

Zinc Industry: The unsung metal of the economy

31st October, 2018 | Industry Research

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Overview

Zinc is a silvery bluish grey metal with a comparatively low melting and boiling point of 420C and 907C respectively. Though zinc is brittle at ordinary temperature, it is malleable at 100C, and can be readily rolled. Normally found in brittle form, when heated it gets converted into a malleable metal.

Zinc is the fourth most widely used metal globally after steel, aluminium and copper and the third most-used non-ferrous metal.

The most common zinc mineral is sphalerite also known as zinc blende. This mineral crystallises from the hydrothermal solution as pure zinc sulphide and is found in almost all currently mined zinc deposits. Zinc is often mined in association with lead, copper, silver and other metals.

Zinc's effectiveness in protecting steel against corrosion by galvanising is well recognised, while the ability to die cast complicated components makes zinc indispensable in a multitude of industry and household products. It also has important markets in the brass and construction industries and in chemicals and constitutes an essential nutritional element.

The total metal content in reserves/ resources of zinc is estimated to be 36 million tonnes. Rajasthan is endowed with the largest reserves/ resources of lead-zinc ore amounting to 670 million tonnes (89.44%).

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Production

Primary Zinc

Hindustan Zinc (HZL) is the only integrated zinc company engaged in mining and smelting operations. Edayar Zinc Limited (erstwhile Binani Zinc Limited) used to produce zinc from imported concentrates. However, currently the plant is not operational.

At present, HZL has 5 prominent mining regions, all in Rajasthan; (1) Rampura- Agucha mine (Bhilwara district) which is also the second largest zinc mine in the world (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 four distinct zinc smelters engaged in the process of refining zinc, located in close proximity of the mines.

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

Location	Process	Technology	Capacity
Chanderiya	Hydrometallurgy	Outokumpu roast-leach-electro winning	430
Dariba	Hydrometallurgy	Outokumpu roast-leach-electro winning	220
Debari	Hydrometallurgy	Outokumpu roast-leach-electro winning	88
Chanderiya	Pyrometallurgy	Imperial smelting	105
			843

Source: Hindustan Zinc Annual Report 2017-18

*KT: kilo tonnes/ thousand tonnes

Chart 1: Mining of Zinc Concentrate (KT)

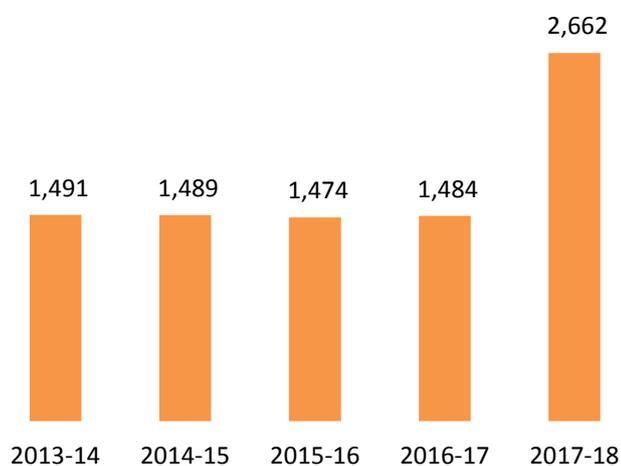
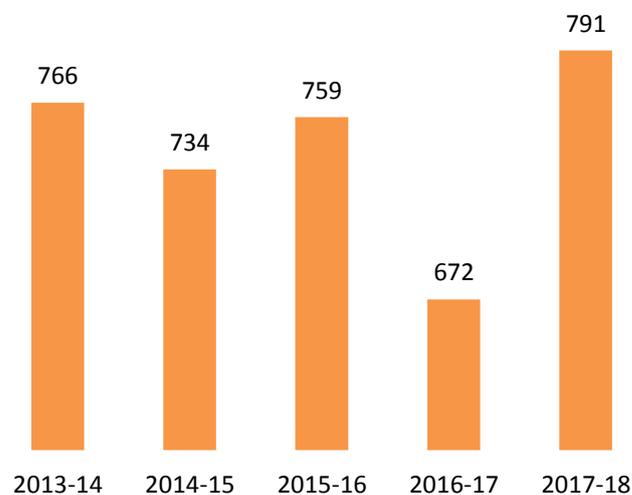


Chart 2: Production of Zinc Ingot (primary) (KT)



Source: Ministry of Mines, Vedanta and Hindustan Zinc Company Filings

Mining of zinc concentrates has grown at a CAGR of 15.6% during FY14-18. The industry adopted underground mining during FY14, which was a paradigm shift from opencast mining, resulting in a transitional period for the industry. Production of the ores and concentrates has been the highest during FY18 (79.4% increase y-o-y) due to the ramp up of the underground mines which resulted in an increase in ore production. Mining of zinc will not be done via open cast operations from FY19 onwards as HZL has now fully transitioned into underground mining by converting and commissioning all its open cast mines into underground mines.

The concentrates then undergoes the pyrometallurgy or hydrometallurgy process to get converted into zinc ingots which is used by the end users. Production of primary zinc ingots has grown at a CAGR of 0.8% during FY14-18. Production fell by 4.2% during FY15 due to the permanent shutdown of operations of the 38KT smelter operated by Edayar Zinc. During FY17, the zinc ingot production was the lowest on account of lower availability of zinc concentrates during the first half of the year. Production has been the highest during FY18. The increase was driven by uniform availability of zinc concentrates during the year and debottlenecking of the smelter capacity.

Table 2: Zinc Ingot Production (primary) during 2018-19 (KT)

	H1- FY18	H1- FY19	% Change
Zinc ingots	386	334	-13.4%

Source: Ministry of Mines

Zinc ingot production during FY19 has decreased by 15.2% y-o-y on account of lower availability of zinc concentrates. Zinc concentrates production was lower due to the closure of the open-cast mining. In the remaining part of the fiscal year production of zinc concentrates from the underground mines is expected to pick up.

Secondary Zinc

The zinc once used for galvanising as well as for brass making and manufacturing of oxides and chemicals is not recoverable. Hence, the quantum of zinc recycling is comparatively small as compared to lead recycling. A part of zinc can be recovered from pure zinc scrap in the form of sheet cutting, zinc roofings, old zinc anodes, zinc used in dry batteries, die castings and alloys containing zinc as a major constituent. Recovery of secondary zinc is economically superior as it results in lesser energy consumption, low capital cost, less environmental hazards and high metal contents. *However, most of the secondary producing units are in the unorganized sector for which concrete production and capacity data is not readily available.*

Trade Data

Chart 3: Exports and Imports of Zinc Ores and Concentrate (KT)

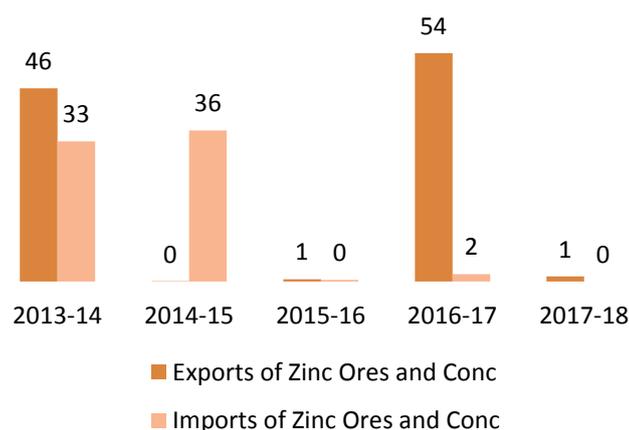
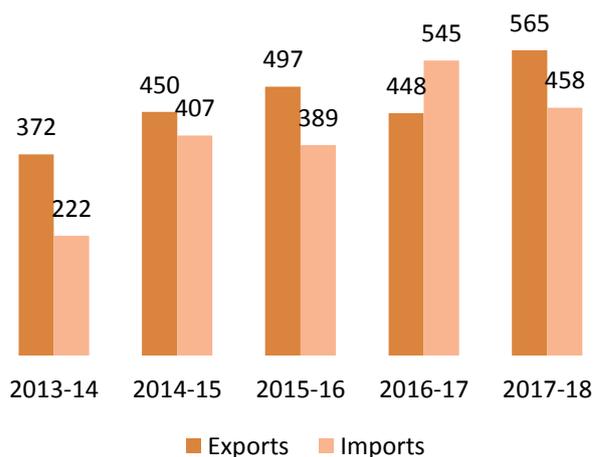


Chart 4: Exports and Imports of Zinc* (KT)



Source: Ministry of Commerce, Ministry of Mines

* Note: We have considered imports and export numbers of zinc and zinc articles and of unwrought zinc

Imports of zinc ore and concentrates have been nil post FY15 due to the permanent shutdown of operations of the 38KT smelter operated by Edayar Zinc. During FY18, exports were also almost negligible due to the increase in demand in the domestic markets. India exports zinc ores and concentrates primarily to China.

India has been a net exporter of refined zinc. There has been a 26% increase in zinc exports vis-à-vis to a 20.6% decline in imports y-o-y during FY18.

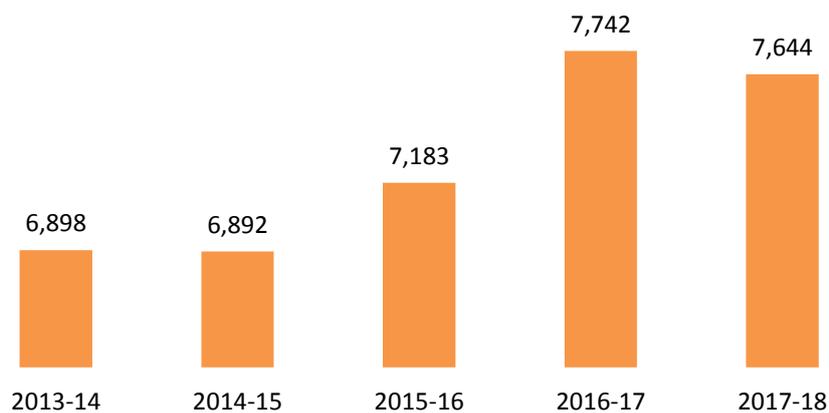
Unwrought zinc is imported from South Korea, UAE, Australia, Spain and Taiwan and exported to China, South Korea, Malaysia, Taiwan, Nepal, UAE, USA, Vietnam, Saudi Arabia, Montenegro and Singapore.

Application/Usage of Zinc

Zinc is primarily used in galvanizing of steel products due to its anti-corrosion properties in the atmosphere, in hard/fresh/salt water, as well as with many natural and synthetic substances. It can also be mixed with various other metals of different properties due to its ability to work well with other metals. Zinc when combined with aluminium forms alloys to produce components of high utility. Brass (copper and zinc), bronze (copper, tin and zinc) and nickel silver (copper, nickel and zinc) are also products formed due to the malleable properties of zinc. Zinc metal sheets are used for roofs or facades, on counters, on bar tops. It is also used to make zinc die cast parts like door handles and lock and can also help in making an average automobile last longer by protecting the vehicles from rust.

Galvanising: The single largest use of zinc is for industrial purposes, with the galvanized industry (57%) making up the lion's share of zinc demand. Widely known as hot dip galvanizing, zinc provides protection from corrosion to steel articles. The galvanized coating is applied by dipping cleaned steel articles thoroughly into molten zinc, which are known as Galvanized Plain / Galvanized Corrugated steel (GP/GC) sheets. GP/GC sheets account for approximately 7%-8% of the domestic available for sale steel production.

Chart 5: Domestic Production of GP/GC sheets* (KT)



Source: CMIE

*Note: The above data of GP/GC sheets is of Production for Sale

Production of GP/GC sheets has grown at a CAGR of 2.6% during FY14-18. Galvanized steel is used extensively in building & construction, infrastructure, household appliances, automobiles, steel furniture, telecommunication, automobile, consumer goods and in other applications where zinc is needed to protect the steel surface.

Coatings: Other than its use for manufacturing GP/GC sheets galvanising steel, zinc can also be used as coatings, to reduce corrosion. It is widely used for painted and unpainted building panels and roofing and for higher temperature applications in vehicle powertrain and heat-reflective components. A pure zinc coating that is the standard continuous galvanized product typically used in building panels, steel framing, agricultural and automotive applications, as well as in numerous other functions. It has good surface finish and adhesion properties.

Die Cast alloys: Die casting is a manufacturing process that can produce geometrically complex metal parts (usually non-ferrous metals) through the use of reusable molds, called dies. Zinc alloys occupy a unique place in die casting industry on account of their superior founding properties and are an ideal material for die casting. These alloys are extensively used in hardware, electrical equipment, automotive and electronic components. Owing to its relatively low melting point, zinc can be easily alloyed with other metals to form a number of alloys such as brass (copper and zinc), bronze (copper, tin and zinc) and nickel silver (copper, nickel and zinc). These alloys find applications in a number of industries.

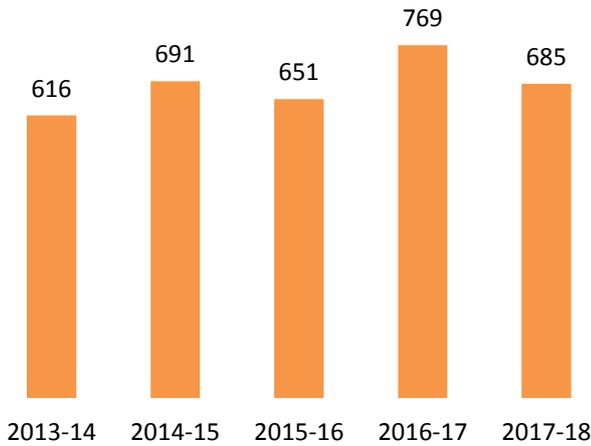
Oxides and Chemicals: Zinc oxide is a white pigment which is one of most commonly used compound in a variety of industries (paints & pigments, rubber products, cosmetics, pharmaceuticals, floor coverings, plastics, printing inks, soap, textiles, electrical equipment, and other products). It is used for the vulcanisation of rubber which is critical for in the manufacturing of tires. Ceramics is another major market where zinc oxide is used for the production of frits, artistic glasses and enamels. In the paints industry, it acts as a pigment to improve the light-fastness and hardness of the coating and also imparts corrosion protection properties to the paint which acts as an anti-fouling agent. A special grade of zinc oxide has long been used in photocopiers as well.

Zinc in the form of chemicals is used to manufacture fertilizers and mineral supplements. Zinc sulfate and zinc chloride, can promote plant cell respiration and carbohydrate metabolism whereas zinc is used in the manufacturing of supplements as it is vital for a healthy immune system, correctly synthesizing DNA, promoting healthy growth during childhood, and healing wounds. Zinc in medicines- Improves eyesight, prevents respiratory infections, treats ache, common cold, and age related chronic diseases, and also has healing properties.

Extruded Products: Zinc can be produced as sheet, strip, plate, rod and wire, and in many compositions and alloys, depending on the requirements of the end product. Today, zinc sheet is typically produced by continuous casting/rolling. Zinc sheets are used extensively in the building industry for roofing, gutters, railings, flashing and weathering applications. Rolled, pure zinc sheets are widely used in ship-building industry to protect the parts of the hull exposed to harsh corrosive conditions. Rolled zinc is also used in graphic art to make plates and blocks, and coinage.

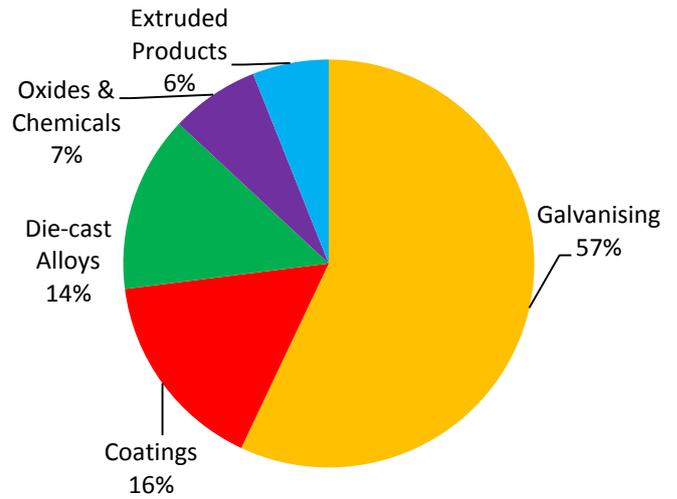
Dry Batteries: Organized dry cell battery market accounts for more than 90% of the Indian market and zinc-carbon and zinc-chloride batteries are often used for household items such as electronics, flashlights, and toys. These batteries have a long shelf-life which allows them to retain a charge for lengthy durations even when left unused. These batteries have an anode of zinc, a cathode of manganese dioxide, and a slightly acidic electrolyte. Zinc carbon batteries work due to an electrochemical reaction within the cell.

Chart 6: Apparent Consumption* of Primary Zinc (KT)



Source: CARE Ratings

Chart 7: Domestic end-use pattern of Zinc ingots



Source: Ministry Of Mines

*Note: The apparent consumption of zinc was calculated by considering zinc ingot production (primary) and imports & exports of zinc.

Refined zinc consumption had grown steadily, at a compounded annual growth rate of 2.7% during FY14-18 supported by the growth in the steel industry. Use of zinc in healthcare, automobiles, telecom and architectural applications (roofings) has also been an impetus to the increase in consumption of zinc.

Growth drivers for Zinc

- Infrastructure:** The Union Budget of FY19 has announced an all-time high provision towards infrastructure development of Rs 5.97 lakh crore. Allocation towards roads, highways and railways has increased and accounts for 38% of the total capital expenditure. The investments deployed for the development of smart cities, improved road & rail connectivity by building highways, bridges and dedicated freight and superfast rail corridors have huge potential to spur the usage of galvanised steel in all the above sectors. The developments of smart cities is also to encourage the usage of galvanized guard rails/ crash barriers, street lamp poles, high mast lighting columns, road signage etc. use of Galvanised steel is also used in the ship building industry because of its anti-corrosive properties.
- Housing and Construction:** Given the stable operations relating to housing and construction; there will be a rise in demand for architectural applications namely for roofing, cladding, light steel framing, building studs, false ceilings, sandwich panels, ducting and HVAC applications (Heating, Ventilation & Air Conditioning). This would lead to increased use of steel in all the above segments and consequently result in enhanced demand for zinc in order to protect steel from corrosion.
- Healthcare:** The domestic demand for formulations is expected to grow steadily backed by growth in presence of chronic diseases, increasing per capita income, improvement in access to healthcare facilities and penetration of health insurance. The various initiatives taken up by the government of India and NGOs for the consumption of zinc tablets for the avoidance of diarrhoea related deaths is to increase the usage of zinc as a chemical compound.

- Consumer Durables:** Easier access to credit, improving standard of living, changing lifestyles and higher disposable incomes are to augment the consumption of consumer durables going forward.
Use of galvanised steel for the production of refrigerators, deep freezers, washing machines and air coolers will increase the use of zinc.
- Renewables:** An increase in investments in the renewable energy domain has given rise to solar and wind energy generation capacity in the country.
The support structures use for solar panels and wind mill towers are usually galvanized which will result in increased demand for zinc coatings.
- Automobiles:** Auto demand is expected to improve on back of various initiatives taken by the government during the announcement of the FY19 Union Budget 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 the growth in the automobile sector will be an added impetus to the increase in usage of zinc for galvanising of steel which is used in the manufacture of automobile body panels and auto internal components. As per a proposal made by the road transport and highways ministry, it is recommended to make it mandatory for automobile manufacturers to use 70% galvanised steel for car body panels. As of now automobile manufacturers use only 30% galvanised steel for vehicles to be sold in the domestic market, but the percentage rises to 70% for the same model if it is to be exported. The global average usage of galvanised steel in automobiles is 50%.
- Dry Cell Batteries:** The growing purchasing power, rising influence of the social media, increasing use of electronic gadgets using portable batteries and the advent of a number of battery-operated gadgets like remotes, toys, clocks and torches is to drive the Indian dry cell battery market, where zinc carbon battery segment is virtually dominating the entire market with 97% share.
- Emerging Segments (Zinc Batteries):** Zinc is finding its usage in the manufacturing of batteries, (which can be used as an automotive battery and for powering renewable projects) becoming an innovative energy storage system solution and an alternative to lithium-ion batteries which have limited reserves and has been the focus for large-scale power storage and electric vehicles.

Global Zinc Market

Table 3: Global Zinc Market (KT)

	2013	2014	2015	2016	2017	Jan- Aug	
						2017	2018
Mine Production	13,036	13,471	13,681	12,802	12,978	8,175	8,341
Metal Production	12,980	13,398	13,812	13,547	13,219	8,629	8,687
Metal Usage	13,151	13,675	13,643	13,675	13,687	8,990	8,976

Source: ILZSG

According to US Geological Survey (USGS) and ILZSG during CY17, the global mine production of zinc amounted to 12,978 KT, of which China followed by Peru accounted for 39% and 11% of the production respectively. Other nations which contributed to the global mine production of lead were India (10%), Australia (8%), USA (6%), Mexico (5%), Bolivia (4%), Kazakhstan (3%) and Sweden (2%).

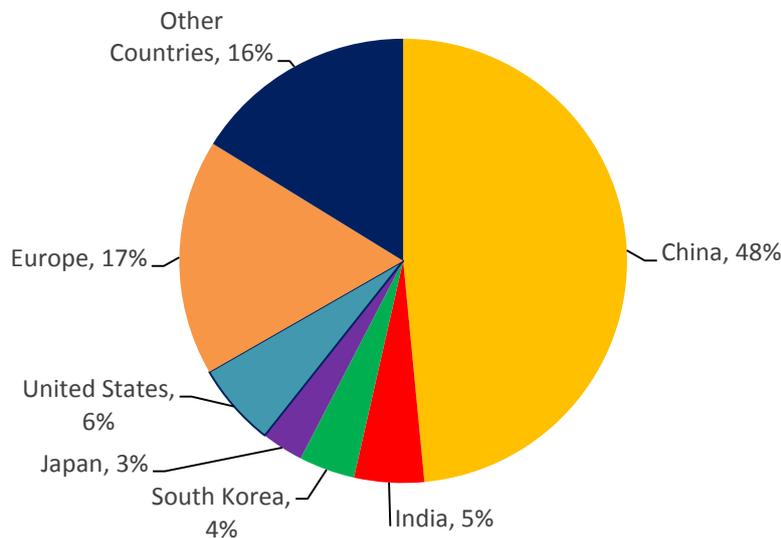
Australia is the leading storehouse of zinc reserves with 64,000 KT (28% of the world reserves) followed by China with 41,000 KT (18% of the world reserves). India ranks 6th and is endowed with 11,000 KT of zinc reserves (5% of the world reserves).

Global zinc mine production in CY17 was estimated to be 12,978 KT, a 1.4% increase as compared with the levels during CY16. Increase in global zinc mine production can be attributed to the completion and complete transformation of the Rampura Agucha mines into an underground mine. Increase in the Bisha Mine in Eritrea and Antamina Mine in Peru also added to the global mine production increase.

The zinc metal market continued the deficit during CY17 as well, with the consumption of zinc exceeding production. Global refined zinc production in CY17 was 13,219 KT, and consumption was recorded at 13,687 KT resulting in a production-to-consumption deficit of 468 KT of refined zinc.

Zinc metal market still continues to be in a deficit during CY18 with the consumption of zinc exceeding production by 289 KT even as the mine production has increased by 2% in the current calendar year. Mine production has increased on account of increase in mining activities from the Australian zinc mines; MMG’s Dugald River mine and from the commissioning of the New Century Resource’s and Hellyer tailings projects.

Chart 7: Regional global refined Zinc consumption patterns



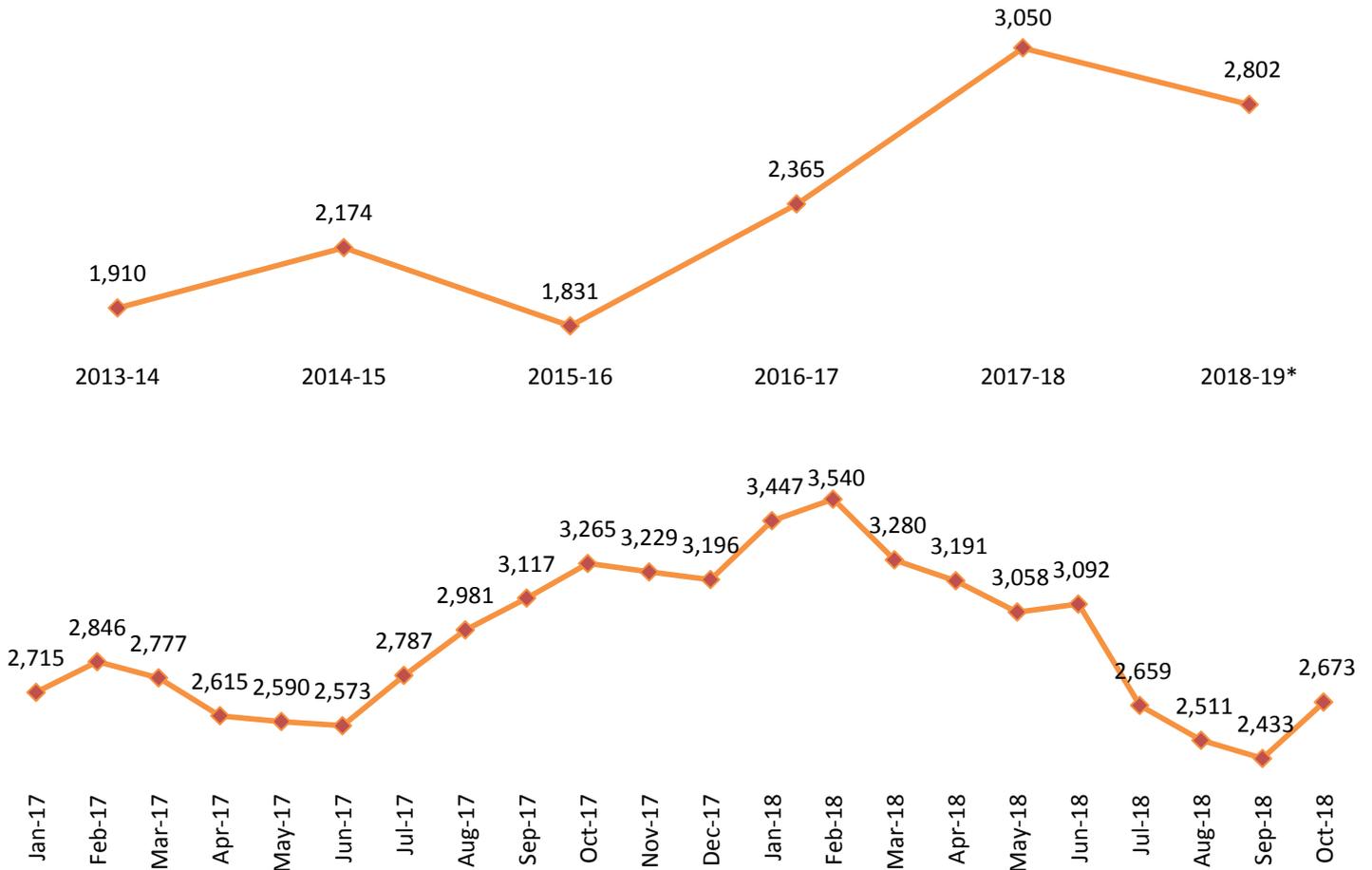
Source: ILZSG

Zinc demand in the global markets is driven by its usage in galvanizing steel and iron (50%), alloys (17%), brass and bronze (17%), semi- manufacturers (6%), chemicals (6%) and miscellaneous other applications (4%).

Price Movements of Zinc

Zinc 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 zinc prices. Zinc prices are also influenced by the steel and iron-ore industry as 50% of zinc end use consumption is used for galvanising steel.

Chart 8: Trend in Price movements of Zinc in Global markets (USD/tonne)



Source: LME, CMIE

Note 2018-2019* refers to April- October period & October prices are an average till 24th October, 2018

Global zinc prices had declined by 15.8% during FY16 due to the slowdown in the Chinese economy. China accounts for almost 48% of the world consumption and has a direct bearing on zinc prices. The Chinese economy experienced 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, zinc included. Slowdown in the European economy was also responsible in supressing the prices of zinc.

FY17 there was a pickup in Chinese demand due to stimulus measures, adopted by the Chinese economy, but during FY18 zinc prices reached an all- time high of USD 3050/tonne (as compared with the annual prices prevailing since the past 5 years) on the back of supply side concerns, declining warehouse stocks and a positive Chinese demand outlook. Century Mine (one of the largest zinc mine of the world which contributes to around ~4% of the world zinc ores and concentrates

output) faced an issue of dwindling resources coupled with the shutdown of China's targeted polluting mining and smelting industries as a part of China's environmental clampdown to curbing pollution (operation blue sky) added onto the woes of the supply side concern which lead to an increase of global zinc prices.

Prices of zinc have 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 zinc to a 2 year low. Concerns of a slowdown in the steel industry because of the imposition of tariffs (25%) on steel imports by the United States government is also impacting zinc price.

CARE Ratings Outlook

The zinc industry is poised to perform well in line with the stable demand outlook for the Indian steel industry. Zinc consumption in India is 0.5 kg/capita as compared to China's consumption of around 5.0 kg/capita and the average global consumption- 1.9 kg/capita. The lower per capita consumption of zinc in India, coupled with government initiatives offers a favourable growth potential for the industry. Growth in the infrastructure, cosmetics, medicines, paints, rubber, surgical tools, plastics, textiles, soaps and batteries has stimulated the growth of the zinc industry over time.

In terms of supply, zinc mine production is to pick up in H2FY19, given the ramp up and transition of the open cast mining to underground mining of the concentrates. Refined zinc production to be in line with the zinc concentrate availability.

Zinc demand is likely to increase by 5.5% to 722 KT by the end of FY19 (consumption was 685 KT by the end of FY18). Growth in zinc consumption is fundamentally to be supported by the issues of rust and corrosion in steel which is to drive the consumption of zinc. (in accordance to the growth in the steel industry)

- *Government initiatives such as 'Smart Cities', modernisation of railways, and the construction of highways is expected to boost the infrastructure industry which uses galvanised steel for durability and endurance.*
- *Additionally, the shift towards the use of galvanized materials and growth in the automobiles, housing construction, consumer durables and machinery industry is likely to pave the way for increased zinc consumption in India. While galvanized steel sheets are primarily used in house roofing & under construction sites (for fencing and other purposes), the galvanized steel structural and galvanized fasteners are to also find application in power transmission, railway electrification and substations construction.*

Global zinc prices have declined from their recent peaks, primarily on account of the uncertainty in global steel demand on the back of ongoing tariff wars. Furthermore, appreciation of the dollar index, vis-à-vis other major currencies of the world has also resulted into downward pressure on the global zinc prices.

- *Going forward, we expect global **prices of zinc are to recover** in the coming months and hover around **USD 2,700/tonne –USD2,750/tonne levels**. Once the winter cuts are announced by China, zinc prices are poised to rise depending on the severity of the shutdown as the authorities are expected to maintain their strict stance. China's zinc smelters have faced environmental pressures due to the residues produced by the smelting process which are now being classified as hazardous waste by the government and it will be subjected to an environmental tax.*
- *Deficit in the global zinc metal market is also likely to support the global zinc prices.*

Appendix

Advantages of Galvanising

Zinc-coated steel resists decay, corrosion, termites, fire, wind, floods and earthquakes better than any other construction material. Galvanized steel lasts for many years in a non-aggressive environment, and is more effective in protecting steel. The cost-benefit ratio represents outstanding value for the consumer by using galvanising products.

The use of galvanized sheet for automotive body panels allows today's automakers to guarantee up to 12 years' corrosion resistance, while adding only a fraction of a percent to the cost of the vehicle. The same applies to building panels – galvanized coil coated products are now available with up to 50 year performance warranties. The improved performance and added value generated by zinc coated steel sheet is vastly superior to the small additional production cost. Durability, aesthetics, long-term stability of surface appearance and low maintenance are all significant advantages for the final user.

In the construction industry, galvanized steel decking combined with high-speed concrete pouring allows faster construction, thereby lowering construction costs.

In the consumer durables segment, commercial and industrial washing machines can operate every day around the clock thanks to galvanized steel sheet casings that are resistant to soaps, bleaches and chemical solutions.

Substitutes

Many elements can be used as substitutes in the place of zinc but aluminium in particular is a cheaper alternative and can replace zinc in a variety of zinc end user operations particularly in galvanizing, die cast alloys applications and it's usage in chemicals & pigments.

- **Aluminium and plastics** can substitute for zinc in *galvanizing* steel particularly used in automobiles;
- **Ceramic and plastic coatings, electroplated cadmium & aluminium and special steel** compete in some *galvanising applications*.
- **Aluminium alloys, cadmium, paint, and plastic coatings** replace *zinc coatings* in other applications.
- **Aluminium- and magnesium-base alloys** are major competitors for *zinc-base die-casting alloys*.
- **Aluminium, magnesium and titanium** can replace zinc in *chemicals and pigments*.

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