to curbing pollution (operation blue sky).

Price of lead has been declining since the start of FY19. The global on-going trade wars, appreciation of the dollar and fears of a global slowdown have been dragging the prices of lead to an all-time 19 month low.

CARE Ratings Outlook

The lead industry in India is poised to perform well on the back of good demand prospects. India is Asia's largest lead consuming market after China where growth is largely dependent on the demand from the automotive sector and the industrial sector. India has the second largest number of mobile subscribers in the world after China, and is currently ranked 5th in global vehicle production. India's growing telecom industry and on-going infrastructure development has boosted the industrial battery demand, as is the case with an expanding photovoltaic market which is planned to reach 227 GW by 2022.

Lead will continue witnessing a robust demand, driven mainly by the automotive and industrial battery segments. India's automobile market is expanding fast and is expected to play a significant role in leading demand growth going forward. The automobile sector, the telecom sector and the power sector (solar, wind and invertors) will be the main demand drivers for lead usage. Lead usage to increase by 16.6% reaching ***533 KT by the end of FY19****.*

- *Stable automobile manufacturing growth, implementation of smart grid projects, deployment of vehicle-charging infrastructure, popularity of the usage of hybrid and electric vehicles and growing installation of renewable energy systems will support the lead acid battery growth.*
- *Use of lead as automotive batteries will not be capped with the roll out of electric vehicles (EV). All hybrid cars and EVs use lead-acid for auxiliary power. Considering cost and various technical parameters, lead acid batteries will continue to be preferred energy storage device and their demand is not expected to fall.*

Global prices of lead to hover around ***USD 2,000/tonne – USD 2100/tonne*** *due to the on-going tariff wars and instability in the world economy. We can expect this price level till mid-November. Once the winter cuts are announced by China, lead prices are poised to rise depending on the severity of the shutdown of the operations. We can expect prices of lead to be around* ***USD 2,250/tonne- USD 2,400/tonne*** *during the winter months.*

Appendix

Advantages of the Usage of Lead Acid Batteries

Lead acid batteries are economical to manufacture and need relatively low technology equipment. They have the ability to overcome its weakness (low energy density) with its cost competitiveness, safety, availability of raw materials and recyclability.

Substitutes

Lead can be substituted in battery applications. Batteries of nickel-zinc, zinc chloride, lithium sulphide or nickel hydride can be used in the place of lead. Lithium and nickel have a better energy density (energy-to-weight ratio) as compared to lead and is usually preferred as automotive batteries when it comes to electric vehicles.

In cable operations, polyethylene and other materials work as substitutes. In electronic industry, there has been a move towards lead-free solders with varying compositions of tin, bismuth, silver and copper. Tin has replaced lead in solder for potable water systems. Steel and zinc are common substitutes for lead in wheel weights.

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